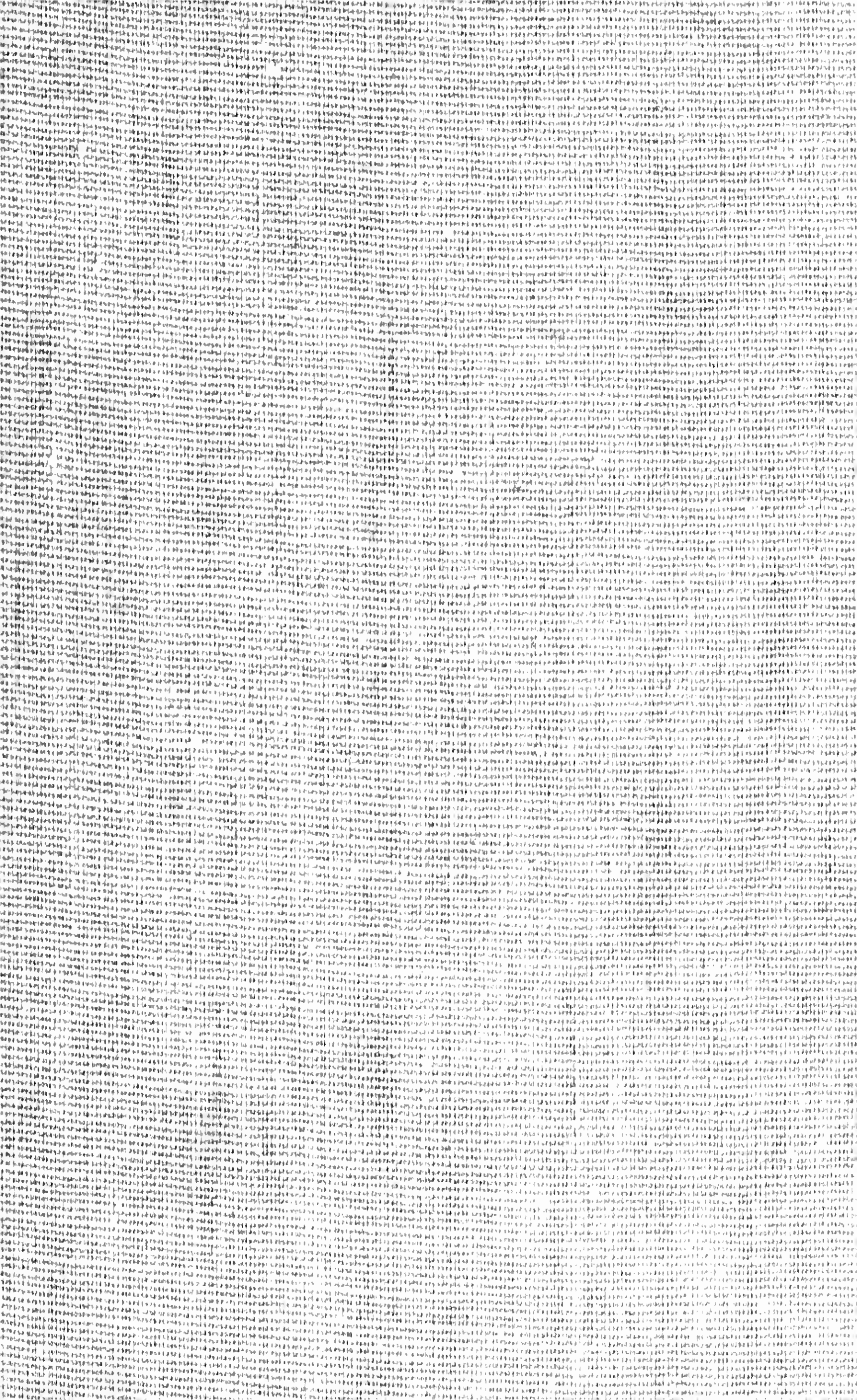

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1893

VOL. XXVI.

(Ninth of New Series)

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

BY

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

Director

Issued May, 1894

WELLINGTON

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CORRIGENDA.

Page 397, line 23: *for* Island Bay *read* Lyall Bay.
Art. LIII.: throughout, *for* Nova Auriga *read* Nova Aurigæ.

CONTENTS.

TRANSACTIONS.

I.—Zoology.

IV.—MISCELLANEOUS.

NEW ZEALAND INSTITUTE.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

* See also pages 687–688.

AUCKLAND INSTITUTE.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OTAGO INSTITUTE.

WESTLAND INSTITUTE.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

NELSON PHILOSOPHICAL SOCIETY.

APPENDIX.

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 by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the 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 in 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-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in 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 by-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 especially 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 by-laws to be framed by the Board.

Section III.

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,—

1. 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.
2. 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.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd Oct., 1868.
Otago Institute	18th Oct., 1869.
Westland Institute	21st Dec., 1874.
Hawke's Bay Philosophical Institute	31st Mar., 1875.
Southland Institute	21st July, 1880.
Nelson Philosophical Society	20th Dec., 1883.

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1894.—*President*—Major-General Schaw, C.B., R.E.; *Vice-presidents*—S. Percy Smith, F.R.G.S., C. Hulke, F.C.S.; *Council*—Sir James Hector, K.C.M.G., F.R.S., E. Tregear, F.R.G.S., G. Denton, R. C. Harding, W. T. L. Travers, F.L.S., W. M. Maskell, G. V. Hudson, F.E.S.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

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 1894.—*President*—J. H. Upton; *Vice-president*—Professor F. D. Brown, F.C.S.; *Council*—Rev. J. Bates, W. Berry, C. Cooper, G. Mueller, E. A. Mackechnie, T. Peacock, Rev. A. G. Purchas, M.R.C.S.E., E. Roberton, M.D., T. H. Smith, J. Stewart, C.E., E. Withy; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

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 subscription 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 1894.—*President*—R. M. Laing, M.A., B.Sc.; *Vice-presidents*—Professor A. M. Bickerton, F.C.S., Dr. W. Thomas; *Secretary*—R. Speight, B.Sc.; *Treasurer*—J. T. Meeson, B.A.; *Council*—S. Page, W. H. Symes, M.D., H. R. Webb, F.R.M.S., T. W. N. Beckett, F.L.S., F. C. B. Bishop, W. G. Pye, M.A.

Extracts from the Rules of the Philosophical Institute of Canterbury.

8. 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 1st November in each year.

The Institute may also admit associates, who shall contribute five shillings annually to the funds of the Institute, and shall have all the privileges of members, except that they shall not have the power to vote, or be entitled to the annual volume of the Transactions.

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

15. The ordinary meetings of the Institute shall be held on the first Wednesday in each month during the months of May to October, both inclusive.

OTAGO INSTITUTE.

Office-bearers for 1894.—*President*—E. W. Melland; *Vice-presidents*—Dr. T. M. Hocken, C. W. Adams; *Treasurer*—Professor F. B. de M. Gibbons; *Secretary*—A. Hamilton; *Auditor*—D. Brent; *Council*—Rev. Dr. Belcher, Professor J. H. Scott, M.D., T. J. Parker, D.Sc., F.R.S., G. M. Thomson, F.L.S., F. R. Chapman, Dr. W. Brown, C. Chilton, D.Sc.

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, and 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 1894.—*President*—H. L. Michel; *Vice-president*—W. C. Fendall; *Hon. Treasurer*—A. H. King; *Trustees*—Messrs. Barron, Cresswell, Croft, J. Churches, W. L. Fowler, T. H. Gill, Dr. Macandrew, A. Mahan, Morton, R. Ross, R. W. Wade, and D. Macfarlane.

Extracts from the Rules of the Westland Institute.

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

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

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1894.—*President*—T. Humphries; *Vice-president*—J. W. Carlile, M.A.; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—G. White; *Auditor*—J. Crerar; *Council*—Miss Browning, J. H. Smith, J. W. Craig, H. Hill, B.A., F.G.S., H. H. Pinckney, B.A., J. Ringland.

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.

SOUTHLAND INSTITUTE.

OFFICE-BEARERS. — *Trustees* — Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1894. — *President* — The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. L. Boor; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. James Hudson; *Hon. Curator of the Museum*—R. I. Kingsley; *Hon. Custodian of the School of Mines*—Mr. Worley; *Council*—Dr. W. Mackie, J. W. Joynt, Messrs. J. Holloway, Kingsley, and Worley.

Extracts from the Rules of the Nelson Philosophical Society.

4. That members shall be elected by ballot.

6. That the annual subscription shall be one guinea.

7. That the sum of ten guineas may be paid in composition of the annual subscription.

16. That the meetings be held on the second Monday in every month.

23. The papers read before the Society shall be immediately delivered to the Secretary.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1893.

I.—ZOOLOGY.

Art. I.—*Contribution to the Osteology of the Aborigines of New Zealand and of the Chatham Islands.*

By John H. Scott, M.D., Professor of Anatomy in the University of Otago.

[*Read before the Otago Institute, 13th June and 14th November, 1893.*]

Plates I. and II.

In preparing this paper I have made use not only of the collection of bones in the anatomical museum of the University of Otago, but also of those in the Colonial Museum, Wellington, and the Canterbury Museum, Christchurch, and of such private collections in Dunedin as were, through the kindness of their owners, made available to me. To these gentlemen, and to Sir James Hector and Professor Hutton, I take this opportunity of expressing my great indebtedness.

Maori Crania.

As craniometry still suffers from variety of method, I preface my description of the crania examined by a statement of the measurements I have adopted. In the main I have followed the directions given by M. Paul Broca,* but in a few instances I have taken the measurements recommended by other anthropologists.

Maximum Length.—So that my results may be comparable with those of other observers, I have taken this in three different ways, measuring the greatest length from the

* "Instructions craniologiques et craniométriques," 1875.

ophryon, from the glabella, and from the nasion. In calculating the cephalic and vertical indices, I have, however, used only the second of the three, the glabello-occipital length, as recommended by M. Broca, Sir William Turner, and others.

Maximum Transverse Diameter.—This was taken as directed by Broca.

Glabello-iniac Length, Basi-bregmatic Height, Stephanic Diameter, Biauricular Diameter, Temporal Diameter, Minimum Frontal Diameter, Asterionic Diameter, Mastoid Height, Length and Breadth of Foramen Magnum.—These were all taken in accordance with Broca's directions.

Horizontal Circumference, with its Pre-auricular and Post-auricular Subdivisions.—In this also I have followed Broca, carrying the tape round the skull at the level of the ophryon in front, and the most distant occipital point behind. When I began this series of measurements I took a second horizontal circumference, from the glabella round the most distant part of the occipital bone; but, after an experience of about sixty skulls, I gave this up, owing to the irregularities introduced by the varying amount of projection of the external angular process of the frontal bone.

Nasio-opisthic Arc, with its Subdivisions—Vertical Transverse Arc, superior and inferior.—These were measured in the ordinary way between the points given by Broca. I found it impossible, however, to measure the inferior arc of the transverse vertical circumference at all accurately with a stiff broad tape, such as is used for the other curves, owing to the very irregular character of the undersurface of the skull. Broca recommends twisting the tape somewhat, so that it may pass between the styloid process and the spine of the sphenoid; but even with this precaution my results were very variable, and much in excess of the actual length of the curve. I found it easy, however, to take a satisfactory measurement with a piece of fine cord, and this was used accordingly.

Cranial Capacity.—In estimating the cranial capacity I have followed as closely as I could the directions given by Sir William Turner in his report on the crania collected by the "Challenger" expedition.* I was, however, unable to procure the two-litre graduated glass used by him, and in estimating the quantity of shot contained in each skull I used the litre and half-litre measures used by Broca. Each skull was measured at least twice.

Basi-alveolar Length.—Here I follow Professor Sir William Flower.† Unfortunately the central incisor region was fre-

* "'Challenger' Reports," part xxix.: Report on the Human Skeleton—the Crania. 1884.

† "Catalogue of the Museum of the Royal College of Surgeons of England," part i., 1879.

quently broken, or altered by absorption consequent on loss of teeth, and in many skulls a true alveolar point did not exist. But, while even moderate absorption of the alveolar arch in front materially shortens those vertical measurements of the face which have their lower end at the alveolar point, the distance between the basion and the centre of the alveolar arch is not altered to the same extent. I have therefore sometimes given the basi-alveolar length in skulls whose ophryo-alveolar, naso-alveolar, and spino-alveolar lengths I have omitted.

Facial Angle (*Ophryo-spino-auricular Angle*).—This is the angle made by the ophryo-spinal and auriculo-spinal lines. It was measured by means of the goniometer designed for the purpose by Professor Broca, and made by Mathieu, of Paris.

Projection of the Zygomatic Arches.—This is shown by the terms "phænozygous" and "cryptozygous," introduced by the late Mr. Busk. In estimating this feature the skull was placed on a Topinard's craniophore, with the condyles and alveolar point in one horizontal plane. If the zygomatic arches were visible to the observer's right eye placed at a distance of one metre vertically above the bregma, the skull was noted as Phænozygous. If they were invisible it was noted as Cryptozygous. In the tables the letters P and C are used to signify these conditions. When P alone is used, I mean that the arches, though visible, are not seen as free from the side of the skull. P + means that the interval between the arch and the skull can be seen from above.

Other Face-measurements.—These require but little explanation. They were all, excepting those of the palate, taken in strict accordance with Broca's directions. The *palate* was measured in the way proposed by Professor Flower,* and adopted by Sir William Turner. The length given is the distance between the alveolar point and a line drawn between the most posterior parts of the maxillary tuberosities. The breadth includes the alveolar arch, and is measured at the level of the second molar tooth.

Indices.—The following are the indices selected, with the formulæ by which they are calculated:—

$$\text{Cephalic index} \quad .. \quad .. \quad \frac{\text{Maximum transverse diameter} \times 100}{\text{Glabello-occipital length}}$$

$$\text{Vertical index} \quad .. \quad .. \quad \frac{\text{Basi-bregmatic height} \times 100}{\text{Glabello-occipital length}}$$

$$\text{Frontal index} \quad .. \quad .. \quad \frac{\text{Minimum frontal diameter} \times 100}{\text{Maximum transverse diameter}}$$

$$\text{Index of foramen magnum} \quad .. \quad \frac{\text{Width of foramen magnum} \times 100}{\text{Length of foramen magnum}}$$

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* "The Cranial Characters of the Natives of the Fiji Islands": Journal of the Anthropological Institute, 1880.

Orbital index	.. ..	$\frac{\text{Orbital height} \times 100}{\text{Orbital width}}$
Nasal index	.. ..	$\frac{\text{Width of anterior nares} \times 100}{\text{Nasio-spinal length}}$
Gnathic index	.. ..	$\frac{\text{Basi-alveolar length} \times 100}{\text{Basi-nasal length}}$
Palato-maxillary index	..	$\frac{\text{Palato-maxillary length} \times 100}{\text{Palato-maxillary breadth}}$.

In grouping the skulls according to their indices I have used the divisions as named and defined by Flower* and Turner†.

Dolichocephalic ..	Cephalic index	below 75.
Mesaticephalic ..	„	between 75 and 80, inclusive.
Brachycephalic ..	„	above 80.
Tapeinocephalic..	Vertical index	below 72.
Metriocephalic ..	„	between 72 and 77, inclusive.
Akrocephalic ..	„	above 77.
Microseme ..	Orbital index	below 84.
Mesoseme ..	„	between 84 and 89, inclusive.
Megaseme ..	„	above 89.
Leptorhine ..	Nasal index	below 48.
Mesorhine ..	„	between 48 and 53, inclusive.
Platyrhine ..	„	above 53.
Orthognathous ..	Gnathic index	below 98.
Mesognathous ..	„	between 98 and 103, inclusive.
Prognathous ..	„	above 103.
Dolichuranic ..	Palato-maxillary index	below 110.
Mesuranic ..	„	between 110 and 115, incl.
Brachyuranic ..	„	above 115.

The grouping of the skulls according to their cranial capacities is as follows:—

Microcephalic	.. Below 1,350c.c.
Mesocephalic	.. Between 1,350c.c. and 1,450c.c., inclusive.
Megacephalic	.. Above 1,450c.c.

I give in Tables I. and II. the measurements of eighty-three Maori skulls. Fifty are adult males, twenty-six are adult females, and seven are the skulls of children. Thirty-five of these are in the Canterbury Museum at Christchurch; twenty-nine are in the anatomical museum of the University of Otago; twelve are in the Colonial Museum at Wellington; while the remaining seven are in private collections.

The number of skulls of the Maori race already described by competent observers is sufficient to adequately establish the cranial characters of the race generally. I therefore did not undertake this series of measurements with

* "Catalogue of the Museum of the Royal College of Surgeons."
† "'Challenger' Reports": Human Crania.

the object of possibly slightly modifying our knowledge on some points, but rather with the idea of ascertaining the craniometric expression of the differences which exist between certain tribes, and whether there is within the tribes themselves much individual variation in any of the more important cranial features. We know the Maoris to be a mixed race, the result of the mingling of a Polynesian and a Melanesian strain. The crania already examined leave no room for doubt on this point. But such skulls were for the most part collected either singly or in small groups from a very wide area —the whole of New Zealand, practically. Few, therefore, come from any one tribe, and, though their evidence as to the race-type, and its variations in the people as a whole, is ample, they tell us but little as to the characters of the smaller groups or tribes. So far as I have been able to ascertain, there has been but one contribution of any importance to the tribal craniometry of the Maoris. Sir William Flower gives in the Catalogue of the Museum of the College of Surgeons the measurements of twenty skulls, nineteen of which are adult, from near Whangarei. As these were found together in one cave it is probable that they all belonged to one tribe. They show considerable variety in form, but are, on the whole, rather long and narrow. I shall frequently refer to them in what follows. A much smaller group of six skulls found in a cave on the Island of Kapiti, and now in the anatomical museum of the University of Edinburgh, is described by Sir William Turner in his "Challenger" report; and to these may be added the two from the same island brought Home by the "Astrolabe." Unfortunately two of the crania in Professor Turner's small series are not full grown; and the history of the island must make us careful of accepting as of one tribe, skulls collected at different times by different people.

With these objects in view, I have measured eighty-three skulls, forty-five of which belong to a single tribe. These last were all found in the South Island, in the Provinces of Otago and Canterbury. Though this is a very large area, it really supplies as satisfactory material for the study of variation within one tribe as can be got in New Zealand. A district of corresponding size in the North Island would yield individuals from several tribes, but in the South Island this is not so. In this Island, if we except the northern end, there is practically only one tribe, and skulls coming from widely-separated districts may therefore be made use of. To make this clear, I shall, following Mr. Stack's account,* show how the South Island was peopled. We have first a tradition of a

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* "Traditional History of the South Island Natives": Trans. N.Z. Inst., vol. x., 1877.

tribe called Waitaha crossing Cook Strait from the north. Little is known of these Waitaha, but they are supposed to have come originally from the Bay of Plenty, and to have made their way south through the centre of the North Island. They are said to have spread themselves over the whole of the South Island, peopling it densely. This migration is held to have occurred in the latter half of the fifteenth century, but all such dates are of course most uncertain. The Waitaha held undisturbed possession of the land for at least a hundred years, when, about 1577, another band of invaders crossed Cook Strait, and soon conquered and destroyed or enslaved the peaceful Waitaha. These invaders, the Ngatimamoe, were an offshoot of the Ngatikahungunu, a powerful East Coast tribe, whose descendants still occupy the whole of the eastern half of the North Island to the south of Poverty Bay. After another more or less peaceful hundred years, the Ngatimamoe were, in their turn, called upon to defend themselves from the Ngaitahu, a second offshoot of this same Ngatikahungunu Tribe. The history of the Waitaha conquest was repeated, and the Ngatimamoe were absorbed by their more powerful relations. Still another invasion took place in 1827, when the Ngatitoa, a tribe from the west coast of the North Island, under Te Rauparaha, harried the settlements of the South Island Natives. But this was a mere raid, and did not result in settlement. The Ngaitahu still remain as the dominant tribe, and have given their name to the descendants of the conquered Ngatimamoe. The present Maoris in Otago and Canterbury are, then, though called Ngaitahu, the result of the fusion of that tribe with the Ngatimamoe. But these tribes, though hostile, were not distinct. They were really only sub-tribes given off at different times from the parent Ngatikahungunu stock. I describe forty-five skulls which belong to one or other of these two subdivisions. Their measurements are given in Table I. In Table II. are given the measurements of thirty-eight skulls from different parts of the North Island, a series obviously too small to be of any use alone towards answering either of the questions mentioned above. I include them in the present paper, however, from their bearing on the general type of the race, and also because they can be made use of to some extent when taken with those described by others. I hope that some day I may be in a position to make this North Island table more complete. In the meantime I divide the skulls into three groups, according to the districts where they were found. The first includes skulls from the East Coast, between Poverty Bay and the Wairarapa, the country of the Ngatikahungunu. In this group there are fifteen skulls, fourteen of which are adult.

Those in the second group were found on the shores of Cook Strait and the line of coast running northwards towards Cape Egmont. This contains ten adult skulls, one of which was found on the southern shore of the Strait, in the Nelson Province. I have, however, included it in this table because this part of the South Island was mainly peopled by Natives from the opposite coast. There are thirteen skulls in the third group, twelve adults and one child, from the Bay of Islands and the neighbourhood of Auckland.

In analysing these two tables, I give the results, as far as possible, in tabular form. In the first line of each of these smaller tables I take the skulls from Otago and Canterbury—Ngaitahu—then come the three groups of North Island skulls, while the last line gives the combined result of the entire series. Each line gives the average of the indices or measurements—(1) of the male skulls, (2) of the female skulls, (3) of those of doubtful sex, and (4) the general average of both sexes, with the extremes between which the individual skulls have varied. In each case the number of skulls on whose measurements the average is based is given. None but adult skulls are included in these tables of averages.

CRANIAL CAPACITY.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	23	1,448	9	1,280	2	1,273	34	1,393	1,725	1,183
S.W. coast, N.I.	10	1,549	1	1,345	1	1,375	12	1,518	1,608	1,345
E. coast, N.I. ..	6	1,443	1	1,350	..	..	7	1,429	1,605	1,333
Auckland, &c. ..	6	1,494	4	1,275	1	1,235	11	1,391	1,635	1,188
Total ..	45	1,476	15	1,288	4	1,289	64	1,420	1,725	1,183

The average male index of the Ngaitahu skull is therefore mesocephalic, but almost at the upper limit of the group. The average of both sexes is of course much lower, but it is still mesocephalic. The range of variation for male skulls is 517c.c. Ten of the twenty-three male skulls, or 43 per cent., are megacephalic ; eleven, or 47·8 per cent., are mesocephalic ; two, or 8·7 per cent., are microcephalic. Of the North Island skulls, those which give the highest average are from the south-west coast, all the males being megacephalic. Those from the east coast have an average and a range of variation closely resembling the Ngaitahu skulls. Taking the combined results for both Islands, we find that the average of the forty-five male skulls whose internal capacity could be measured places them in the megacephalic division. Twenty-six, or 57·8 per cent., are also megacephalic; fifteen, or 33·3 per cent., are mesocephalic; while only four, or 8·9 per cent., are microcephalic.

CEPHALIC INDEX.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	25	75·8	12	76·1	3	80·5	40	75·9	85	69·1
S.W. coast, N.I.	11	75·4	1	75·1	2	75·8	14	75·5	79·6	71·6
E. coast, N.I. ..	7	74·9	3	73·8	..	..	10	74·6	78·3	70·7
Auckland, &c. ..	7	71·4	4	71·7	1	71·7	12	73·3	76·9	70·4
Total ..	50	75·4	20	74·7	6	77·9	76	75·4	85	69·1

This table shows that the Ngaitahu come very low down in the mesaticephalic group, the male skulls being slightly longer than the female. The combined result for both Islands, however, shows this latter character reversed. The range of variation is 15·9, and between the two extremes the forty skulls from the South Island are arranged as follows: Three, or 7·5 per cent., are brachycephalic; twenty-two, or 54 per cent., are mesaticephalic; fifteen, or 37·5 per cent., are dolichocephalic. Even in much smaller groups the variation is considerable. For example, if we take the eight skulls collected in the small area in the neighbourhood of the Otago Heads, we find the cephalic index varying between 83 and 72·5. The average of the three North Island groups is dolichocephalic, though one of them is just within the mesaticephalic division. In none of these three groups is there a single brachycephalic skull. The most dolichocephalic group is that from Auckland and the Bay of Islands. Professor Flower's series of skulls from Whangarei, already referred to, and the three described by Sir William Turner from Auckland, likewise show a low cephalic index. The average of Professor Flower's—omitting the child's skull—is 73·5, and had he used the glabello-occipital length it would have been lower. Professor Turner's give an average of 72·7. We have therefore the measurements of thirty-four skulls from the northern end of New Zealand, not one of which is brachycephalic, and whose average index (even taking Professor Flower's at 73·5) is 73·4.

The average for the whole of New Zealand, according to my tables, shows the typical Maori skull to be at the lower limit of the mesaticephalic group: 4 per cent. are brachycephalic, 52·6 per cent. are mesaticephalic, 43·4 per cent. are dolichocephalic. Three have indices under 70. The seventy-two crania referred to by Sir William Turner in his paper show the same small number of brachycephalic skulls, and have an average index of 74, a little lower than that given in this paper.

VERTICAL INDEX.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	24	74·2	11	74·9	3	76·4	38	74·6	81·9	66·8
S.W. coast, N.I.	11	76·1	1	75·7	2	75·6	14	76	79·3	71·7
E. coast, N.I. ..	7	75·5	3	73·2	..	..	10	74·8	77·8	71·2
Auckland, &c. ..	7	73·2	3	72	1	72·8	11	72·8	77	70·4
Total ..	49	74·7	18	74·2	6	75·5	73	74·6	81·9	66·8

The Ngaitahu skulls are therefore metriocephalic. The range of variation is 15·1. Of the thirty-eight in the table, ten, or 26·3 per cent., are akrocephalic; nineteen, or 50 per cent., are metriocephalic; nine, or 23·7 per cent., are tapeinocephalic. The most northern of the North Island groups has again the lowest index, almost tapeinocephalic. The average for both Islands is the same as that for the Ngaitahu, and the grouping of the skulls is as follows: Fourteen, or 19·2 per cent., are akrocephalic; forty-four, or 60·3 per cent., are metriocephalic; fifteen, or 20·5 per cent., are tapeinocephalic. The general average also shows that the male skulls, following the usual rule, are slightly higher than the female. The comparatively low indices, which we have just seen to be characteristic of the Auckland skulls measured by me, are also shown by those examined by Professors Flower and Turner from the same district. The Whangarei skulls in the College of Surgeons' Museum have an average index of 73·9, while that of Professor Turner's three is 71. The general average of the entire set of thirty-three crania is therefore 73·2. Comparing the *cephalic* and *vertical indices*, we find that in the Ngaitahu the average cephalic exceeds the average vertical by 1·3, and in the Auckland group by 0·5. In the other two groups from the North Island the vertical exceeds the cephalic—in one case by 0·5, and in the other by 0·2. The general average gives a slight superiority—0·8—to the cephalic index.

In sixteen Ngaitahu skulls (nine males and seven females) the *Basi-bregmatic height* exceeds the *maximum transverse width*, while in twenty-two (fifteen males and seven females) the width is greater than the height. The greatest excess of width over height is in No. 6, Table I., where the height is 125mm. and the width is 141mm., giving a height-breadth index of 89·3. The North Island skulls, on the other hand, have a majority whose height exceeds their width. In twenty-one is this the case, while in twelve the opposite condition is present. In two both diameters are equal. In these skulls the lowest height-breadth index is 92·8, the height in this skull being 128mm., and the breadth 138mm. Though the skulls which come from the southern half of the North Island are those in which the height exceeds the breadth of the brain-case most frequently, the numbers observed are too few and the district too large to allow of any tribal character being based on their measurements. Fortunately we are, thanks to Professors Flower and Turner, in a position to speak more definitely with regard to the skulls from the northern part of the Island. Combining their results with mine, we have, out of a set of thirty-three adult skulls, nineteen in which the height exceeds the width, thirteen in which the width exceeds the height, and two in which both diameters are equal. Contrasting these skulls in this respect with those from the South Island, we find that, while in 42·1 per cent. of the Ngaitahu the height is in excess of the width, there are 57·6 per cent. of these high skulls from this northern district. The average height of the Ngaitahu skulls is 136mm.; the average maximum width of the same skulls is 137·3mm. These diameters in the thirty-three of the Auckland group average 136·2mm. and 136·3mm.

FRONTAL INDEX.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	25	68	12	68·9	3	63·5	40	67·9	74·6	60·3
S.W. coast, N.I.	11	68·3	1	69·9	2	65·8	14	68·1	73·8	64
E. coast, N.I. ..	7	68·1	3	67	..	..	10	68·6	73·3	63·8
Auckland, &c. ..	7	67·7	4	39·5	1	66·7	12	68·2	75	63 6
Total ..	50	68·2	20	68·8	6	64·8	76	68·1	75	60·3

The proportion between the *maximum width* of the brain-case and its *minimum frontal width* as shown by this index varies little in the four groups. The range of variation is 14·7, and 59 per cent. of the indices are between 65 and 70. Comparing the *asterionic* and *stephanic widths*, we find that among the male Ngaitahu skulls there are eleven in which the asterionic and twelve in which the stephanic is the greater diameter. In two they are equal. Among the female skulls the asterionic is the greater in four, the stephanic in eight, and in two they are equal. The numbers in the North Island groups are: Males — asterionic greater, eight; stephanic greater, fifteen; both equal, one. Females — asterionic greater, six; stephanic greater, five.

INDEX OF FORAMEN MAGNUM.

—	Both Sexes.			
	No.	Av.	Max.	Min.
Ngaitahu	37	87·4	100	73
South-west coast, North Island ..	14	89·2	100	80·6
East coast, North Island	10	86·3	97	73
Auckland, &c.	12	87·9	97	80
Total	73	87·8	100	73

The large range of variation, 27, shows that the foramen magnum has no very fixed proportions. The length is equalled by the width in three cases.

ORBITAL INDEX.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	24	86·7	9	85·6	1	86·8	34	86·4	97·4	73·8
S.W. coast, N.I...	11	86·7	1	86·8	2	84·8	14	86·4	95·0	78·6
E. coast, N.I. ..	7	83	1	82·5	..	..	8	83	90·0	76·7
Auckland, &c. ..	7	86·4	4	88·2	1	84·6	12	86·8	95·1	80
Total ..	49	86·1	15	86·2	4	86·2	68	86·1	97·4	73·8

The average index in the Ngaitahu group is mesoseme, and the range of variation in it is 23·6. Of the thirty-four Ngaitahu skulls measured, nine, or 23·5 per cent., are megaseme; fourteen, or 44·1 per cent., are mesoseme; eleven, or 32·4 per cent., are microseme. The proportion of female skulls is greatest in the lower groups, and this low orbital index in the female is worthy of note, as not being in accordance with the generally-received view. Two of the North Island groups have indices almost the same as the Ngaitahu. The east coast skulls, however, have a lower index, which brings them into the microseme division, but there are not enough of these skulls in the series to lower the general average for both Islands below 86·1, in the mesoseme group. Of the total sixty-eight skulls, seventeen, or 25 per cent., are megaseme; twenty-nine, or 42·6 per cent., are mesoseme; twenty-two, or 32·4 per cent., are microseme.

The average interorbital distance is 20mm.

The average orbital index of Professor Flower's Whangarei series, 91·9, is much higher than that of any of my groups. Professor Turner's three, on the other hand, have a lower index — 80·3. Combining their results with my Auckland group, we have an average of 89·3 for these northern skulls.

NASAL INDEX.

	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	23	48·2	9	47·7	1	44·2	33	48	59·6	40·4
S.W. coast, N.I.	11	46·8	1	50	2	48·5	14	47·2	50·9	42·6
E. coast, N.I. ..	6	48·6	1	46	..	..	7	48·2	52·9	43·4
Auckland, &c. ..	7	48	4	55·1	1	48	12	50·4	56·8	41·1
Total ..	47	47·9	15	49·1	4	47·3	66	48·1	59·6	40·4

The average index of the Ngaitahu skulls of both sexes places them in the lowest possible position in the mesorhine group. The males are also mesorhine, but the females are leptorhine. The range of variation is 19·2. Sixteen of these South Island skulls, or 48·5 per cent., are leptorhine; thirteen, or 37·4 per cent., are mesorhine; while only four, or 12·1 per cent., are platyrhine. The only leptorhine group is that from the south-west coast of the North Island. The east coast skulls are mesorhine, and those from the northern districts are higher in the same division. The general average for both Islands places the Maori skull very low down in the mesorhine division. Sixty-six skulls were available for the required measurements, and, of these, twenty-nine, or 43·9 per cent., are leptorhine; thirty, or 45·5 per cent., are mesorhine; seven, or 10·6 per cent., are platyrhine.

The highest average is, as we have just said, found in the Auckland group, where 25 per cent. of the skulls measured are platyrhine; but a small group like this, containing only twelve skulls, does not allow of conclusions being drawn as to the character of the nasal opening in the tribes of the far north. By making use, however, as before, of Sir William Flower's collection from Whangarei, and of those from the same part of the Island described by Professor Turner, we get a set of thirty-four, and these give a result but little different from that given in the table. Sir William Flower's skulls have an average nasal index of 49·9; Professor Turner's of 50·4; and the general average derived from their results and mine is 50·2. We get therefore a nasal index of 50·2 from thirty-four skulls collected about Auckland, and in the region to the north; while my series of thirty-three Ngaitahu skulls give, as we have seen, an index of 48. It must be remembered, however, that the nasal index has been found to vary much even in races which are generally regarded as fairly pure.

GNATHIC INDEX.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	22	98·4	9	94·7	2	102·2	33	97·6	104·9	92
S.W. coast, N.I.	10	94·5	..	..	2	95·3	12	95	99	93·2
E. coast, N.I. ..	4	95·9	1	95·7	..	..	5	95·9	97·1	94·3
Auckland, &c. ..	7	96·1	4	100·5	1	94·1	12	98·2	103·9	88·8
Total ..	43	97	14	96·4	5	97·8	62	96·9	104·9	92

According to the averages all the groups are orthognathous, with the exception of the most northern, which is very slightly mesognathous. The range of variation is 12·9. Of the thirty-three of the Ngaitahu Tribe measured, eighteen, or 54·5 per cent., are orthognathous; twelve, or 36·4 per cent., are mesognathous; three, or 9·1 per cent., are prognathous. And of the sixty-two skulls which form the entire series, thirty-eight, or 61·3 per cent., are orthognathous; twenty, or 32·3 per cent., are mesognathous; while only four, or 6·5 per cent., are prognathous. The comparatively high index of the northern group seems to be the usual arrangement, for Professor Flower's set, omitting the child's skull, has an average index of 98·2, and Sir William Turner's of 100; giving with mine an average of 98·4 for thirty-four skulls from this district.

OPHRYO-SPINO-AURICULAR ANGLE.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	22	70½°	9	73°	1	70°	32	71½°	80°	66°
S.W. coast, N.I.	10	71	..	..	2	71	12	71	74	69
E. coast, N.I. ..	6	73½	1	71	..	..	7	73	80	69
Auckland, &c. ..	7	72	4	74	1	74	12	72	76	67
Total ..	45	71	14	73½	4	71½	63	71½	80	66

As the gnathic index shows the projection of the whole face, so this angle shows the degree of projection of the parts above the alveolar arch. This table, therefore, does not closely correspond with the previous one, which deals with the gnathic index. The range of variation is considerable—14 degrees.

Palato-maxillary Index.

—	Male.		Female.		?		Both Sexes.			
	No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	21	119·4	9	125	2	116·5	32	120·8	137·8	106·9
S.W. coast, N.I.	10	123·4	..	..	2	124·1	12	123·5	129·6	115·4
E. coast, N.I. ..	4	117·1	1	124·5	..	..	5	118·6	129·2	115·1
Auckland, &c. ..	6	120	4	117·4	1	128·3	11	119·9	128·3	110·5
Total ..	41	120·3	14	122·8	5	121·9	60	121	137·8	106·9

The averages place all the divisions in Sir William Turner's brachyuranic group. The greatest range of variation, 30·9, occurs as usual in the Ngaitahu Tribe, and the distribution of its thirty-two skulls is as follows: Brachyuranic, twenty-four, or 75 per cent.; mesuranic, six, or 18·8 per cent.; dolichuranic, two, or 6·9 per cent. In the south-west-coast group all the skulls are brachyuranic, and the index is highest. In Professor Turner's six skulls from Kapiti, however, one is dolichuranic, and three are mesuranic. The general average for the whole of New Zealand is, of course, brachyuranic. Of the sixty skulls in the tables, forty-four, or 73·3 per cent., are brachyuranic; thirteen, or 21·7 per cent., are mesuranic; three only, or 5 per cent., are dolichuranic. The measurements given by Professor Flower of his skulls from Whangarei do not permit of this index being calculated.

The *width of the face relative to that of the brain-case* is shown by comparing the bizygomatic diameter with the maximum transverse, and stephanic diameter of the cranium. In looking over the tables we find that in the great majority of the skulls the maximum transverse diameter is greater than the bizygomatic width. Among the male Ngaitahu skulls fourteen have the transverse diameter greater than the bizygomatic, while the reverse is the case in five skulls. Among the females of the same tribe six show the former condition, one the latter, while in another the two diameters are equal. In the combined North Island groups the proportion is twenty-two of the former type to seven of the latter, and in two the diameters are equal. The terms "phænozygous" and "cryptozygous" roughly indicate the relation between the bizygomatic width and the stephanic, or, rather, the maximum frontal diameter. As shown in Tables I. and II., all the male skulls from both Islands, with two exceptions, are phænozygous; and one of these cryptozygous skulls cannot be regarded as normal in this respect, as a complete and early obliteration of the sagittal suture has checked materially the growth in width of its brain-case. In fifteen of these male phænozygous skulls, though the zygomatic arches are visible from above, the space between them and the bones of the temporal fossa is covered and invisible. In thirty the arches are seen free and open. The projection is less in the female skulls, and three of them are cryptozygous.

Basi-nasal Length, or Cranio Facial Axis.—The average length of this important dimension and its variations are shown in the following table:—

—	Male.				Female.				?		Both Sexes.			
	No.	Av.	Max.	Min.	No.	Av.	Max.	Min.	No.	Av.	No.	Av.	Max.	Min.
Ngaitahu ..	24	103	112	95	11	102	110	94	3	95·7	38	102·4	112	93
S. W. coast, N.I. ..	11	105·1			1	101			2	105·5	14	104·9		
E. coast, N.I.	7	103·6	109	99	3	97·3	110	93	..	..	10	101·7	110	93
Auckland, &c. ..	7	104·4			4	98·8			1	102	12	102·3		
Total ..	49	103·9	112	95	19	100·5	110	93	6	100	74	102·7	112	93

In the paper on the cranial characters of the Fiji Islanders, already referred to, Sir William Flower gives a table showing the average length of this line in several races, both savage and civilised. In the male Esquimaux it is 106·1mm.; in the male Fijian, 104mm. In none of the other examples given does the length equal that given above as the average for the male of the Maori race, while the average for the female Maoris of my series exceeds that of the females of all the races included in the table.

If we compare the *basi-nasal length* with the *distance between basion and nasion, as measured over the vertex in the middle line,* we find little variety in the different groups. Expressing the lower line as a percentage of the upper curve, we get for the Ngaitahu, 25·3; for the group from the south-west coast of the North Island, 25·5; for the east coast group, 24·9; and for the skulls from Auckland and the Bay of Islands, 25·2.

Professor Cleland,* and, following him, Sir William Turner,† make for purposes of comparison a somewhat different division of this mesial vertical circumference. Instead of using the

* "An Inquiry into the Variations of the Human Skull": Philosophical Transactions, 1870.

† "'Challenger' Reports": Human Crania.

basi-nasal, they take the opistho-nasal length, and, regarding this as 1, they give its proportion to the length of the upper arch between the opisthion and nasion. The highest proportion of arch to base—2·91—was found by Cleland in Irish skulls; the lowest—2·47—in Esquimaux. My series of Maori skulls, looked at in the same way, shows that in the Ngaitahu the proportion is 2·71; in those from the south-west coast, 2·69; in the east coast skulls, 2·72; and in the Auckland group, 2·74.

Median Circumference of Brain-case.—Of the three subdivisions of the nasio-opisthic arc the frontal is the longest in twenty, or 80 per cent., of the male Ngaitahu skulls. In one the parietal equals it, and both are longer than the occipital or lambdo-opisthic portion of the arc. In two the occipital segment equals the frontal, the parietal being the shortest. In two cases the parietal arc is the longest, the frontal coming second. In no case is the occipital the longest. It, however, exceeds the parietal in twelve skulls, while the parietal exceeds it in eleven. The parietal portion of the arc is the shortest in fourteen skulls; the occipital in ten. In nine of the fourteen female skulls of the same tribe the frontal arc is the longest. The parietal equals it twice, while in one skull the frontal, parietal, and occipital divisions are all equal. Though the parietal thus equals the frontal in three female skulls, in no case does it exceed it; but in two cases the occipital portion of the arc is the longest, the frontal coming second. The parietal is the shortest in five female skulls; the occipital in eight. Combining the sexes, we have the frontal arc longest in 82 per cent. of the skulls, and the parietal and occipital in 5 per cent. The occipital arc is shortest in 46·2 per cent., and the parietal shortest in 48·7 per cent.

The fourteen skulls from the south-west coast of the North Island have the frontal arc longest in six, the parietal in five, while these two bones are equal in three more. The occipital is the shortest in every case.

The group of ten skulls from the east coast of the North Island has the frontal arc longest in five, the parietal in four, and equal to the frontal in one. As in the last group, in every skull the occipital portion of the arc is the shortest.

Of the twelve skulls from Auckland and the district to the north of it, one has the sutures so completely obliterated that the limits of the bones could not be determined. The frontal is the longest portion of the arc in eight, and equals the parietal in the other three. The occipital is the shortest in all except one, where it exceeds the parietal.

All this shows clearly that the Melanesian characteristic, a parietal bone longer than the frontal, does not obtain among Maori skulls.

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1. Skull as seen from the front.
Fig. 2. Skull as seen from the side.

Plate II.

Fig. 3. Skull as seen from above.
Fig. 4. Skull as seen from below.

B. Basion.
I. Inion, or external occipital protuberance.
O. Occipital point.
L. Lambda.
Ob. Obelion.
Bg. Bregma.
Op. Ophryon.
Gl. Glabella.
N. Nasion.
S. Spinal point, or nasal spine.
A. Alveolar point.
St. Stephanion.
Pt. Pterion, with epipteric bone.
As. Asterion.
Op. Opisthion.
G. Gonion.
St.st. Stephanic diameter.
F.F. Minimum frontal diameter.
E.E. External biorbital diameter.
J.J. Bijugal diameter.
Z.Z. Bizygomatic diameter.
Gl.O. Glabello-occipital length.
B.Bg. Basi-bregmatic height.
M.M. Maximum transverse diameter.
B.N. Basi-nasal length.
B.A. Basi-alveolar length.
N.S. Nasal height.

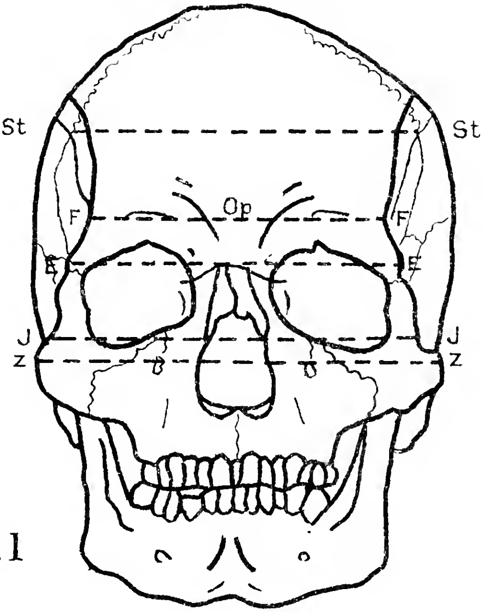

Fig. 1

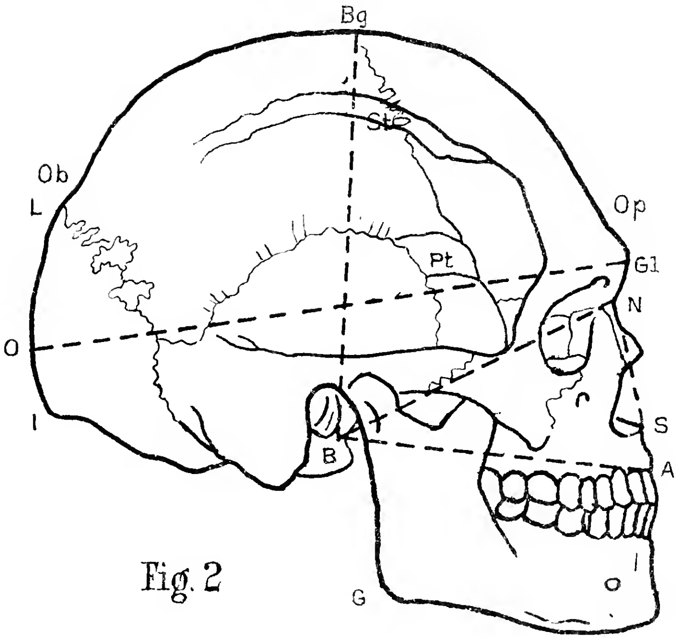

Fig. 2

Human Skull

J.H.S. del.

F.H.T. Lith.

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1. Skull as seen from the front.
Fig. 2. Skull as seen from the side.

Plate II.

Fig. 3. Skull as seen from above.
Fig. 4. Skull as seen from below.

B. Basion.
I. Inion, or external occipital protuberance.
O. Occipital point.
L. Lambda.
Ob. Obelion.
Bg. Bregma.
Op. Ophryon.
Gl. Glabella.
N. Nasion.
S. Spinal point, or nasal spine.
A. Alveolar point.
St. Stephanion.
Pt. Pterion, with epipteric bone.
As. Asterion.
Op. Opisthion.
G. Gonion.
St.st. Stephanic diameter.
F.F. Minimum frontal diameter.
E.E. External biorbital diameter.
J.J. Bijugal diameter.
Z.Z. Bizygomatic diameter.
Gl.O. Glabello-occipital length.
B.Bg. Basi-bregmatic height.
M.M. Maximum transverse diameter.
B.N. Basi-nasal length.
B.A. Basi-alveolar length.
N.S. Nasal height.

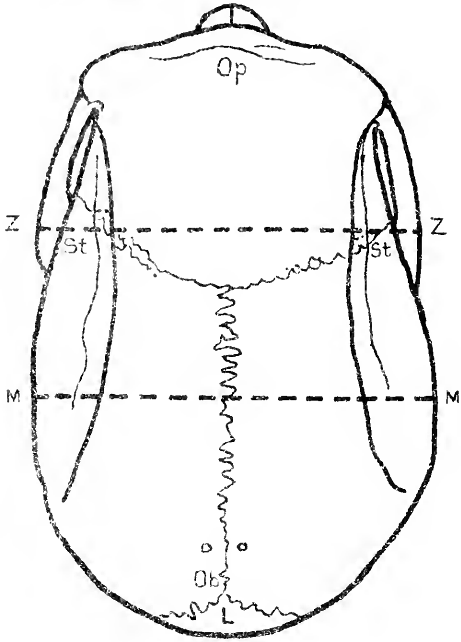

Fig. 3.

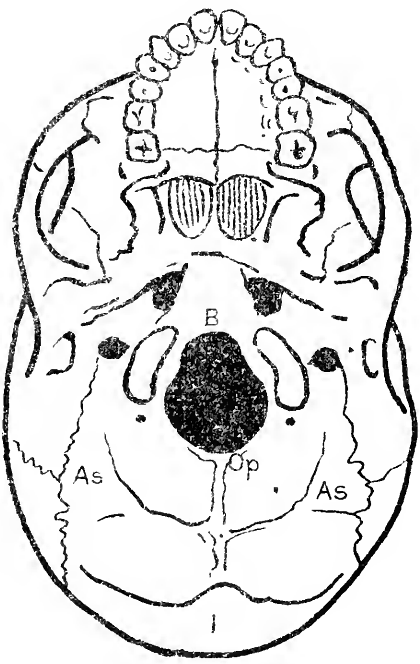

Fig. 4

Human Skull

J.H.S. del.

F.H.T. lith.

Characters of Cranial Vault.—In the majority of skulls the vertex is roof-like, with a more or less sharp and prominent median ridge in the parietal region, and a flattening, or sometimes hollowing, of the parietal bones between this ridge and their eminences. Some, however, have a rounded vault, and intermediate forms are met with. The outline of the longest skulls as seen from above is a very regular oval, the parietal eminences in these not being distinct. In most skulls, however, the parietal eminences are sharp and prominent, and, as they lie towards the back of the brain-case, the norma verticalis is obovate. Some skulls are pentagonal, as seen from behind. The forehead is, as a rule, moderately high and rounded, and any such pronounced flattening of the frontal region as is so characteristic of Moriori skulls is rare. A post-bregmatic depression was noted in seven skulls. The obelion was markedly depressed in two. The relative width of the parietal and frontal regions has been already described. The greatest transverse width is most often, in 36·9 per cent., on the parietal bones between the eminences and the lower border. In 29·8 per cent. it lies at the level of the parietal eminences, and in an equal number of cases at the squamous suture. I have noted it as being on the squamosals in two skulls, and in one on the suture between the mastoid portion of the temporal and the parietal. One skull alone showed the characteristic form due to early hydrocephalus.

The *glabella* is, as a rule, in the male skulls large and prominent, and the superciliary ridges long and curved. The *temporal fossæ* are large, and the *temporal ridges* usually run above or across the parietal eminences.

Sutures.—The coronal suture is generally simple, except for a short distance above the stephanion, where it is in most skulls deeply serrated. The sagittal suture, though not so simple as the coronal, is not complex. Nos. 2, 3, and 4 of Broca's scale would in most cases represent its serration. The lambdoidal is, as in Europeans, the most complicated suture. In one case it was, however, exceedingly simple, showing scarcely any serration.

The obliteration of the sutures of the vault does not seem to follow any very definite order, though on the whole these skulls lend support to the view that in savage races the closure begins anteriorly. In twenty-four skulls in which the obliteration of the coronal and lambdoidal sutures is partial it is further advanced in the coronal than in the lambdoidal in fifteen; in six the process is equally advanced in both; and in three the lambdoidal is in advance. The sagittal is in advance of the coronal in this respect in the proportion of eleven to six. In the sixteen cases which show partial obliteration of the sagittal suture the closure has begun anteriorly in three cases only, while posterior fusion—the anterior end being free—is seen in twelve. In one the ossification has apparently begun about the centre.

In two skulls the sagittal suture has disappeared prematurely, not a trace remaining. One (No. 22, Table I.) is that of an adult; the other (No. 43, Table I.) is a child's skull, five or six years of age. They are both, in consequence, much more elongated than others of the same ages. The cephalic index of this adult skull is 69·6.

Metopism.—One skull is fully metopic. It was found in the Nelson Province, and is described with the North Island skulls. It is No. 11 of the group from the south-west coast, in Table II. In four other skulls a short fissure is to be seen in the glabella, and in a fifth a small triangular ossification is to be seen extending upwards into the glabella from immediately above the nasal bones.

Inter-parietal Bone.—No example of this irregularity was met with among the Maori crania, but in one case a small fissure 13mm. in length passed on one side into the occipital bone from its lateral angle.

Pterion.—The pterion is in almost all the cases in which it could be observed of the H-shaped type. The length of the parieto-sphenoid articulation varies from 3mm. to 20mm., the average being 9·5mm. In one specimen it seemed as if a K-shaped pterion had been present, but this could not be determined with certainty, because of extensive obliteration of the sutures. In one only is there an articulation between the squamosal and the frontal, and this, as in the Moriori to be afterwards noted, takes place by means of an oblong bony process which projects forwards from the squamosal as if an epipteric bone had fused with it. In a separate Maori temporal bone in my possession this same condition is present.

Epipteric bones are of fairly frequent occurrence. They occur in five skulls on both sides, and in ten more on one.

Wormian bones occur in thirty-seven skulls. In addition to the region of the pterion, they are found in the lambdoidal suture, where they occur most frequently, in the occipito-mastoid and parieto-squamous sutures, and at the asterion. In one skull there occurs in each orbit a small separate ossification in the angle between the frontal, the malar, and the great wing of the sphenoid, and it is this skull which has the separate ossification at the root of the nose in the glabella already alluded to.

Incomplete union between the squamosal and petro-mastoid elements of the temporal bone was seen in two skulls, occurring on both sides in each. In these a fissure, such as has been described in European skulls, is seen running obliquely from the angle between the squamous and mastoid above, downwards across the mastoid process, nearer its anterior than its posterior border. In neither case is the separation between the two elements complete.

Paramastoid Process.—This was noted in eight skulls, in four of which it is present on both sides. As a rule they are small and unimportant, but those of a skull from near Dunedin merit a short description. They are both low and blunt, but are each articular; one, the left and the longer, articulates with the outer surface of the corresponding lateral mass of the atlas, while the other articulates with the upper and back part of the right lateral mass. This skull is part of a complete skeleton, and the atlas shows the facets which correspond to these paramastoid articular surfaces. In another skull there is a non-articular paramastoid on one side, while on the other there is, not a projection, but a smooth flattened area on the undersurface of the jugular process, which in all probability was for articulation with the transverse process of the atlas.

In one female skull, also from Otago, the atlas is fused to the occipital bone by its anterior arch and lateral masses.

Third Condyle.—A slightly-raised third condyle, 8mm. broad, is present in one skull close to the anterior edge of the foramen magnum. In another the anterior border of the foramen is articular, but not raised. On the contrary, it is slightly concave, as if the tip of the odontoid had pressed on the occipital. In a third skull, although there is no articular surface, there are two bony nodules lying close together on the undersurface of the basi-occipital, a very short distance in front of the border of the foramen.

Parietal Foramen.—This, though present in the great majority of skulls, is often exceedingly minute. It is absent in 20 per cent. of the crania examined. It is present on both sides in 32·5 per cent., and on one side in 45 per cent. One skull has two foramina on one side, the right; and in four the foramen is in the middle line.

Posterior Condyloid Foramen.—This also varies in size, but not to the same extent as the parietal foramen. It is absent in nearly 8 per cent. of the skulls measured. It is present on both sides in 56 per cent., on one side in 36 per cent., occurring more often on the left side than on the right side.

External Auditory Meatus.—No obvious diminution in the size of this canal was observed. No exostoses are present, but in one adult skull the tympanic plate is perforated.

The superior curved line of the occipital bone is clearly double in 33 per cent. of the crania examined.

Equilibrium of Skull.—Nearly 40 per cent. of the skulls, when placed on a table, rest on the teeth, and either the postero-lateral edges of the foramen magnum or the occipital bone near the foramen. Thirty-four per cent. rest on the mastoid processes, a posterior mastoid equilibrium being present more frequently than an anterior. In a little over 20 per cent. the condyles project beyond the mastoids, and the skull rests on them, while in a few the lateral points of contact are one mastoid and one condyle.

Infra-orbital Suture.—Thirty-one per cent. of the skulls have this suture present on both sides. In 15 per cent. it is present on one side only. In about 10 per cent. of the instances observed it is partly obliterated.

Lachrymal Bone.—A pronounced deviation from the ordinary type was observed in only one New Zealand skull. The inner wall of the orbit is, however, frequently greatly broken. In the skull referred to there is no separate lachrymal on either side, the nasal process of the superior maxilla being prolonged backwards to meet the os planum of the ethmoid. A small space is, however, present in the lower part of this suture, and this was in all probability filled during life by an ossicle. The os planum is occasionally narrowed anteriorly, the shortest ethmo-lachrymal suture I have noted being 5mm.

In another skull, which I believe to be Maori, though it was found at the Chatham Islands, an irregularity also occurs in this region. The measurements of this skull are given with those of the others from the Chathams, in Table III., but the lachrymal irregularity may be described here. It occurs in the right orbit. In it the lachrymal bone and the os planum come in contact by a mere point. Below they are separated from each other by a triangular process of the orbital plate of the superior maxilla, above by a triangular ossicle which articulates along its third side with the frontal bone.*

Spheno-pterygoid Foramen.—Traces of this are present in nearly 50 per cent. of the skulls of my series. In one it is complete on both sides; in two more it is complete on one side, and in one of these the bridge of bone which connects the pterygoid plate and the spine of the sphenoid is 7½mm. deep. It is nearly complete in six skulls, one of these having the same condition on both sides; it is more than two-thirds formed in nine more; while in nineteen a spine is to be seen projecting backwards from the posterior edge of the external pterygoid plate. In those skulls which

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* For a full description of lachrymal irregularities and their mode of production, see "Notes on the Varieties and Morphology of the Human Lachrymal"; Professor Macalister, Proceedings of the Royal Society, 1884: also, "The Orbito-maxillary-frontal Suture in Man and the Apes, with Notes on the Varieties of the Human Lachrymal Bone"; Mr. Arthur Thomson, "Journal of Anatomy and Physiology," vol. xxiv., 1890.

have the foramen complete, or nearly so, the pterygoid plate is very much broader than usual.

Nasal Bones.—The nasal bones show considerable variety in size and form, even in skulls from the same district; but in male skulls the bridge of the nose generally seems sunken below the prominent glabella. In a few it is here very narrow, and in three skulls, one nasal bone alone reaches the frontal. The lower part of the nasal bones is usually convex; and though in a number of skulls they are short, and in a few flat, yet in many the bridge of the nose is high, prominent, and curved.

Anterior Nares.—In one skull only is this opening quadrangular. Though it varies considerably in its proportions, it is almost invariably rounded, and much narrower above than below. The lower margin is rounded in 37 per cent., sharp in 31 per cent., two-lipped in 20 per cent., and bevelled or sloping gradually to the facial surface of the superior maxilla in 12 per cent. of the skulls in which it could be examined.

Alveolar Arch.—In nearly half the skulls this is of the ordinary parabolic curve. Of the remainder, the great majority are hyperbolic; while in only from 9 to 10 per cent. is the hypsiloid form of curve present. In none is the curve elliptical. In one, a female from the west coast of Otago, there is an incurving of the premolar and anterior molar region, so that the arch in this part is concave outwards.

Lower Jaw.—This bone is generally strong and massive. The angle is occasionally sharp and easily localised, but is more frequently rounded, and this rounding is in many bones carried forwards along the undersurface of the body, curving upwards anteriorly towards the chin. Indeed, in some cases the posterior margin of the ramus, the angle, and the lower border of the body form one long continuous curve, whose most dependent part is below the first molar tooth.

The coronoid height is greater than the condyloid in the great majority of the mandibles examined. In five cases it is less, and in one these two measurements are equal.

The intergonial diameter exceeds the gonio-symphysial length in every case.

Teeth.—In very few of the skulls in this series are all the teeth present. The loss has in most cases occurred after death, or in advanced age, but in several adult skulls there are undoubted signs of *ante-mortem* loss of teeth. These have probably been lost as the result of injury, as in no case have I been able to observe the slightest sign of dental caries. But though I have not seen decayed teeth in these Maori skulls, I have noted in seven the cavities of alveolar abscesses. Six of these cavities are found in the upper jaw, one in the lower; and most of them have been at the roots of either the incisor or the premolar teeth. Professor Rolleston* has noted this condition in several of the skulls from British barrows examined by him—skulls belonging to a people whose habits in many respects, in all probability, closely resembled those of the Maoris. Most of his instances occurred in female skulls. All mine were met with in males.

The third molars are, as a rule, not ground, or only very slightly so; and the second molars are usually not much worn; but all the other teeth, except in one or two skulls, show in a marked degree the wearing-down of the teeth characteristic of races in the condition of the Maoris, frequently the whole crowns having been ground away. In several skulls I have observed a curious condition of the first molar teeth of the upper jaw. In its slighter degrees there is merely an oblique wearing of the crown, the outer side being most worn. In the most pronounced cases, however, the pressure from without has caused a gradual dislocation of the tooth inwards, so that it comes to lie transversely in the jaw, with the two outer fangs exposed, and these, with the remaining portion of the crown, are ground down so that the pulp-cavity is exposed in its entire length. The chewing-surface so produced is not flat, but rounded from within outwards. The incisor teeth are quite as much worn as the first molars and the premolars, and, instead of cutting-edges, have flattened crowns. Unfortunately they have been lost even more frequently than the molar teeth, and in comparatively few cases have I been âble to determine satisfactorily the relation that the upper incisors have had to the lower; but in some skulls it is clear that the upper teeth do not, as with us, project in front of the lower, but lie directly above them, the flatly-ground surfaces of each being in contact. This arrangement has been described by Sir William Turner in Australian skulls.†

The molar teeth are generally three on each side, or, rather, have been so during life, as, of course, many have been lost after death, and many more, though once present, have been lost during life from old age or other causes. In fifteen skulls, however, I have been unable to find any trace of a third molar on either side of the superior maxilla, and in another, this tooth, though present on one side, has apparently never been developed on the other.

Children's Skulls.—The measurements of nine young skulls are given in the tables. Two of these were found at the Chathams; the others come from different parts of New Zealand.

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* Scientific papers and addresses; Ed. Turner, 1884: "General Remarks upon the Series of Prehistoric Crania."

† "The Relations of the Dentary Arcades in the Crania of Australian Aborigines": "Journal of Anatomy and Physiology," vol. xxv., 1891.

The large cranial capacity of these skulls is worthy of note. Their average is 1,417c.c. The average cephalic index, 78·5, shows them to be more brachycephalic than the adults. The altitudinal index, 76·3, also shows a greater relative height; but, as in the adult skulls, the cephalic index is higher than the altitudinal. There is, however, a greater difference between these indices in the young skulls than was found in the adult crania. The mean frontal index, 65·5, is, as might be expected, lower in this group than in the adult skulls. The mean orbital index, 93·7, is markedly higher; indeed, in one skull it is 103·1. The nasal index is almost identical with the average for the adult crania. For the young skulls it is 48·2, for the adults 48·1. The more feeble development of the face results in the lower gnathic index and the higher palato-maxillary. The premature closure of the interparietal suture in the most dolichocephalic of these skulls has been already referred to.

Crania from the Chatham Islands—Moriori.

Our knowledge of the now almost extinct Moriori inhabitants of the Chatham Islands is very slight. It is true that they have been known to Europeans for rather more than one hundred years, as the islands were discovered by Lieutenant Broughton, in Her Majesty's brig "Chatham," in 1790; but no use seems to have been made of this discovery till about 1828, when whalers and sealers from Sydney first began to visit them. These men, however, left no written record, and when the regular settlement began, between 1840 and 1850, the Morioris were a rapidly-dying race, much inferior in point of numbers to the Maoris, who had conquered them and taken possession of the islands in 1835, and so timid from ill-usage that intercourse with them was not easily established. They were a gentle people, who, in the words of one of the Maori invaders, "did not know how to fight, and had no weapons," and had been quickly either massacred or enslaved. An epidemic in 1839 had aided the work of destruction; so that during the twenty years that followed the Maori invasion their numbers had dwindled from an estimated 2,000 to 212. Since then, though, of course, Maori oppression has ceased, they have not been able to accommodate themselves to the new conditions of life, and the decrease has continued steadily. In 1881 there were forty-three adults and one child, and now only thirty-five are left, and some of these are not of pure Moriori blood.*

According to their own traditions, their ancestors came

* A. Shand: "The Occupation of the Chatham Islands by the Maoris in 1835"; "Journal of the Polynesian Society," vol. i., 1892.

from Hawaiki, some twenty-seven or twenty-eight generations ago. On arrival they found the islands thickly inhabited by natives who differed considerably from them, being darker, and having very black hair. After much fighting, they made peace with the islanders, and, intermarrying with them, the two races became fused. There is another tradition of the arrival of a second body of immigrants at a later date. These are said to have come from New Zealand.*

This traditional history tends to show that the Morioris, like the Maoris, are of a mixed Polynesian and Melanesian stock.

One of the earliest of the English settlers† describes them as "of middle stature, with almond-shaped eyes and hooked noses," bearing "a most remarkable resemblance to the Jewish race." I am told, however, by one of the European residents that this Jewish nose is by no means universally present—that, indeed, broad and rather flat noses are more common. They differed considerably from the Maoris in appearance, as they did not practise tattooing. In character, too, they were unlike the New Zealand natives, being gentle and timid, and totally devoid of the energy, intelligence, and ferocity of their conquerors.

The measurements of about thirty Moriori skulls have, I believe, been already published. Four crania, one of them a child's, were collected by the "Challenger" expedition. These, with five others in the anatomical museum of the University of Edinburgh, have been described by Sir William Turner‡ in his report on the human crania in that collection. Eight crania are in the museum of the Royal College of Surgeons in London, and have been measured by Sir William Flower.§ Three are described by Dr. Zuckerkandl,‖ from the collection made by the "Novara" expedition, and one of these is figured. Five are in the Paris Museum, and are described by MM. de Quatrefages and Hamy;¶ one of these is also figured. Dr. Barnard Davis** gives the measurements of three more, one of which, however, is a child's. Some measurements of one skull are given by Dr. F. J. Knox,†† in describing a

* Gilbert Mair: "Notes on the Chatham Islands and their Inhabitants"; Trans. N.Z. Inst., vol. iii., 1870. W. T. L. Travers: "Notes on the Traditions and Manners and Customs of the Morioris"; Trans. N.Z. Inst., vol. ix., 1876.

† F. Hunt: "Twenty-five Years' Experience in New Zealand and the Chatham Islands." 1866.

‡ "'Challenger' Reports": Human Crania.

§ Catalogue of the museum of the Royal College of Surgeons.

‖ Reise der "Novara," Anthropologischer Theil.

¶ "Crania Ethnica."

** "Thesaurus Craniorum."

†† Trans. N.Z. Inst., vol. v., 1872.

Moriori skeleton in the Colonial Museum, Wellington; and a few crania are, I believe, in the Godeffroy Museum at Hamburg.

I describe in this paper fifty skulls from the Chatham Islands. Thirty-four of these are adult or aged males; seven are adult females. In three other adult skulls the sexual characters are very ill-defined, and I class them as of doubtful sex. Six are the skulls of youths or children.

Twenty-eight of these skulls are in the anatomical museum of the University of Otago; seventeen are in the Canterbury Museum; five are in the Colonial Museum at Wellington.

Though all fifty were, I believe, found at the Chathams, I do not regard them all as Moriori skulls. From what has been said above it is clear that Chatham Island skulls are not necessarily those of the Moriori aborigines. They may be so; but they may also be Maori, or even European; and in my collection it is easy to recognise different types of skull, and, though none of them are European, I have come to the conclusion that four skulls are Maori rather than Moriori. These differ from the others in several respects, but especially in the form of the cranial vault, and resemble more closely some of the skulls found in New Zealand, near the western opening of Cook Strait—that part of the North Island where the Ngatiawa and other invaders of 1835 lived before their exodus to the Chathams.

The other forty-six skulls are, in my opinion, Moriori, but not all of one type. Amongst the adult skulls two types may be recognised, and the skulls may be divided into groups according to their resemblance to one or other—groups, however, which shade into each other through intermediate forms. The typical members of the first group are usually large and rather heavy skulls, with prominent parietal eminences and roof-like vertices. They are all more or less pentagonal as seen from behind, some very markedly so, and the low flattened retreating frontal region is a most striking feature. The excess of width over height is generally well marked; indeed, in the most typical members of the group the brain-case is distinctly flattened. The orbits are, as a rule, high, and the appearance of height is increased by the form of the superciliary ridges; while the nasal opening is narrow, with long prominent nasal bones, which are convex below. The air-sinuses in the frontal bone are mainly confined to the region above the root of the nose, so that, while there is, as a rule, a massive prominent glabella, the superciliary ridges are short, and do not pass far out over the orbits. The majority of the skulls from the Chatham Islands that I have examined are of this type. The skull numbered 27, in Table III., shows a different type, and several others resemble it more or less closely. These form the second group. The main differences between these skulls and those I have just described are the higher and more rounded forehead, the less pentagonal norma occipitalis, the less projecting jugal arches, and the smaller orbital openings. By the "smaller orbital openings" I do not mean that the orbital index is lower in these skulls. This is certainly not the case in all. I mean rather that the orbital opening relatively to the rest of the face is smaller in the skulls which compose this group than in those of the first. The more overhanging superciliary ridges do, however, take away somewhat from the appearance of vertical height. Some of the skulls in this group are also large, one having a capacity of 1,650c.c. These crania are of a more Maori type than those in the former group; but I class them all as Moriori, because I have a clear series of gradations between them and the most typical members of the other group, and also because I have been told by one of the English settlers that in undoubted Moriori burial-places skulls of both types are found. That there should be found among Moriori skulls some which might be regarded as Maori is almost to be expected, as there can be little doubt that both Maori and Moriori are the result of a mingling of the same races—in different proportions perhaps, but still the same. There is, besides, as already noted, a tradition of the early introduction of a pure Maori strain direct from New Zealand; and, remembering the nearness of the Chatham Islands to New Zealand, it is difficult to believe that this occurred only once in the long period that elapsed between the settlement and the arrival of Europeans.

The measurements and indices of these Chatham Island skulls, taken in the way already explained, are given in Table III. I give in the table the entire series, but the four skulls which I regard as Maori are placed in a division by themselves at the end. They are numbered 47, 48, 49, 50.

The short tables included in the text contain, as before, averages calculated from the figures in the larger table. They deal with adult skulls alone.

CRANIAL CAPACITY.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
29	1,455	6	1,276	3	1,321	38	1,416	1,650	1,185

The average of the male skulls shows them to be megacephalic; the female average is microcephalic; and both sexes combined give an average which is in the upper half of the mesocephalic group. The small number of female skulls makes the combined average rather unsatisfactory. Had the sexes been in more equal proportions the average would have been lower, and would have more correctly expressed the general fact.

The range of variation is 465c.c. if we include both sexes, 365c.c. if we take the male skulls alone.

Of the male skulls, fifteen, or 51·7 per cent., are megacephalic; eleven, or 37·9 per cent., are mesocephalic; while only three, or 10·3 per cent., are microcephalic. One of the females and one of the skulls of undetermined sex are at the lower limit of the mesocephalic group; the others are microcephalic.

Professor Flower has taken this measurement in seven Moriori skulls, and these have an average capacity of 1,396c.c. The average of Sir William Turner's series of eight is still lower, 1,387c.c; but in both groups the percentage of female and doubtful skulls is higher than in mine. It is also to be noted, as explaining my higher results, that the collections measured by these two observers contain none of the skulls of exceptionally large size described by MM. de Quatrefages and Hamy.* The mean cranial capacity of the three males in the Paris Museum is given by them as 1,600c.c., of the two females as 1,565c.c., while one of the male skulls has a capacity of 1,785c.c. Sir William Turner's largest has a capacity of only 1,492c.c., Professor Flower's of 1,560c.c., whereas I show in my table three skulls whose capacity ranges from 1,580c.c. to 1,650c.c. The three "Novara" skulls have a mean capacity of 1,428c.c.; Dr. Barnard Davis's two adults of 1,475cc.

Combining these measurements with mine—in all, sixty-three skulls—we get the following results: Average capacity of forty-seven male skulls, 1,460c.c.; average capacity of sixteen skulls of female or of doubtful sex, 1,326c.c. The male Moriori skull is therefore low down in the megacephalic group. The female is microcephalic.

CEPHALIC INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
30	76·3	7	77·1	3	75·0	40	76·3	81·3	70·2

* "Crania Ethnica," p. 461.

The male skulls, the female skulls, and the skulls of undetermined sex have all, therefore, average indices in the mesaticephalic group, the females having slightly higher indices than the males. The general average is also low down in the same division.

The range of variation is 11·1.

One skull only is brachycephalic. Thirty-one, or 77·5 per cent., are mesaticephalic; eight, or 20 per cent., are dolichocephalic; but no skull has a cephalic index under 70.

Professor Flower's series of eight has a higher average index—78; but, as already pointed out, his method of calculating the index leads to a higher result than that which I have adopted. My results are more directly comparable with Sir William Turner's. The eight skulls measured by him have an average index of 75·2. The three of the "Novara" collection average 75·9. The Paris skulls average 76·3; and the adults measured by Dr. Barnard Davis, 74·9.

Combining these results—exclusive of Professor Flower's—with mine, we get from fifty-eight skulls an average cephalic index of 76·1.

The average glabello-occipital length in my male skulls is 187mm.; in the female, 175·6mm. In the males the maximum transverse diameter of the brain-case averages 142mm.; in the females, 134·2mm.; while the average of both sexes is 140·1mm.

Vertical Index.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
31	72·6	7	72·9	3	73·1	41	72·7	79·5	66·2

In all the groups the average index is metriocephalic, close to the lower limit of the group. The index of the female skulls is very slightly higher than in the case of the males, but the small number of female skulls measured makes it impossible to say whether the Morioris are really exceptions to the general rule in this respect.

The range of variation is 13·3.

Only two skulls in my set are akrocephalic, and these are both males. Twenty-one, or 51·2 per cent., are metriocephalic; eighteen, or 43·9 per cent., are tapeinocephalic. Five of the females belong to the metriocephalic group; the others are tapeinocephalic.

As the mean length-breadth, or cephalic index, is 76·3, we see that the average Moriori skull is distinctly lower than it is broad. Indeed, if we look at the measurements of the individual skulls, we find that in only two (Nos. 22 and 29) does the height exceed the maximum width, and then only by two millimetres in one case and by one in the other, while in two skulls more these diameters are equal. In one skull (No. 11) this excess of breadth over height amounts to 18mm., giving a height-breadth index of 88.

In this respect the Moriori skulls differ distinctly from the Maori. As will be seen by referring to the earlier part of this paper, the average vertical index in Maori skulls is 74·6—slightly lower than the cephalic index, which is 75·4. In them there is an excess of the cephalic index over the vertical of 0·8. In the case of the Morioris, however, the excess is 3·6. It is true that there are several Maori skulls given in the tables whose vertical indices are lower than the Moriori mean, but there is no Maori skull with an index as low as the lowest Moriori, nor no Moriori as high as the highest Maori. Also, in over 90 per cent. cf the Moriori skulls the width is greater than the height, while in only from 40 to 50 per cent. is this the case with the Maori skulls that I have examined.

The highest cephalic index and the highest vertical index belong to the same skull, and there is a general correspondence between these indices throughout the series.

Professor Flower's series have again a higher index than mine—73·9—because of the measurements selected; and Professor Turner's have an average of 73. I have not calculated this index for the "Novara" skulls, as the height given is not the basi-bregmatic; but the mean index of those in the Paris Museum is 72·8.

The average basi-bregmatic height of the male skulls that I have examined is 135·5mm.; of the females, 128·1mm.; while the combined average is 133·7mm., showing an excess of breadth over height of 6·4mm.

FRONTAL INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
31	66·1	7	67·8	3	68·7	41	66·6	73·4	57

The range of variation is here 16·4.

In my series of Maoris this index averages 68·1. The anterior narrowing of the cranium is therefore more pronounced in the Moriori than in the Maori.

In the forty skulls in which it was possible to compare them, the *asterionic diameter* exceeds the *stephanic* nineteen times; the reverse condition occurs eighteen times; and in three skulls the two diameters are equal.

Though in the majority of cases the stephanic diameter is the maximum frontal, yet in fifteen of the skulls examined the greatest frontal width lies a little below the stephanion.

INDEX OF FORAMEN MAGNUM.

Both Sexes.			
Number.	Average.	Maximum.	Minimum.
42	87·3	97·2	73·7

The range of variation is here 23·5.

ORBITAL INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
32	88·6	7	91·6	3	87·3	42	89	102·7	78·6

The male average is high up in the mesoseme division; the female is low in the megaseme; and the combined average is almost in the latter group.

The range of variation is 24·1.

Of the forty-two skulls measured, twenty, or 47·6 per cent., are megaseme; eighteen, or 42·9 per cent., are mesoseme; and four, or 9·5 per cent. are microseme. A much larger proportion (32·4 per cent.) of the Maori skulls examined were noted as microseme, while the percentage of megaseme Maori skulls was only 25.

The average female index is seen to be higher than the male. This is not the case with the Maoris measured by me.

The average index of the skulls in the Paris Museum is 96, while that of Professor Flower's series is 93·7, both considerably higher than what I give above. Professor Turner's have 88 as their average.

Combining their results with mine, we get, from a series of sixty-three skulls, an average orbital index of 90·1, a little higher than what I get from my own measurements, which brings the Moriori into the megaseme group.

The average interorbital distance in my skulls is between 20mm. and 21mm.

NASAL INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
32	46·1	7	48.2	3	50·1	42	46·8	52·9	39·6

The group of male skulls is leptorhine, as also is the general average. The female skulls and the skulls of doubtful sex are low down in the mesorhine group.

The range of variation is 13·3.

Twenty-seven skulls, or 64·3 per cent., are leptorhine; fifteen, or 35·7 per cent., are mesorhine; none are platyrhine. The anterior nasal opening is therefore narrower in these Moriori skulls than in the Maoris that I have examined.

Professor Flower's eight skulls have an average index of 46·1; Professor Turner's eight give an average of 47·4; while that of the five in the Paris Museum is 47·5. The average when these four series are combined with mine—sixty-three skulls—is 46·8, the same as that given by my collection alone.

GNATHIC INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
31	97·8	7	97·1	3	97·4	41	97·7	103	92

The above table of averages shows that all the divisions are orthognathous, though close to the upper limit of the group.

The range of variation is 11.

Nineteen skulls, or 46·3 per cent., are orthognathous. Twénty-two, or 53·7 per cent., are mesognathous. Seven have indices over 100, but none are actually in the prognathous group.

Seven of Sir William Flower's series allowed of the calculation of this index, and these yield an average of 99·2, somewhat higher than that of my set; while Professor Turner's have a mean index of 96, a trifle lower. The average of the whole fifty-six skulls is 97·6.

OPHRYO-SPINO-AURICULAR ANGLE.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
32	67°	7	69½°	3	69½°	42	67½°	72°	62°

The range of variation is 10.

The projection of the nasal portion of the face, as shown by this angle, is greater in the Moriori than in the Maori skulls.

PALATO-MAXILLARY INDEX.

Male.		Female.		?		Both Sexes.			
No.	Av.	No.	Av.	No.	Av.	No.	Av.	Max.	Min.
30	120·8	7	120·5	2	123·5	39	120·8	132·8	110·2

The average of each group is brachyuranic.

The range of variation is 22·6.

All the skulls with the exception of four are brachyuranic. The four exceptions are mesuranic. Expressing this in percentage form, 89·7 per cent. belong to the former, 10·3 per cent. to the latter group.

A palato-maxillary index is not given in the catalogue of the College of Surgeons' Museum, nor the measurements by which it is calculated. I cannot therefore compare my skulls with those in that museum in this respect. Those measured by Professor Turner seem to have had narrower palates than those included in my table, as their average index is only 113. His range of variation, between 120 and 107, differs also considerably from mine. Combining his results with mine, we get a general average of 119·5 for 47 skulls.

The *width of the face compared with that of the anterior part of the brain-case* is great. In every adult skull, whether male or female, the zygomatic arches are visible from above. In eight, the arches, though visible, do not show their opening, but in the other thirty-four they project freely beyond the part of the brain-case above them. The *maximum transverse diameter* of the brain-case is, however, exceeded by the *bizygomatic* in only six skulls, while it is the longer of the two in thirty-one. In two these diameters are equal. This proportion is much the same as that noted in connection with the Maori skulls.

Basi-nasal Length or Cranio-facial Axis.—In thirty-two males this averages 103·8mm. This is almost identical with what I find in the male Maori skull. The seven females have a mean diameter of 98·6. The extent of variation is from 116mm. to 98mm. in the males, while in one of the females the axis is 95mm.

In this dimension the Moriori skull is, like the Maori, exceeded in Professor Flower's table already referred to only by the Esquimaux, and to a very slight extent indeed by the Fijian.

Comparing the *basi-nasal length* with the rest of the *mesial vertical circumference,* as we did with the Maori skulls, we find that, taking the mean of all the measurements, the direct length from basion to nasion is 24·7 per cent. of the curve over the vertex between the same two points. This is the mean of both sexes combined. Or, making the similar comparison suggested by Professor Cleland, we get the proportion between the opistho-nasal diameter and the opistho-nasal arc to be as 1 to 2·69.

Treating the upper and lower divisions of the *transverse vertical circumference* of the brain-case in the same way we find that the mean infra-auricular distance is to the supra-auricular arc as 46·5 to 100.

Nasio-opisthic Median Arc.—The frontal portion of this curve exceeds the parietal and occipital in twenty of the thirty-two male skulls examined, while in two more, though longer than the occipital, it is equalled by the parietal. In five cases the parietal is the longest; in five also the occipital exceeds the other two. The parietal is the shortest in thirteen male skulls, the occipital in sixteen. The female skulls have the frontal arc longest thrice, the parietal also thrice, and the occipital once. The only case amongst either Morioris or Maoris in which the frontal is the shortest subdivision of the arc is the Moriori of doubtful sex, numbered 40 in Table III.

Shape of the Cranial Vault.—As already mentioned, the frontal region in a large proportion of the skulls examined is in a very marked degree flat and retreating. This has been noted by other observers. The roof-like form of the vertex in the parietal region is also a very noticeable feature of the brain-case. The median ridge varies in height, but it is present in almost all skulls, and the parietal bone between it and the eminences is almost invariably either flat or even hollowed. Those few skulls which have more rounded vaults are, for the most part, female, or scarcely full grown. This type of vertex, especially when combined with the usually prominent parietal eminences, gives to most of these skulls, when viewed from behind, a markedly pentagonal form. The narrowness of the frontal region as compared with the parietal has been already noted, and, in consequence, the skull as seen from above is decidedly obovate. The level of the *maximum transverse diameter* varies. In six skulls it is at the parietal eminences, in nine on the parietal bones lower down, in twenty-two on the squamous suture, and in four on the squamosal portion of the temporal bone. The *temporal fossæ* are large, and include the parietal eminences, and a *post-bregmatic hollowing* is not uncommon. The form and size of the glabella and superciliary ridges has been already described.

Sutures.—The coronal and sagittal sutures are, as a rule, simple. The lambdoid is complicated, sometimes exceedingly so. In many skulls the coronal suture is quite unserrated, except for a short distance above the stephanion. The part below the stephanion is always simple, and is frequently ossified; indeed, this suture shows partial or complete fusion much more frequently than does the lambdoidal. In those skulls which show commencing obliteration of the sagittal suture I have noted that the process had begun anteriorly in eight skulls; posteriorly, or in the region of the obelion, in six.

No skull in my series is metopic, but three show a short fissure in the glabella.

An *interparietal bone* is present in one skull—an adult male. In it a distinct serrated suture passes across the occipital bone from lateral angle to lateral angle. In three others, though the division of the occipital is not complete, yet there are fissures extending in towards the protuberance from the lateral angles. An interparietal bone was also present in one of the skulls examined by Professor Turner.

Pterion.—In the great majority of cases this is H-shaped, the length of the articulation between the parietal and the great wing of the sphenoid varying from 1mm. to 19mm., and averaging between 8mm. and 9mm. A K-shaped pterion was noted once. In another case the squamosal bone articulates with the frontal, but this is by means of a process projecting forward from the former bone, an epipteric which has fused with it. Free epipteric bones were noted twenty-six times in nineteen skulls. Sometimes these completely separate the four bones of the region, but in other cases the sphenoid and parietal articulate with each other either in front of or behind the epipteric bone.

Wormian Bones.—These are very often present, in addition to the epipterics just described. I have noted their occurrence in the lambdoid suture in twenty-eight skulls, in one completely separating the occipital from the parietal bones except for a very slight contact close to the asterion; at the asterion in ten; in the occipito-mastoid suture in eight; in the parieto-squamous in two. Small epactal bones were observed twice.

In the parieto-mastoid suture I have seen a wormian once; in the parieto-frontal, above the stephanion, twice; while in the suture, between the great wing of the sphenoid and the malar in the outer wall of the orbit, I have met with wormian bones in two skulls.

Paramastoid Process.—Two skulls show this projection on both sides. Two have a single process. One of these last, though broken, is 10mm. long.

Auditory Meatus.—In six skulls the lumen of the meatus is diminished, or almost obliterated, by a hyperostosed condition of its bony walls. In another, distinct exostoses are present. Two skulls show perforation of the tympanic plate. In one of these the meatus is much dilated, as if by a polypus or some other morbid growth. An exostosed condition of the meatus has been noticed by others as being not uncommon among the South Sea Islanders.

Parietal Foramen.—This is absent in eight skulls, but in several others it is very small. In twenty-three skulls it is present on one side, while in three there is a foramen in the line of the sagittal suture.

Posterior Condyloid Foramen.—The complete absence of this foramen was noted eight times. It is present on the right side alone in fourteen skulls, on the left alone in four.

Superior Curved Line of Occipital Bone.—This is, as usual, best marked in the male skulls, forming in one of them a very projecting ridge. In a large number of skulls it is distinctly double.

Equilibrium of Skull.—Posterior mastoid in eleven cases; anterior mastoid in one; double mastoid in four; posterior condyloid in two; anterior condyloid in four; posterior condylo-mastoid in two. Eighteen skulls rested on the teeth in front, and either on the conceptacula cerebelli or the posterior margin of the foramen magnum behind. In one the posterior point of support was as far back as the inion, while in another it was a paramastoid process.

Spheno-pterygoid Foramen.—In no case is this foramen present in its fully-completed form, but it is nearly perfect on one side in six skulls, and in another on both. In a somewhat less complete condition it is present on both sides in an eighth skull; whilst in ten more a bony spicule projects backwards from the posterior margin of each external pterygoid plate towards the spine of the sphenoid. In all these cases the pterygoid plate is generally broader than usual.

Nasal Bones.—In some specimens the nasal bones are short, and the root of the nose is sunken; but more often they are long, narrow, prominent and convex below, and the root of the nose is not depressed, or only slightly so: in some it is even remarkably high. The Jewish nose, which is said to have been frequently seen among the Morioris, should be remembered in this connection. It must not be supposed, however, that this form of nose is peculiar to the Morioris among Pacific Islanders. Such noses are not uncommon among the Maoris of some districts of New Zealand, and Professor Moseley * states that they occur to the extent of 5 or 6 per cent. among the Admiralty Islanders.

Lower Margin Anterior Nares.—In twenty skulls this is rounded; in thirteen sharp, as in Europeans; in six the margin is doubled; while in four it is bevelled off.

Infra-orbital Suture.—In a large number of skulls this suture is present, either complete or partially obliterated. It was noted as present on both sides in twenty-one skulls.

Third Condyle.—Though no true example of this condition was observed, in one skull a smooth articular surface was present on the anterior margin of the foramen magnum. This was probably caused by the rubbing of the tip of the odontoid process.

Lachrymal Bone.—Unfortunately, owing to the broken state of the inner wall of the orbit in many of the skulls, I was unable to determine the nature of the articulations in this region in more than a few cases. In some of these, the only peculiarity is a marked shortening of the ethmo-lachrymal suture. In one this is reduced to 5mm., in another to 4mm., and in another to 1½mm. But six skulls show peculiarities which, I think, merit special notice. In the first, the lachrymal bone of the right orbit is a narrow, delicate, curved plate, separated from the frontal by a narrow neck of bone connecting the os planum with a backwardly prolonged nasal process of the superior maxillary. In front of and behind the lower part of this rudimentary lachrymal are spaces which were probably at one time filled by additional ossicles. Behind this the orbital process of the superior maxilla sends a triangular process upwards to within 2mm. of the frontal bone. In the left orbit of the same skull the lachrymal is still further reduced, and a similar process of the superior maxilla passes up between the nasal process and the os planum, and articulates with the frontal bone. In another skull (left orbit) there is no separate lachrymal bone, but its place is taken by the extension backwards of the nasal process of the superior maxilla, behind which a broad triangular process of the frontal passes down, completely separating it from the os planum, and articulating with the orbital surface of the superior maxilla. My collection, therefore, shows two examples of the rare orbito-maxillary-frontal suture. This articulation has been described and figured by Sir William

* "On the Admiralty Islanders"; Journ. Anthrop. Inst. (1877).

Turner* and Mr. Arthur Thomson†, and it is worth noting that, though this condition was found only thrice in the 1,037 skulls in the Oxford collection examined by this last observer, yet one of these three skulls was from the Chatham Islands, while another was a Maori. The third was an Andamanese; and Professor Turner's specimens were bushmen. In another skull in my collection, in the left orbit, a triangular process from the frontal bone and one from the orbital plate of the superior maxilla approach each other between the os planum and lachrymal to within a millimetre. This small interval is filled by an ossicle distinct from both lachrymal and ethmoid. In the right orbit of the same skull the ethmo-lachrymal suture is only 1½mm. in length. In two other skulls—right orbit in one, left orbit in the other—the lachrymal bone is absent, its place being taken by a backward prolongation of the nasal process of the superior maxilla, which articulates with the os planum. A somewhat similar condition occurs in the right orbit of another skull, but two small ossicles are present in this maxillo-ethmoid suture, which almost completely separate the bones from each other. In this same orbit the frontal bone articulates with the orbital process of the palate behind the os planum. In the left orbit of this skull there is another modification of the same condition. The broadened nasal process of the superior maxilla articulates with the ethmoid behind; but the articulation is shortened below by the presence of an ossicle, which articulates with the orbital plate of the superior maxilla.

In the right orbit of another skull the osplanum is divided into three parts.

Alveolar Arch.—The curve is either parabolic or hyperbolic in almost all the specimens examined; but in three the molar portions are parallel to each other, and the arch would be classed by Broca as hypsiloid. In one skull there is a slight incurvation of the premolar region.

Lower Jaw.—The mandible is present in fourteen skulls, and shows considerable variation as to the degree of rounding of the angle and the character of the lower margin of the body, some bones being of the ordinary European type in these respects, others being convex from behind forwards, as we have seen is frequently the case with this bone among the Maoris. The coronoid exceeds the condyloid height in every case except one, and in it the two diameters are equal. The bigonial width also exceeds the gonio-symphysial length in every case. In one, however, these measurements differ by only 1mm.

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* "'Challenger' Report": Human Crania, pl. i.

† *Loc. cit.*

Teeth.—With the exception of the third molars, the teeth are always much worn, though the second molar is not as a rule so much so as the first. The first molars in the upper jaw occasionally show the same dislocation and peculiar wearing already described in connection with the teeth of Maori skulls.

In seven adult skulls the absence of one or both third molars was observed; and in a lower jaw, also adult, there was no second premolar on the right side, the second milk molar being still in place.

Though in no case was any trace of dental caries recognised, yet in six skulls—three males and three females—the cavities caused by alveolar abscesses are present.

Children's Skulls.—Two of the young skulls (Nos. 49 and 50) in Table III. are, in my opinion, Maori. The other four I regard as Moriori, and their more important features I shall now briefly note. Their cranial capacity, though of course lower than that of the adult skulls, is still comparatively high, as it averages 1,358c.c. The average cephalic index is 79·9, considerably higher than that of the adult, and showing them to be on the verge of brachycephaly. The average vertical index, 74·8, is also higher, but in all four skulls the width exceeds the height of the brain-case. The frontal index, 64·3, is lower than in the adult skulls, and shows the greater preponderance in width of the posterior over the anterior part of the brain-case in the child. The orbital index, 95·3, and the nasal index, 51, are also much in excess of those of the adult. The distinctly lower gnathic index, 89·5, and the wider facial angle, 77·8°, are due to the infantile condition of the face. The feeble development of the face is also shown by the slight projection of the zygomatic arches, and by the proportion between the transverse width of the brain-case and the bizygomatic width. In all four skulls the former exceeds the latter. The shortness and width of the palate in the child is well shown by the high palato-maxillary index, 143·2.

Vertebral Column (Maori).

I give in Table IV. the measurements and the indices of thirteen more or less complete Maori columns. The measurements given are the anterior and posterior vertical diameters, and the transverse and antero-posterior horizontal diameters of the vertebral bodies. The horizontal diameters are taken at the lower surface.

The indices of the individual vertebræ, the vertebral indices, are calculated from the formula—

$$\frac{\text{Posterior vertical diameter} \times 100}{\text{Anterior vertical diameter}};$$

and the general indices of the different regions—cervico-, dorso-, and lumbo-vertebral, according to the formula—

$$\frac{\text{Sum of posterior vertical diameters} \times 100}{\text{Sum of anterior vertical diameters}}.$$

I give the general index for each region, but I have not thought it necessary to give the indices of the individual vertebræ, except in the case of those in the lumbar region.

Cervical Vertebræ.

The average *cervico-vertebral index* of the columns given in the table is 105·8, showing that the sum of the anterior diameters of the bodies is less than that of the posterior diameters, and that consequently the cervical curve is due to the intervertebral discs being deeper in front than behind. In one column the sum of the anterior and posterior measurements in this region is nearly equal, the index being 101·3, while the greatest difference between the two is seen in the column whose cervico-vertebral index is 107·9. In no case, therefore, does the anterior depth exceed the posterior.

In no case does the body of the sixth cervical vertebra exceed that of the seventh in transverse diameter, but its antero-posterior diameter was noted as greater in four cases, as equal in two, and as less in one than the corresponding measurement of the seventh.

The condition of the *cervical spines* in certain of the lower races has been described by Owen, Hamy, Turner, and Cunningham. These observers have noted that in these races the spines, instead of being bifid at their extremities, as is usually the case among Europeans, are either simple or but slightly bifurcated. The typical European arrangement is that the spines of the second, third, fourth, and fifth vertebræ are bifid; the sixth spine is frequently simple; and the seventh is invariably long and not bifid. In the coloured races it has been shown that, while the axis as a rule still retains its bifid spine, the third, fourth, and fifth vertebræ have spines which are not only shorter than in Europeans, but are more frequently not bifid. The following table shows that the Maori spinal column agrees in this respect with those of the uncivilised races already examined.

—	Bifid.	Feebly Bifid.	Not Bifid.
Second cervical vertebra ..	5	2	2
Third " ..	1	3	5
Fourth " ..	3	1	5
Fifth " ..	2	2	4
Sixth " ..	0	2	7
Seventh " ..	0	0	9

I have examined twenty *atlas* vertebræ. In none is the vertebral groove behind the lateral mass completely bridged by bone on both sides; but in three a complete foramen is present on one side, while in six others an imperfect arch was noted in this position. In one of the bones in which this foramen occurs the rarer condition of a bony bridge passing from the lateral mass to the upper surface of the transverse process is also present.

Fusion of the atlas with the occipital bone was seen once. This occurs in a female skull, and the anchylosis is between the lateral masses and anterior arch of the atlas and the corresponding parts of the occipital.

The *axis* in one instance seems to have articulated with the margin of the foramen magnum. In this bone a distinct flat eburnated surface occurs on the anterior surface of the tip of the odontoid process.

Dorsal Vertebræ.

The average dorso-vertebral index of the nine columns measured is 106·2, showing the posterior depth of the bodies to be greater than the anterior. This difference is most marked and most constant in the lower half of the dorsal region. The indices vary from 104·3 to 111·6.

The transverse measurements of the bodies show that the smallest vertebra, as in the European column, is either the fourth or the fifth. I should mention that in taking this measurement I have omitted the projection of the costal articular surfaces. The antero-posterior diameters show a steady increase from the first to the last vertebra. In several columns in the lower part of the region the maximum diameter is oblique, passing anteriorly somewhat to the right.

The costo-central articulations do not differ much from the ordinary European type. In one column from Hawke's Bay the last rib to articulate with two vertebræ is the eighth. The eighth vertebra has therefore one demi-facet above on each side of its body, and none below. The ninth has a single facet, as have also the tenth and eleventh. The usual costal facet on the twelfth vertebra is not present, but instead there is a small articular surface on the outer side of its transverse process. This vertebra therefore closely resembled a lumbar when its costal process was in position. In another column a similar condition of the twelfth vertebra was noticed, the rib-surface being very small, and much further back than usual. In one column the tenth rib articulates with the ninth dorsal vertebra, as is not uncommonly seen in Europeans. In three cases there is no articulation on either side between the transverse process of the tenth dorsal vertebra and the tubercle of the tenth rib; and in three more the absence of this articulation on one side was observed.

The spines of the twelfth and eleventh dorsal vertebræ were noted as being exceptionally small in one female column. In two cases I observed a spinous process in the upper dorsal region, divided longitudinally into two approximately equal parts, due no doubt to a want of union between the two centres from which the neural arch is developed.

Lumbar Vertebræ.

The average lumbo-vertebral index of the twelve sets of lumbar vertebræ given in the table is 105·9, showing that the sum of the posterior vertical diameters of the bodies exceeds the sum of the anterior measurements. The highest index, that of a male, is 116·4, and the lowest, also a male, is 95·3. In this latter case and in two others, females, the index is under 100, and shows that in these the anterior depth is greater than the posterior, though the average of the series shows the reverse condition. The Maori vertebral column, described by Professor Turner in his "'Challenger' Report," has a lumbar region whose index is 100, the sum of anterior and posterior vertical diameters being the same, 101mm.

Professor Cunningham, in his memoir on the lumbar curve,* shows that the European differs markedly from the uncivilised races in the relation between the anterior and posterior depths of the vertebræ in the lumbar region; and Sir William Turner has made the same observation. The sum of the anterior depths is in the European greater than the sum of the posterior depths, and the vertebræ are, in consequence, shaped in a manner favourable to convexity of the lumbar portion of the column. In savage races, on the other hand, the opposite condition holds, and the vertebræ are shaped in a manner unfavourable to the curve. The average index of seventy-six Europeans measured by Cunningham is 95·8; that of the Andaman Islanders, according to the same observer, is 104·8; of Negroes, 105·4; and of Australian blacks, 107·8; while in the gorilla, chimpanzee, and orang it is still higher. The Maori then, judging from my measurements, has an index practically the same as that of the Negro, and widely different from the European.

The divergence from the European type is more fully brought out if we compare the indices of the individual vertebræ in the two races, as in the following table, in which the European column is taken from Dr. Cunningham's paper.

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* "The Lumbar Curve in Man and the Apes," "Cunningham Memoirs," No. II. Royal Irish Academy. 1886.

—	Seventy-six Europeans.	Twelve Maoris.
Index of first lumbar vertebra ..	106·1	128·6
" second " ..	101·4	116·0
" third " ..	97·2	107·5
" fourth " ..	93·5	97·1
" fifth " ..	81·6	87·0

Not only does the table show that the index of each vertebra is higher in the Maori, but also that, while in the European only one vertebra—the first—has the posterior surface of its body distinctly deeper than the anterior, in the Maori, on the contrary, there are three—the first, the second, and the third—deeper posteriorly than anteriorly.

In Sir William Turner's Maori the first and second vertebræ are also deeper behind than in front, the third and fourth are of equal depth on both surfaces, and the fifth is deeper in front than behind.

The following table shows to what extent the individual vertebræ agree with the average.

—	Anterior Depth of Body greater than Posterior Depth.	Anterior Depth of Body equal to Posterior Depth.	Anterior Depth of Body less than Posterior Depth.
First lumbar vertebra ..	0	0	12 (100%)
Second " ..	0	0	12 (100%)
Third " ..	0	3 (25%)	9 (75%)
Fourth " ..	5 (41·7%)	5 (41·7%)	2 (16·7%)
Fifth " ..	12 (100%)	0	0

Looking now to the sexual differences as shown by the measurements, we find the average general index of the seven males to be 106·2, while that of the five females is 104·4. The relatively greater posterior depth is therefore shown by the lumbar vertebral bodies in both sexes, but the females have it in a less decided degree than the males, though, as before noted, the lowest index in the whole series belongs to a male column.

The table below gives the average indices of the individual vertebræ grouped according to sex, and shows that though both sexes clearly have their lumbar vertebræ built on the savage type, yet that those of the Maori woman, like her European sister's, are shaped in a manner more favourable to the lumbar curve than those of the male.

—		Seven Males.	Five Females.
First lumbar vertebra	.. ..	130·2	126·4
Second "	.. ..	117·9	113·7
Third "	.. ..	108·1	106·7
Fourth "	.. ..	97·2	97·1
Fifth "	.. ..	87·8	85·8

In two cases the body of the first lumbar vertebra shows a much more than usual excess of the posterior depth over the anterior. In one of these, while the depth behind is 28mm., in front it is 18mm., and in the other the depth diminishes from 25mm. to 15mm. In both there is also considerable transverse hollowing of the upper surface.

Imperfections in the devolopment of the neural arch were more frequently seen among the lumbar vertebræ than in the dorsal region of the spinal column. The separation of its posterior part (the laminæ with the spine and the inferior articular processes) from the pedicles was observed nine times. Six of the fifth lumbar vertebræ show this peculiarity; the fourth shows it in two instances; and even in the third I noted it once. In this latter case not only does the third vertebra show this defect in ossification, but the fourth also, as if to compensate for the undue rigidity of the loins caused by the fusion of the fifth vertebra with the sacrum which is present.

The fifth lumbar vertebra was seen to articulate by an enlarged transverse process with the lateral mass of the sacrum in three instances, and fusion between these bones occurs in the one case noted above.

The presence of a lumbar rib was noted once. This articulated with the right side of a first lumbar vertebra. The transverse process on this side is like that of the twelfth dorsal vertebra, while on the pedicle is the articular surface for the rib. The other side is normal.

STERNUM (MAORI).

I have seen only one sternum in which the manubrium is fused with the body of the bone. In all the others these two segments are distinct.

PELVIS (MAORI).

In Table V. I give the measurements of twenty-four Maori pelves, ten males and fourteen females.

The following are the measurements adopted, given in the order in which they occur in the table :—

Breadth of entire pelvis : The maximum distance between the outer lips of the iliac crests.

Breadth between anterior superior iliac spines : The distance between the most prominent parts of these eminences.

Breadth between posterior superior iliac spines ; The distance between the inner borders of the spines.

Height of entire pelvis : From the highest part of the iliac crest to the most distant part of the tuberosity of the ischium.

Breadth between the outer surfaces of the tuberosities of the ischia : The maximum width.

Breadth between the ischial spines : Between their tips.

Breadth of Sacrum : The maximum width across the base.

Length of Sacrum : The distance in a straight line from the middle of the anterior border of the upper surface of the first sacral vertebra to the corresponding point on the lower border of the fifth. Even in sacra with six vertebral elements the same points are chosen.

Length of sacral arc : The length of the sacrum taken in a curve along the front of the bodies. By comparing this length with that taken in a direct line, the arc with its cord, a good idea is got of the degree of curvature of the bone.

Pubo-ischiatic depth : The distance between the upper surface of the pubis immediately in front of the ilio-pectineal eminence and the lowest part of the tuberosity of the ischium. This gives the depth of the pelvic cavity laterally.

Depth of pubic symphysis.

Transverse diameter of pelvic brim : The maximum width between the ilio-pectineal lines.

Sagittal or conjugate diameter of pelvic brim : From the middle of the upper margin of the anterior surface of the first sacral vertebra to the nearest point on the posterior surface of the pubic symphysis. When a median ridge is present on the pelvic face of the symphysis the measurement is taken somewhat to one side of the middle line.

Transverse diameter of pelvic outlet : Taken as recommended by Dr. Garson, between the most widely separated points on the lines which pass forwards from the ischial spines towards the lower ends of the obturator foramina.

Sagittal diameter of pelvic outlet : From the centre of the lower margin of the fifth sacral vertebra to the lowest part of the pubic symphysis.

Subpubic angle.

Height of acetabulum : From the upper margin below the anterior inferior iliac spine to the opposite border of the cavity.

Breadth of acetabulum : Taken across the cavity at right angles to the previous measurement.

Height of obturator foramen.
Breadth of obturator foramen.
Interobturator width: The distance between the inner margins of the obturator foramina.
Breadth of innominate bone: The distance between the angle of the os pubis and the most distant part of the iliac crest, generally a little above the posterior superior iliac spine.
Breadth of ilium: The distance between the anterior superior and posterior superior spines of the ilium.

As far as possible, the measurements about the innominate bone were taken on the right side.

The indices used, and the formulæ by which they are calculated, are as follow:—

Breadth-height index	$\frac{\text{Pelvic height} \times 100}{\text{Pelvic breadth}}$
Index of the pelvic brim	$\frac{\text{Sagittal diameter of brim} \times 100}{\text{Transverse diameter of brim}}$
Index of the pelvic cavity ..	$\frac{\text{Pubo-ischiatic depth} \times 100}{\text{Transverse diameter of brim}}$
Sacral index	$\frac{\text{Sacral width} \times 100}{\text{Sacral length}}$
Obturator index	$\frac{\text{Obturator width} \times 100}{\text{Obturator height}}$

The following table gives the *breadth* and *height* of the whole of the pelvis, and the *height-breadth* index, or proportion between the two, distinguishing the sexes, and giving the maximum and minimum as well as the average in each case.

—	Male.				Female.			
	No.	Av.	Max.	Min.	No.	Av.	Max.	Min.
Pelvic breadth	10	261·4	285	243	14	258·6	290	243
Pelvic height	10	213	232	200	14	200	208	191
Height-breadth index ..	10	80·8	85·2	75·4	14	77·6	85	68·3

The greater height of the male pelvis, not only absolute, but relative to width, is clearly shown in the table.

The measurements of two Maori pelves, both males, are given by Sir William Turner.* The maximum width of one is 255mm., and its height is 221mm.—a pelvis, therefore, somewhat narrower and higher than the average of my male specimens. Its index is 87, higher than that of any in my series. In the other pelvis, which was scarcely full grown, the breadth is 238mm., the height 188mm., and the index 79mm.

* "'Challenger' Report": Human Skeletons, part xlvii.

These twelve male pelves are, on the whole, both narrower and shallower than the average pelvis of the European male, but the height is proportionally to the breadth slightly greater in the Maori, as is seen by comparing the height-breadth index in the two races. The average male index, as given by M. Verneau, in Europeans is 79.

The female Maori pelvis, so far as shown by the fourteen now described, is also narrower than that of the European female, but is its equal as to height. It has therefore a higher index, that of the European female being 74 according to M. Verneau, 75 according to Dr. Garson.

In both sexes, then, but to a slightly greater extent in the female than in the male, the Maori pelvis is higher relatively to its width than is the case with the majority of Europeans.

The following table, arranged like the last, gives the average measurements and index of the *brim of the pelvis* :—

	Male.				Female.			
	No.	Av.	Max.	Min.	No.	Av.	Max.	Min.
Transverse diameter ..	10	118·3	127	109	14	127·5	136	117
Sagittal diameter ..	10	101·2	112	90	14	111·8	131	94
Index of brim ..	10	86·1	92·2	79·6	14	87·7	102·3	70

The figures show that while the two diameters of the brim are, as is always the case, longer in the female than in the male, yet that the proportion between them is much the same in the two sexes, the female showing a slightly greater proportional length in the sagittal diameter.

It is curious that both the highest and the lowest index should be found among the female pelves. The maximum index, 102·3, does not, however, belong to a pelvis with an unusually short transverse diameter. On the contrary, this is 128mm., a little above the female average. It is the great length of the antero-posterior measurement which is the cause of this exceptionally high index. This is the only pelvis of either sex in which the antero-posterior diameter of the brim exceeds the transverse.

Professor Turner's two male pelves have higher brim indices than of any of my males. In one the index is 97, and in the other it is 95. Even allowing for the fact that Professor Turner measures to the back of the upper end of the symphysis, the indices show that in these two pelves the conjugate diameter is longer proportionally to the transverse than in any of the male pelves that I have measured. Including these two pelves with mine, we get an average brim index for males of 87·9, a little higher than that given in the table, and almost the same as that yielded by the measurements of the female pelves.

If we now compare the Maori and European pelves with regard to these measurements of the brim, we find that the antero-posterior is longer relatively to the transverse in the Maori of both sexes than in the European. M. Verneau gives the brim index in European males as 80, in females as 78; Professor Turner gives 77 for males and 79 for females as the result of his measurements; Dr. Garson gives 80 for females; Sir William Flower, 81 for males, 78 for females; and, though some anatomists give higher results, those of others—as, for example, Martin, who gives 69 as the brim index of Irish women—are lower.

We may safely say, then, that the Maori pelvis, with its index of nearly 88, is narrow compared with the European type, but it falls into the same group if we follow Sir William Turner's classification. He divides pelves into three groups—platypellic, those with a brim index below 90; mesatipellic, those whose index is from 90 to 95; and dolichopellic, those whose index is above 95. Europeans, Chinese, and some savage races, such as American Indians and Fuegians, belong to the first group; Negroes are found in the second; while Australians and Andaman Islanders are members of the third. According to my measurements, the Maoris, both male and female, are also platypellic. All the pelves in my series, however, do not belong to this group. Fifteen—seven males and eight females—do so; but six—three males and three females, are mesatipellic; and the remaining three females are dolichopellic. Professor Turner's two males are also dolichopellic.

The *depth of the pelvic cavity*, as shown by the pubo-ischiatic diameter, and its relation to the transverse diameter of the brim, are shown in the following table.

—	Male.				Female.			
	No.	Av.	Max.	Min.	No.	Av.	Max.	Min.
Pubo-ischiatic depth ..	10	98·1	103	85	14	91·4	96	84
Transverse diameter of brim	10	118·3	127	109	14	127·5	136	117
Index of pelvic cavity ..	10	83	89·9	76·6	14	72·3	82	64·7

The difference between the average depth in the male and in the female is seen to be 6·7mm. In a previous table it was shown that the average height of the entire male pelvis exceeds that of the female by 13mm. The lower height of the pelvis in the female is therefore shown to be due in almost equal proportions to a shortening of the iliac bones and to a shallowing of the pelvic cavity.

The characteristic shallowness of the female pelvis is, however, brought out in a more striking way by taking not the absolute depth, but the index of the pelvic cavity—that is to say, the proportion between the pubo-ischiatic depth and the width as taken at the brim. As shown in the table, the male index exceeds the female by 10·7.

Professor Turner's two specimens have a depth of 92mm. and 106mm., and scarcely alter the average. Their indices are 84·4 and 86·9. These raise the male average to 83·4.

The *width of the pelvic outlet* in the males averages 94·1mm.; in the females, 114·1mm.

There is very little difference between the sexes as to the *depth of the pubic symphysis.* In the males it averages 36·3mm.; in the females, 35·7mm.

The *obturator foramen* is, as usual, wider in the female than the male. The mean male index is 62·7; the female, 71·7.

The *subpubic angle* also shows the customary greater width in the female pelvis, the average angle in the males being 63·3°; in the females, 82·1°.

The *acetabulum* is in almost every case smaller in the female than in the male. In fourteen cases its two diameters are equal; in ten the height slightly exceeds the width.

Sacrum (Maori).

Twenty-five sacra were sufficiently perfect to allow me to measure both the length and the breadth. Their measurements are summarised in the short table below. The individual measurements of twenty-four are given with the pelves in Table V. Nine of these are given again with the twenty-fifth, in the table of vertebral columns (Table IV.).

In eight bones a sixth vertebral element is present. This is the first coccygeal in seven instances, and the fifth lumbar in one. In measuring the length, this additional vertebra is, as already explained, always omitted.

—	Male.				Female.				M. and F.	
	No.	Av.	Max.	Min.	No.	Av.	Max.	Min.	No.	Av.
Sacral breadth ..	9	115	123	108	16	119·9	128	101	25	118·1
Sacral length ..	9	105·9	113	97	16	102·6	121	85	25	103 8
Sacral arc ..	9	114·7	122	108	16	111·1	125	97	25	112·4
Sacral index ..	9	108·8	126·8	101·9	16	117·2	135·2	99·2	25	114·2

Comparing these figures with the transverse diameter of the pelvic brim, we find that in the male pelvis the sacral width is 97 per cent. of the brim width, while in the female it is 94 per cent., showing that the curvature of the back part of the iliopectineal lines is more pronounced in the female than in the male.

It will also be seen that the average degree of curvature of the sacrum, as got by comparing the length with the arc of the bone, is practically the same in both sexes.

Though the female index is distinctly higher than the male, it is worth noting that the highest and lowest indices both belong to female sacra.

The length of the sacrum in Professor Turner's two male Maoris is 101mm. and 120mm., while the breadth is 97mm. and 115mm. The sacral index is in each case, therefore, 96. If we include these with my set of males we get an average for that sex of 106·5, nearly eleven less than the average female index.

According to M. Verneau's measurements, the average length of the European sacrum is 105mm. in males, and 101mm. in females, while the width in the male is 118mm. and in the female 116; though Dr. Garson gives this latter average as 118·3. The Maori sacrum, then, so far as my measurements go, is in both sexes of almost the same length as the European; but it is somewhat narrower in the male and broader in the female than the European average for each sex.

Looking to the proportion between these two measurements, the index, we see that the Maori sacrum is in both sexes broader than it is long, and, in consequence, belongs to the platyhieric group (platyhieric, index over 100; dolichohieric, index under 100)*, in common with Europeans. The male sacra are, however, almost in what Professor Paterson† calls the subplatyhieric division—those with an index between 100 and 106, a group containing, amongst others, Andaman Islanders and Negroes. The female sacra have, on the other hand, indices equal to the average of the European female. Only one sacrum is dolichohieric, and that is a female with an index of 99·2.

As five of my pelves belong to skeletons of which I have also the skulls, I give in the following table some of the more important indices of the two cavities in each body.

* Professor Sir William Turner: "'Challenger' Report": Human Skeletons.

† "The Human Sacrum": Royal Society Proceedings, 1892.

Cephalic.	Vertical of Cranium.	Pelvic Brim.	Breadth-height of Pelvis.	Sacral.	Sex.
76·6	70·7	81·9	82·3	112·3	M.
76·1	71·3	82·9	84·5	103·7	M.
80·0	79·4	86·5	81·1	108·9	M.
75·4	66·8	90·2	81·2	..	M.
74·0	74·6	90·0	74·9	115·9	F.

The above comparison does not seem to bring out anything definite as to whether certain types of pelvis accompany certain forms of skull, and the number of instances is too small to be of any value by themselves. They may possibly assist others with more material at their disposal.

Bones of the Limbs (Maori).

The principal measurements of the limb-bones of thirteen skeletons, nine of which are male and four female, are given in Table VI. Few of these skeletons are sufficiently perfect to allow of all the bones being measured, but I include in the table all those which have allowed of any of the usual comparisons between bones of the same body being made. In the text I give also the results of the measurements of numerous other bones, none of which could be with certainty identified as belonging to the same skeleton.

Scapula.

The measurements were taken in the manner originally proposed by Broca, and adopted by Flower, Garson, Turner, and others. The *length* is the distance in a straight line between the upper and the lower angles. The *breadth* is the distance between the centre of the posterior margin of the glenoid cavity and the point where a line drawn along the attached margin of the spine would cut the posterior border of the bone. The *infra-spinous length* is the distance between the last point and the inferior angle. The two indices are also calculated in the usual way:—

$$\text{Scapular index} = \frac{\text{Breadth} \times 100}{\text{Length}}.$$

$$\text{Infra-spinous index} = \frac{\text{Breadth} \times 100}{\text{Infra-spinous length}}.$$

Twenty-five scapulæ were sufficiently perfect to let me make the above measurements; of these, thirteen were right bones, and twelve belonged to the left side. I have not attempted to distinguish male and female bones, excepting in the case of those included in the table, which belong to skeletons sufficiently perfect to allow of the sex being determined. Though the number of undoubted female bones is too few to permit of any conclusions being drawn from their measurements, it may, however, be of interest to note that their average scapular index is higher than that of the males, in this respect resembling European bones.

The scapulæ examined vary in their length from 174mm. to 142mm., and in breadth from 119mm. to 90mm. The mean length is 156·9mm., and the mean width 102mm. The average scapular index is 64·9; the extremes are 70·6 and 60. There is practically no difference between the bones of the two sides in this proportion. The average infra-spinous index is 89·4. The extremes are 100 and 72·4, showing that in the Maori, as in other races, there is great individual variation in the position of the spine. In Sir William Turner's "'Challenger' Report"* he gives the indices of a Maori scapula from Otago. In this bone the scapular index is 63·9, and the infra-spinous 88·5. M. Livon† has measured thirty-two Polynesian scapulæ, but how many of these are Maori I cannot say. He gives the scapular index as 66·6.

The broadest scapulæ seem to belong to the Andaman Islanders, whose index is 70·2; the narrowest to the Tasmanians, with an index of 60·3; while the average index of 65·3 shows the European bone to be slightly broader than the Maori.

The scapulæ were also examined with reference to the condition of the supra-scapular notch. In seven bones no notch is present, and the upper border forms one continuous concavity from the upper angle to the base of the coracoid process, while in several others the notch is very shallow. In no case did I notice ossification of the supra-scapular ligament.

Clavicle.

The length was taken in a straight line between the extremities of the bone. I have measured twenty-nine clavicles —fourteen belonging to the right side, and fifteen to the left. The average length of the entire series is 143·3mm.—that of the right bones 141·5mm., of the left bones 144·9mm. This excess in length of left bones over right was also observed in the clavicles of the eight skeletons in which I was able to compare the bones on the two sides. In seven of these the left was the longer bone, and in the eighth the right exceeded the left by only 1mm. The maximum length observed is 171mm.; the minimum 130mm.

The condition of the subclavian groove was looked at in each case. It is almost invariably shallow and indistinct.

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* "Human Skeletons," part xlvii.

† Quoted by Turner, *loc cit.*

Claviculo-humeral Index.

The relation between the lengths of clavicle and humerus was noted fifteen times, and the index was calculated according to the formula—

$$\frac{\text{Length of clavicle} \times 100}{\text{Length of humerus}}.$$

The average of these fifteen indices is 45·8—the maximum is 50·5, the minimum is 41·9. The left indices are higher than those of the right side.

Humerus.

The *length* given is the distance between the highest part of the head and the lowest point on the trochlear surface.

I have measured forty-three bones, and these have an average length of 310·3mm. The longest humerus measured 342mm., the shortest 285mm. Twenty of these belong to the right side, and have an average length of 310·9mm. The average length of the twenty-three left bones is 309·9mm. This shows a trifling preponderance in length of the right bones over the left. In the ten cases in which I was able to compare the bones of the two sides I found the right the longest bone eight times, and equal to the left twice. In the fifty bones examined I found a supra-trochlear foramen present in only three—that is to say, in 6 per cent. This is very little higher than the proportion in which this perforation occurs in Europeans, and differs greatly from what I expected to find. M. Topinard* gives the percentage of perforated bones among Polynesians as 34·3, and among Melanesians as 14·1. There is certainly a very marked difference in this respect between the bones examined by him and those of my series.

In no bone did I see any trace of a supra-condyloid spine.

Radius.

The *length* is the distance between the upper surface of the head and the tip of the styloid process.

The number of bones measured was thirty-five. These have an average length of 245mm. The longest bone measured 276mm., the shortest 216mm. The difference between the right and left radii is slight, the seventeen right bones having an average length of 246·6, the eighteen left bones averaging 244·7mm.

Ulna.

Two *lengths* are given—one, the maximum, from the highest part of the olecranon to the tip of the styloid process; the other to the base of the styloid.

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* "Eléments d'Anthropologie Générale," p. 1016.

Thirty-five bones were measured. The average maximum length of these is 261·6mm., but they vary between 284mm. and 237mm. The eighteen right bones have an average length of 262·4mm.; the left are slightly shorter, averaging 260·8mm.

The antero-posterior curve of the upper third of the shaft is more pronounced than in European bones.

Radio-humeral Index.

The proportion between the maximum lengths of the humerus and radius is expressed by this index, and is calculated according to the formula—

$$\frac{\text{Radial length} \times 100}{\text{Humeral length}}.$$

This I have been able to calculate in twenty cases, taking both right and left arms. In one it is as high as 82·3, in another as low as 72·8, and the average of the set is 77·8. Professor Turner has given this index in two New Zealand skeletons, and these have a mean of 76·5. The mean index of five Polynesians, as given by M. Topinard, is 76. He does not state, however, whether any of these are Maoris.

Amongst Europeans this index averages between 73 and 74. The forearm of the Maori, therefore, is, relatively to the upper arm, longer than it is among the civilised races of Europe. In this respect, however, the Maori is exceeded by the Negro, with an average index of 79, and by a few other savage races.

Sir William Turner proposes to divide races into three groups, according to the height of this index: Brachykerkic, those with an index below 75—*i.e.*, with a relatively short forearm (Europeans, Esquimaux, &c.); dolichokerkic, those with an index above 79—*i.e.*, with a relatively long forearm (Andamanese, Negritos, &c.); and mesatikerkic, those with an index intermediate (Australians, Negroes, &c.). He places Polynesians generally in the middle group, and my measurements show that the Maoris are also mesatikerkic.

If we now look at the influence of sex on this index, as shown in my table, we find that the series of fourteen males have an average index of 78·7, while the average of the six females is only 74·3. It is possible that the female skeletons examined by me have exceptionally short forearms; but, as shown by Topinard,* this index in the female is in all races measured by him lower than in the male; and my results, so far as they go, point to this rule holding also amongst the Maoris.

Os Innominatum.

The measurements of this bone are given with the description of the pelvis.

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* *Loc. cit.*, p. 1043.

Femur.

The table gives the length of the bone as measured in two different ways. One shows the *maximum length* of the bone from the summit of the head to the lowest part of the internal condyle; the other is taken in the oblique position that the bone has in the body, and gives the distances between the highest part of the head and the plane of the condyles. The maximum distance between the top of the great trochanter and the internal condyle is also given, as well as the trochanteric length in the oblique position.

Fifty bones were measured, and the average maximum length of these is 437·5mm. The twenty-six bones of the right side give an average of 438·5mm.; the twenty-four of the left, 436·3mm. This slightly-greater length of the right bones is, however, not shown in those skeletons in which I was able to compare the bones of opposite sides. In six of these the left bones are the longer; in one the right and left are equal; while in four only does the right exceed the left. The longest femur measures 494mm.; the shortest is only 399mm. in length.

I measured also the antero-posterior and the transverse diameters of the shaft of the bone at its centre, as recommended by Topinard, so as to ascertain the degree of projection of the linea aspera. Taking the transverse width as 100, an index was calculated, which is called by Broca "The Index of the Section of the Femur." I call it in the table the index of the middle of the shaft, as I give another for the section of the upper fourth. The transverse diameter taken is parallel to the plane of the posterior surfaces of the condyles, and is in almost all cases slightly less than a diameter taken in somewhat oblique direction at the same level. My results are as follows: The average index of fifty femurs is 115·8, varying from 138·1 to 96·4. Three, or 6 per cent., of the bones have indices over 130; thirteen, or 26 per cent., have indices between 120 and 130; twenty, or 40 per cent., have indices between 110 and 120; thirteen, or 26 per cent., have indices between 100 and 110; and in one only is the index under 100. In a table given in Topinard's Anthropology* this index, in thirteen New Caledonians, is shown as averaging 127·6; while in two prehistoric femora it is still higher; but in none of the other races given does it reach the Maori average as given above. The "fémur à pilastre" may therefore, I think, be regarded as developed to a more than usual extent among the Maoris.

I also give in the table an index which I call the index of the upper fourth, which gives the proportion between the

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* P. 1019.

antero-posterior and transverse diameters of the shaft in its upper part. The transverse diameter is taken as 100. The peculiar flattening and widening of the shaft at this level was first described by Sir William Turner in a Maori femur, but it was subsequently recognised as being a common feature of the femora of savage races. In giving numerical expression to this proportion I make the measurements at the level where the spiral line crosses below the inner border of the root of the lesser trochanter. This point is, as a rule, at the widest part of the bone, and is fairly regular and easily determined. The average index of the fifty bones measured is 64·3, and the variation is between 81·3 and 54·8. This flattening I find is an adult characteristic, and is not seen in young bones. For the sake of comparison, I measured the shaft at the same level, and calculated the indices in twenty European femora. The average of these indices is 86·6, showing that the shaft has here a much rounder section than in the Maori.

Though I did not measure the angle that the neck of the femur makes with the transverse vertical plane, I noticed that the neck in Maori bones, as a rule, projects more forwards than in the European femora with which I was able to compare them.

Tibia.

I give two longitudinal measurements of this bone. One, the "maximum," includes the malleolus, but not the spines. The other excludes both malleolus and spines. These measurements were taken in forty bones, and the average of the maximum length is 354·8mm. The longest tibia has a length of 394mm.; the shortest measures 319mm. The average length of the right bones exceeds that of the left by 5·3mm.

The measurements from which the *index of platycnemia* was deduced were taken as directed by Broca, at the level of the medullary foramen; and the index was calculated according to the formula—

$$\frac{\text{Transverse diameter} \times 100}{\text{Antero-posterior diameter}}.$$

Forty-five bones allowed of these measurements being taken, and the average index of the series was found to be 64·2. The most platycnemic bone has an index of 53·1, while that in which the lateral compression is least marked has an index of 76·5. In most bones the rounding of the posterior surface which is characteristic of platycnemia is well seen. Mr. Arthur Thomson* gives the indices of two Maori tibiæ mea-

* "On the Influence of Posture in the Form of the Articular Surfaces of the Tibia and Astragalus": Journal of Anatomy and Physiology, 1890.

sured by him as 64·7 and 73·5. A well-marked degree of platycnemia is therefore characteristeric of the Maori tibia, contrasting strongly with what the European bone shows in this respect, to which an index of 73·7 is given by Thomson as the result of the measurement of twenty-one specimens. But even among races of a corresponding civilisation the shaft of the Maori tibia is more than usually flattened, as may be seen by referring to the tables of this index as it occurs among other savage races, given in M. Topinard's book and in Mr. Thomson's papers on the subject.

I have also, following Mr. Thomson, examined all the bones that have come under my observation as to the antero-posterior curvature of the external condyloid surface. I have noted it as convex in twenty-eight cases, as plano-convex from before backwards in ten, as flat in one, and as concave in five.

Mr. Thomson has also been the first to note the presence of a facet on the anterior margin of the lower end of the tibia. This, though occasionally met with in Europeans, is of much more common occurrence among savages, and is caused by the pressure of the upper surface of the neck of the astragalus. This condition I carefully looked for, and in every bone examined except two a greater or less degree of flattening or hollowing was found to be present. The antero-posterior curve of the shaft is also more pronounced than among Europeans; but, while in some bones the curve is fairly regularly distributed along the length of the bone, in others it is mainly confined to the upper fourth.

That the squatting posture is the cause of these last peculiarities admits, I think, of no doubt. They are met with in the living races that adopt that attitude, and are all readily explained by the contacts, pressures, and muscular strains consequent on that position, which was also universal among the Maoris at the time when the individuals lived whose skeletons I have examined. Till recently, however, platycnemia has not been put down to the same cause. It is generally said to be due to the muscular development—tibialis posticus—caused by an active life in a rough, hilly country. Professor Havelock Charles,* however, shows that the tibia of the natives of the Panjab have not only the altered outer condyle, the curved shaft, and the anterior astragaloid facet, but has an average index of platycnemia of 69·9. A mountainous country can have nothing to do with the flattening in this case, while squatting is the universal custom. And I think it not impro-

* "The Influence of Function as exemplified in the Morphology of the Lower Extremity of the Panjabi": Journal of Anatomy and Physiology, 1893.

bable that the altered form of the shaft of the femur in the Maori, and the peculiar curve of the fibula, are also due to this cause, not perhaps to altered or increased muscular development, as with platycnemia, but to pressures depending on the position of the body and lower limbs.

Fibula.

The length given is the maximum, the distance between the tip of the spine and the apex of the malleolus.

Thirty-two bones were measured, and these average 345·5mm. in length. The longest fibula measures 375mm., the shortest 316mm.

The peroneal surface is always deeply channelled, and the curve of the shaft is not as usually seen in European bones. Instead of being bent with the concavity of the curve forwards, I have generally found the bone to be either straight or to have a curve which is convex forwards.

Humero-femoral Index.

This gives the proportion between the lengths of the humerus and femur, and is calculated according to the formula—

$$\frac{\text{Humeral length} \times 100}{\text{Femoral length}}.$$

The maximum length of both bones is taken.

The material at my disposal enabled me to calculate the index in twenty-one cases, both right and left limbs of the same body being used when the skeleton was sufficiently perfect to allow of the necessary measurements being made on both sides. The average of these twenty-one indices is 72·5—the highest is 77·5, and the lowest 68·4. Professor Turner's two Maoris give indices of 72·5 and 71·5 respectively, and scarcely alter the average.

This proportion between these two bones is the same as it is in Europeans, but is higher than what has been found in Negroes, Australians, and Andaman Islanders.

Tibio-femoral Index.

This indicates the proportion between the length of the tibia and the femur of the same limb, and is calculated according to the formula—

$$\frac{\text{Tibial length} \times 100}{\text{Femoral length}}.$$

The maximum length of the femur has been used, but in the case of the tibia, though I include the malleolus, I exclude the spines.

Twenty lower limbs allowed of this index being calculated. The mean is 82·6, and the indices vary from 85·7 to 79·2. This average is left practically unchanged by the inclusion of the indices 86 and 77·7 of the two Maoris measured by Sir William Turner; and the index 82·2, the mean of five Polynesians measured by M. Topinard, is but very slightly lower.

Owing to the small number of female skeletons examined by me, I can say nothing definite on the question of the influence of sex on this proportion. The males have an average of 83·2 and the females of 81·4, but these figures are of little value.

Comparing the Maoris with other races, and using Professor Turner's convenient classification,* we find that though they belong, along with Europeans, Mongolians, and others, to the brachyknemic group, yet they are on the verge of the dolichoknemic division, which includes Australians, Negroes, Andaman Islanders, &c. Using the word "leg" in its limited anatomical sense, the Maori lower limb is therefore on the border-line between short- and long-leggedness.

Intermembral Index.

This is calculated according to the formula—

$$\frac{\text{Humeral length} + \text{radial length} \times 100}{\text{Femoral length} + \text{tibial length}},$$

and gives the proportion between the lengths of the upper and lower limbs. The maximum length of the femur, humerus, and radius are used, but the spines are not included in the tibial measurement.

Eighteen indices were calculated, and these give an average of 70·2. The proportionally longest upper limb is shown by the index 73; the shortest, by 66·7. Professor Turner's two Maoris give an average index slightly lower than mine—69·3; but the general average is only lowered $\frac{1}{10}$ by their inclusion in the series.

The proportion between the lengths of the two extremities in different races has been studied by several anatomists, and a comparison of their measurements with mine shows that, while the Maori upper limb is very slightly longer in proportion to the lower than in the European, it is more distinctly so than in the Negro or the Andaman Islander. M. Broca, as the result of the measurements of fourteen skeletons, gives the index for the European as 69·73. Sir George Humphry† has calculated this index in twenty-five Negroes,

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* Brachyknemic, index under 83; Dolichoknemic, index 83 or upwards.

† "The Human Skeleton."

and gives 68·4 as their mean; while 68·27 is the average of Broca's measurements of fifteen of the same race. The twenty-eight Andamanese measured by Flower and Turner have an average index of 67·3.

The *astragalus* shows no obvious peculiarity beyond the presence of a facet on the upper surface of the neck for articulation with the corresponding surface on the tibia already mentioned. This facet varies in distinctness, but it is almost always present.

The *os calcis* in several respects differs from the ordinary European type. The posterior part of the bone is narrower, and the tuberosity is usually more prolonged on to the under-surface, the upper smooth and the lower rough parts of the tuberosity being placed at a distinct angle to each other, both sloping forwards from their line of junction. The articular facet on the anterior part of the upper surface, which is so frequently present in Europeans, occurs in all the Maori bones examined, and is in almost all cases continuous with the surface on the upper face of the sustentaculum tali. I have also noticed in six bones a narrow facet at the upper and outer angle of the anterior surface of the bone for articulation with the scaphoid. I have no doubt that all these modifications are due to the same cause—the habitual adoption of the squatting posture.

VERTEBRAL COLUMN (MORIORI).

The measurements of four incomplete columns are given in Table IV.

Cervical Vertebræ.

In only two columns are the cervical vertebræ in a sufficiently perfect condition to allow of the measurements for the cervico-vertebral index being made. In these the average index is 107·9, showing the greatest depth of the vertebral bodies to be behind.

The condition of the cervical spines is shown in the following table:—

—	Bifid.	Feebly Bifid.	Not Bifid.
Second cervical vertebra	3	1	0
Third "	1	1	1
Fourth "	0	2	2
Fifth "	2	2	0
Sixth "	0	2	1
Seventh "	0	0	4

In one of the four atlas vertebræ examined the groove for the right vertebral artery was completely bridged by bone;

and in one axis the tip of the odontoid process had evidently rubbed against the anterior edge of the foramen magnum.

Dorsal Vertebræ.

The mean dorso-vertebral index of the three columns which allowed of the necessary measurements being taken is 106·4.

In one column the twelfth dorsal vertebra has no costal facet on either side of its body, and those on the eleventh are very small. One of the tenth vertebræ has no costo-transverse articulations, while in another there is none on the left side.

Lumbar Vertebræ.

The average lumbo-vertebral index of the four sets of lumbar vertebræ is 104·7. The highest index, that of a male, is 113·7; the lowest, also a male, is 100. The mean of the three males is 106. The female has an index of 100·7. In two of the males, therefore, the sum of the posterior depths of the bodies is greater than the sum of the anterior depths; in one they are equal; while in the female there is a very slight excess of the posterior depth over the anterior.

The means of the indices of the individual vertebræ is as follows:—

Index of first lumbar vertebra ...	117·8
" second " ...	114·4
" third " ...	108·0
" fourth " ...	98·0
" fifth " ..	87·6

Three vertebræ, therefore—the first, the second, and the third—are deeper behind than in front, taking the average of the four sets of vertebræ. The following table shows the form of the individual vertebræ in this respect:—

—	Anterior Depth of Body greater than Posterior Depth.	Anterior Depth of Body equal to Posterior Depth.	Anterior Depth of Body less than Posterior Depth.
First lumbar vetebra ..	0	0	4
Second " ..	0	0	4
Third " ..	0	0	4
Fourth " ..	3	0	1
Fifth " ..	4	0	0

Pelvis (Moriori).

The measurements of three pelves are given in Table V. Two of these are male, one is female.

The mean of the *height-breadth* indices of the two males is 78·7. The same index in the female is 79·9.

The *brim* index in the males averages 78·9. In the female it is 81·5.

The index of the *pelvic cavity* averages in the males 81·2. In the female it is 70.

The average male *sacral* index is 110·9. The female pelvis has a sacrum of an unusually narrow form, with an index of 105·8.

All three pelves are platypellic. One of the male sacra is platyhieric. The other, with the female, is at the upper limit of the subplatyhieric group.

BONES OF THE LIMBS (MORIORI).

I give in Table VI. the measurements and indices, so far as was possible, of the limb-bones of five Moriori skeletons. Three of these are males. Four of the skeletons are fairly complete so far as these bones are concerned, but in the fifth, a female, the right arm and leg have, unfortunately, been lost.

I have not thought it necessary to give here the averages of the various linear measurements, but I give for what they are worth the mean of the indices calculated from them, with, for purposes of comparison, the corresponding indices as I have found them in the Maoris. The figures in brackets show the number of indices from which the average is taken.

—	Moriori.		Maori.
Scapular index	(6)	61·6	64·9
Infra-spinous index	(6)	82·1	89·4
Claviculo-humeral index	(5)	46·0	45·8
Radio-humeral index	(8)	77·6	77·8
Index of upper fourth of femur	(9)	64·0	64·3
Index of middle of femur	(9)	112·6	115·8
Tibio-femoral index	(9)	80·5	82·6
Index of platycnemia	(9)	63·2	64·2
Humero-femoral index	(8)	71·9	72·5
Intermembral index	(8)	70·7	70·2

These averages show a very close correspondence between the Morioris and the Maoris as to the proportionate lengths of the long bones, but the scapulæ measured are narrower in my Morioris than the average of the Maori bones. The antero-posterior diameter of the femur at the middle of the shaft has much the same relation to the transverse in both races, and the upper part of the shaft shows the same flattening that we have seen to be characteristic of the Maori femur, and almost to the same extent. Platycnemia is slightly more pronounced than in the Maoris, and the tibia shows all the other characteristics due to the squatting posture which have been already described.

The description of the Maori skull contained in the preceding pages agrees in all essentials with that already given by other observers. It is, according to my measurements, mesaticephalic, though on the verge of dolichocephaly; metriocephalic; mesoseme; mesorhine, though almost leptorhine; orthognathous; brachyuranic; phænozygous: and the males are megacephalic.

Though the Maori cranium has, so far as its race characters go, been exhaustively studied—nearly two hundred skulls having now been more or less fully described—few have had the opportunity of examining the other bones of the skeleton. I have been fortunate in this respect, and have been able to show that the vertebral column is typically savage in the form of its component parts; that the pelvis is platypellic, with a platyhieric, almost subplatyhieric, sacrum; that the upper limb is mesatikerkic; while the lower limb, though brachycnemic, is on the verge of the dolichocnemic group; that platycnemia is well marked; and that the limb-bones generally show the modifications of form characteristic of most of the coloured races.

If any further proof were needed of the mixed origin of the Maori race it is given in this paper. An examination of the cranial indices and of the extent of their variation shows this clearly. These demonstrate two distinct types and intermediate forms. At the one extreme we have skulls approaching the Melanesian form, as met with in the Fiji group, long and narrow, high in proportion to their breadth, prognathous, and with wide nasal openings. At the other are skulls of the Polynesian type, such as are common in Tonga and Samoa, shorter and broader, with orthognathous faces. And it must be noted that these extreme forms do not belong to different tribes or districts, but may both be found in one. Among the skulls of the Ngaitahu Tribe alone we have as great a variation in almost all the indices as is met with in the entire collection of crania gathered together from all parts of both these Islands.

Though a thorough mingling of the two parent stocks has thus taken place, it is yet clear that their distinguishing characters are not seen in the same proportion in each district. Undoubtedly intertribal differences exist. The material at my disposal has allowed of nothing more than a comparison between the crania of the Ngaitahu Tribe of the South Island and those from the northern part of the Auckland Province, mainly from the Bay of Islands and Whangarei. The Ngapuhi are now the most important tribe in this region, but I cannot say whether the skulls included in this group belong to this or, indeed, to any one tribe. The district, however, is clearly defined, and the skulls available closely approximate in number to the Ngaitahu examined by me. By availing myself of the twenty-two crania already described by Professors Flower and Turner, I get, with those whose measurements are now given, a set of thirty-four skulls to compare with the forty of the southern tribe. The other two groups from the North Island given in the paper are too small to be of any value in estimating tribal characteristics, and I institute in this paper no comparison between them and the two larger collections. In the Auckland skulls the average cephalic index is 73·3, the vertical 72·8, the frontal 68·2, the orbital 89·3, the nasal 50·2, the gnathic 98·4, the palato-maxillary 119·9; while the same indices in the Ngaitahu are 75·9, 74·6, 67·9, 86·4, 48·0, 97·6, and 120·8; showing that the skulls of the former group are, proportionally to their length, longer than those of the latter, that they have wider nasal openings, and slightly more projecting jaws. And it has also been shown that the proportion of height to breadth is slightly greater in them than in the Ngaitahu. The Melanesian characters are therefore more accentuated in the North than amongst the Natives of the South Island. The prevalence of the Papuan form among skulls from the Bay of Islands has also been observed by MM. de Quatrefages and Hamy, and is noted by them in the "Crania Ethnica"* when describing the Maori cranium.

The measurements now given of the Moriori skull, taken with those already published, show it to be mesaticephalic, though close to the lower limit of the group; metriocephalic, though almost tapeinocephalic; low down in the megaseme group; leptorhine; orthognathous; brachyuranic; phænozygous: and the males to be megacephalic.

It differs from the Maori skull mainly in its lesser height, both absolute and relative to length and breadth; the greater excess of the parietal over the frontal width; the higher orbits; and the narrower nasal opening. The depressed and retreating forehead is also a very marked feature of many Moriori skulls. It is slightly broader relatively to its length, and somewhat more prognathous. The cranial capacity is also slightly less. But, as already pointed out, there is often a very close resemblance between Maori and Moriori skulls.

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* P. 460.

The variation of the indices, though somewhat more restricted than with the Maoris, is still considerable, and points, like the traditions of the people, to an origin from the two great Pacific stocks. The different types of Moriori skull have been already sufficiently described.

Though the number of skulls available for measurement is sufficiently large, I regret to say that I have been unable to secure more than five Moriori skeletons, none of which are quite complete. As nothing definite as to the osteological characters of the race can be deduced from such a small collection, I have done little more than give the measurements and indices, with their averages. These show in most instances a very close correspondence with what we find among the Maoris.

TABLE I.—MEASUREMENTS AND INDICES OF SKULLS FROM THE PROVINCES OF OTAGO AND CANTERBURY.

No.	Sex.	Age.	Capacity in c.cs.	Diameters of Brain-case. Longitudinal. Ophryo-occipital.	Glabello-occipital.	Nasio-occipital.	Glabello-iniac.	Basi-bregmatic Height.	Transverse. Maximum.	Asterionic.	Stephanic.	Minimum Frontal.	Biauricular.	Temporal.	Circumferences of Brain-case. Horizontal. Total.	Post-auricular.	Pre-auricular.	Median. Total.	Frontal.	Parietal.	Occipital.	Lambdo-iniac.	Inio-opisthic.	Length Foramen Magnum.	Basion to Nasion.	Transverse. Total.	Supra-auricular.	Infra-auricular.	Foramen Magnum. Length.	Width.	Basi-alveolar Length.
1	M.	Ad.	1,453	185	187	183	187	145	138	106	107	98	126	134	514	280	234	524	139	131	117	50	67	33	104	458	310	148	33	30	102
2	M.	Ad.	1,490	184	188	183	187	134	143	115	109	95	130	135	520	280	240	516	131	123	126	66	60	35	101	445	300	145	35	29	101
3	M.	Ad.	1,385	182	184	180	184	130	141	107	111	100	127	138	513	274	239	495	130	110	118	61	57	35	102	445	300	145	35	35	107
4	M.	Ad.	1,360	174	175	172	174	139	140	105	117	96	117	128	495	270	235	501	130	120	118	70	48	33	100	445	305	140	33	30	97
5	M.	Ag.	1,475	169	171	169	169	140	142	99	111	91	132	140	500	256	244	500	135	110	119	75	44	36	100	452	310	142	36	32	96
6	M.	Ad.	1,288	179	187	180	187	125	141	113	108	95	120	135	510	265	245	504	120	115	120	63	57	39	110	447	307	140	39	32	110
7	M.	Ad.	1,360	177	179	176	179	135	134	105	102	90	121	132	504	258	246	505	133	119	118	48	70	34	101	441	303	138	34	27	..
8	M.	Ad.	1,410	176	178	178	176	136	142	106	106	91	125	136	510	270	240	503	135	125	110	50	60	35	98	459	310	149	35	27	92
9	M.	Ad.	1,450	182	182	180	171	138	132	104	106	95	114	121	502	285	217	507	120	132	118	78	40	35	102	425	285	140	35	30	95
10	M.	Ad.	1,208	185	186	181	178	134	130	107	106	94	118	121	504	278	236	505	123	127	118	70	48	35	102	420	283	137	35	29	105
11	M.	Ad.	1,480	178	179	177	177	130	140	108	116	95	117	133	513	281	232	503	138	117	120	65	55	33	95	448	318	130	33	29	98
12	M.	Ag.	1,498	190	194	189	194	139	142	121	111	100	133	..	540	275	265	523	134	113	128	68	60	39	109	454	300	154	39	33	114
13	M.	Ad.	1,400	181	184	181	180	134	139	104	111	94	128	135	518	272	246	514	135	121	122	68	54	34	102	440	300	140	34	28	97
14	M.	Ad.	1,398	178	181	179	178	137	140	106	103	95	118	133	510	272	238	500	130	110	127	70	57	33	100	438	303	135	33	..	101
15	M.	Ad.	..	185	190	186	185	140	147	118	111	99	130	142	533	278	255	528	135	110	135	88	47	37	111	461	312	149	37	35	..
16	M.	Ad.	1,393	185	188	185	186	139	138	103	111	92	118	138	520	267	253	518	135	120	117	63	54	34	112	459	322	137	34	32	103
17	M.	Ad.	1,550	178	180	177	180	142	144	117	111	101	133	140	517	263	254	512	130	116	119	69	50	37	110	445	301	144	37	35	102
18	M.	Ad.	1,425	185	185	184	185	141	140	110	109	91	124	133	515	273	242	520	135	125	123	60	63	37	100	448	310	138	37	27	98
19	M.	Ad.	1,725	194	198	192	196	144	148	106	116	101	127	140	543	290	253	544	148	126	128	74	54	38	104	474	332	142	38	32	106
20	M.	Ad.	1,365	182	184	180	180	142	134	104	106	88	120	132	508	270	238	514	130	130	119	60	59	32	103	438	304	134	32	32	103
21	M.	Ad.	1,408	174	176	173	165	142	141	106	112	98	124	132	507	270	237	503	129	127	114	67	47	33	100	453	314	139	33	29	103
22	M.	Ad.	1,500	194	194	189	190	132	135	113	112	95	126	131	532	283	249	523	137	129	120	64	56	36	101	437	298	137	36	33	95
23	M.	Ad.	1,600	188	192	188	184	145	142	113	113	99	131	138	533	284	249	538	142	128	130	75	55	34	104	473	320	153	34	30	103
24	M.	Ad.	..	186	190	185	188	..	140	115	112	97	127	134	520	271	249	..	128	122	..	65	..	..	..	442	300	142	..	..	..
25	M.	Ad.	1,675	203	206	203	197	141	150	114	125	103	135	143	570	310	260	562	143	132	140	90	50	37	110	463	320	143	37	31	104
26	F.	Ad.	1,220	172	173	170	172	138	130	104	106	90	117	..	485	265	220	486	117	115	113	58	55	37	104	427	290	137	37	29	96
27	F.	Ad.	1,290	173	173	170	163	132	131	101	106	93	118	..	488	264	224	483	125	119	106	66	40	35	98	428	290	138	35	29	92
28	F.	Ad.	1,350	171	172	168	168	132	137	112	110	93	119	132	490	260	230	489	127	121	122	72	50	28	101	440	308	132	28	28	97
29	F.	Ad.	1,398	179	178	174	178	140	141	104	111	89	126	136	510	265	245	511	130	130	118	55	63	30	103	456	315	141	30	29	..
30	F.	Ad.	1,183	168	172	170	167	134	130	97	105	88	116	124	478	263	215	485	131	118	108	61	47	29	99	430	295	135	29	26	95
31	F.	Ad.	1,280	176	177	175	177	132	131	106	104	94	117	128	496	252	244	489	123	112	117	65	52	36	101	430	293	137	36	29	94
32	F.	Ad.	1,280	180	181	180	181	130	134	103	106	86	118	129	500	267	233	500	120	115	129	65	64	33	103	425	290	135	33	30	98
33	F.	Ad.	..	176	178	176	176	130	137	103	105	92	114	126	495	273	222	493	120	120	120	55	65	33	100	418	290	128	33	30	97
34	F.	Ad.	..	178	179	..	162	..	138	109	111	92	124	132	503	287	216	..	121	120	122	85	37	..	..	..	290	..	..	..	..
35	F.	Ad.	1,308	190	194	190	194	136	134	107	105	98	118	128	528	275	253	517	131	125	120	54	66	31	110	435	300	135	31	28	104
36	F.	Ad.	1,212	174	176	173	176	132	130	98	104	97	117	126	490	258	232	482	120	120	104	50	54	37	101	414	281	133	37	29	95
37	F.	Ag.	..	184	185	182	183	129	130	..	94	90	..	..	510	255	255	508	..	..	..	..	..	36	102	..	..	..	36	33	..
38	?	Ad.	1,318	174	177	175	174	128	140	100	100	87	119	130	493	269	224	489	130	117	114	63	51	34	94	420	290	130	34	29	96
39	?	Ad.	1,228	163	166	168	161	132	142	102	..	88	125	..	486	264	222	479	131	107	116	77	39	32	93	443	311	132	32	29	95
40	?	Ad.	..	177	178	175	172	138	137	104	100	91	121	130	500	268	232	501	130	120	118	70	48	33	100	437	297	140	33	29	..
41	?	11	1,585	179	179	176	158	138	144	102	117	92	121	132	510	271	239	502	131	127	112	82	30	36	96	439	311	128	36	32	93
42	?	7	1,405	..	173	171	172	130	137	98	106	88	109	127	490	268	222	489	126	121	116	58	58	37	89	428	303	125	37	29	81
43	?	6	..	..	169	166	158	119	124	98	101	85	..	..	466	258	208	467	123	123	106	64	42	31	84	..	..	..	31	26	79
44	?	5	..	..	166	162	160	123	127	101	101	86	105	117	486	248	220	471	122	123	109	60	49	30	87	390	273	117	30	30	79
45	?	4	..	..	152	147	142	..	130	91	98	79	95	104	450	255	195	..	117	117	100	53	47	..	..	377	280	97	..	24	..

No.	Diameters of Face. Transverse. Biorbital, External.	Biorbital, Internal.	Bijugal.	Bizygomatic.	Vertical. Ophryo-alveolar.	Nasio-alveolar.	Spino-alveolar.	Diameters. Of Nasal Region. Nasio-spinal Height.	Width Anterior Nares.	Length Nasal Bones.	Width Nasal Bones.	Of Orbit. Width.	Height.	Interorbital Distance.	Of Palate. Length.	Width.	Auriculo-orbital Distance, Right.	Auriculo-orbital Distance, Left.	Mastoid Height.	Zygomatic Projection.	Facial Angle.	Indices. Cephalic.	Vertical.	Frontal.	Of Foramen Magnum.	Orbital.	Nasal.	Gnathic.	Palato-maxillary.	Lower Jaw. Height. Symphysial.	Molar.	Coronoid.	Condyloid.	Width. Bigonial.	Bicondyloid.	Bimental.	Of Ramus.	Gonio-symphysial Length.	Condylo-coronoid Length.	Bigoniac Curve.
1	110	98	127	144	102	71	17	54	25	24	15	42	35	20	53	60	71	71	36	P+	67°	73·8	77·5	71·	90·9	83·3	46·3	98·1	113·2	35	34	77	66	106	134	53	40	97	37	224
2	108	97	125	141	96	73	14	59	34	26	14	42	35	19	53	64	71	70	37	P+	67°	76·1	71·3	66·4	82·9	81·4	59·3	100·	120·8	32	35	72	64	112	122	49	42	99	35	215
3	108	98	124	143	99	71	19	52	25	28	15	39	38	19	58	62	75	75	39	P+	69°	76·6	70·7	70·9	100·	97·4	48·2	104·9	106·9	34	28	59	56	109	130	56	39	90	35	195
4	103	94	119	133	93	69	17	52	21	24	14	39	33	20	51	62	68	68	39	P+	68°	80·	79·4	68·6	90·9	84·6	40·4	97·	121·5	37	27	63	58	114	120	54	39	98	30	214
5	98	91	119	141	99	74	14	60	25	26	14	41	37	18	50	61	70	68	39	P+	67°	83·	81·9	64·1	88·9	90·2	41·7	96·	122·	31	28	63	66	97	120	45	29	73	37	174
6	110	98	127	143	108	77	21	56	29	25	15	40	34	20	55	62	79	77	40	P+	68°	75·4	66·8	60·3	82·	85·	51·8	100·	112·7	41	36	70	65	107	126	52	42	92	36	210
7	101	94	115	135	..	..	..	60	25	..	..	41	38	18	..	62	73	71	41	P+	..	74·9	75·5	67·2	79·4	92·7	41·7	..	..	..	..	..	..	..	..	..	..	..	..	..
8	101	94	117	138	92	68	20	48	26	..	..	41	36	20	46	61	67	68	41	P+	75°	79·8	76·4	64·1	77·1	87·8	54·2	93·9	132·6	33	24	65	56	100	..	52	31	87	32	190
9	103	93	..	..	..	..	..	49	24	21	16	39	34	21	45	62	67	68	40	..	76°	72·5	75·8	72·	85·7	87·2	49·	93·1	137·8	..	..	..	..	..	..	..	..	..	..	..
10	105	97	111	129	91	66	19	47	28	18	18	43	35	20	60	68	69	69	35	P	76°	69·9	72·	72·3	82·9	81·4	59·6	102·9	113·3	35	29	54	63	96	114	48	34	92	34	205
11	106	96	120	133	92	63	12	51	22	..	..	40	34	19	51	60	65	67	38	P	69°	78·2	72·6	67·9	87·9	85·	43·1	103·2	117·6	..	..	..	..	..	..	..	..	..	..	..
12	113	100	132	..	108	75	15	60	26	..	..	42	39	20	57	70	79	81	46	P+	66°	72·2	71·6	70·4	84·6	92·9	43·3	104·6	122·8	37	38	81	73	111	140	58	41	95	39	220
13	103	96	118	135	86	66	16	50	25	..	..	39	33	22	52	61	73	72	38	P	72°	75·5	72·8	67·6	82·4	84·6	50·	95·1	117·3	..	..	..	..	..	..	..	..	..	..	..
14	105	97	118	132	95	71	22	49	24	25	16	40	35	20	52	61	70	70	36	P+	70°	77·3	75·7	67·9	..	87·5	49·	101·	117·3	..	..	..	..	..	..	..	..	..	..	..
15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	42	..	..	77·4	73·7	67·3	94·6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
16	106	94	121	..	102	76	23	53	27	24	19	41	35	21	53	64	80	79	38	P+	73°	73·4	73·9	66·6	94·1	85·4	50·9	92·	120·8	..	..	..	..	..	..	..	..	..	..	..
17	110	98	125	143	100	76	16	60	25	30	18	42	36	20	52	61	70	72	42	P+	69°	80·	78·9	70·1	94·6	85·7	41·7	92·7	117·3	..	..	..	..	..	..	..	..	..	..	..
18	100	90	112	135	98	73	17	56	26	26	..	37	34	19	50	59	74	75	38	P+	70°	75·7	76·2	65·	73·	91·9	46·4	98·	118·	..	..	..	..	..	..	..	..	..	..	..
19	108	99	121	143	..	..	..	57	27	25	15	41	36	20	53	62	75	74	37	P+	69°	74·7	72·7	68·2	84·2	87·8	47·4	101·9	117·	45	32	76	67	115	134	53	39	94	37	213
20	105	98	118	..	94	66	16	50	25	20	17	42	34	18	51	62	71	72	35	P+	72°	77·2	72·8	64·2	100·	81·	50·	100·	121·6	31	30	70	65	94	123	51	35	85	38	190
21	107	96	121	134	91	65	13	52	27	..	..	39	36	21	54	59	70	..	38	P	70°	80·1	80·7	69·5	87·9	92·3	51·9	103·	109·3	32	33	71	60	111	124	52	40	95	23	210
22	100	93	112	127	91	69	18	51	23	..	..	37	35	32	..	..	72	71	34	C	78°	69·6	68·	70·4	91·7	94·6	45·1	94·1	..	32	26	62	55	93	120	47	31	81	31	185
23	108	101	125	145	95	71	16	55	25	32	16	41	33	21	53	63	75	74	40	P+	68°	74·	75·5	69·7	88·2	80·5	45·5	99·	118·9	..	..	..	..	..	..	..	..	..	..	..
24	109	100	..	..	102	77	17	60	..	24	..	42	36	..	..	..	..	80	39	P+	..	73·7	..	69·3	..	85·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..
25	113	106	125	145	102	72	21	51	27	25	22	42	31	27	54	70	74	73	38	P	72°	72·8	68·4	68·7	83·8	73·8	52·9	94·5	129·6	40	34	81	73	111	136	49	37	91	33	210
26	98	90	110	128	94	69	17	52	24	28	18	40	34	19	45	59	72	70	34	P+	73°	75·1	79·8	69·2	78·4	85·	46·	92·3	131·1	29	30	63	54	96	109	55	34	83	34	190
27	99	91	113	126	84	60	12	48	21	..	..	40	38	16	47	63	70	70	30	P	72°	75·7	76·3	71·	82·9	95·	43·8	93·9	134·	28	25	52	50	94	121	49	35	87	37	194
28	100	91	110	128	90	65	18	47	23	..	..	41	34	18	51	66	62	64	31	C	80°	79·7	76·7	67·9	100·	82·9	48·9	96·	129·4	..	..	..	..	..	..	..	..	..	..	..
29	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	33	..	..	79·2	78·7	63·6	96·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30	94	87	103	121	91	63	16	47	21	23	13	37	35	18	47	54	67	67	29	P	73°	75·6	77·9	67·7	89·7	94·6	44·7	96·	114·9	..	..	..	..	..	..	..	..	..	..	..
31	104	96	109	132	91	66	16	50	24	25	17	42	34	18	48	59	72	74	30	P+	72°	74·	74·6	71·8	80·6	81·	48·	93·1	122·9	28	29	63	64	95	119	47	38	81	35	180
32	99	91	112	123	89	61	16	45	23	..	..	38	31	20	49	62	73	71	29	C	73°	74·	71·8	64·2	90·9	81·6	51·1	95·1	126·5	..	..	..	..	..	..	..	..	..	..	..
33	98	88	106	..	..	..	..	54	24	..	..	40	35	17	44	56	69	71	36	P	74°	77·	73·	67·2	90·9	87·5	44·4	97·	127·3	..	..	..	..	..	..	..	..	..	..	..
34	97	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	37	..	..	77·7	..	66·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
35	108	97	118	..	96	68	16	52	28	23	15	39	32	22	49	61	81	81	37	P+	72°	69·1	70·1	73·1	90·3	82·	53·5	94·5	124·5	..	..	..	..	..	..	..	..	..	..	..
36	102	91	113	130	82	60	13	47	23	..	..	37	30	20	48	55	70	68	37	P	70°	73·9	75·	74·6	78·4	81·1	48·9	94·1	114·6	..	..	..	..	..	..	..	..	..	..	..
37	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	70·3	69·7	69·2	91·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
38	97	89	105	124	96	68	16	52	23	24	14	38	33	19	53	59	67	66	32	P+	70°	79·1	72·3	62·1	85·3	86·8	44·2	102·1	111·3	..	..	..	..	..	..	..	..	..	..	..
39	94	86	..	..	94	69	..	..	..	..	..	..	..	..	46	56	..	..	36	P+	..	85·5	79·5	62·	90·6	..	..	102·2	121·7	36	34	65	58	102	..	52	..	85	..	..
40	101	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	P	..	77·	77·5	66·4	87·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
41	95	84	104	120	85	65	15	50	25	28	17	41	33	17	45	62	70	71	32	C	74°	80·4	77·1	63·8	88·9	80·5	50·	96·9	137·8	..	..	..	..	..	..	..	..	..	..	..
42	90	82	96	109	..	51	10	41	23	18	15	35	33	11	40	56	68	68	29	C	81°	79·2	75·1	64·2	78·4	94·3	56·1	91·	140·	..	..	..	..	..	..	..	..	..	..	..
43	85	76	89	..	78	55	12	43	20	18	10	32	33	15	35	50	..	..	..	C	81°	73·4	70·4	68·5	83·9	103·1	46·5	94·	142·9	..	..	..	..	..	..	..	..	..	..	..
44	88	79	94	106	69	54	15	39	18	18	14	33	32	16	37	51	59	59	29	C	83°	76·5	74·1	67·7	100·	97·	46·2	90·8	137·8	25	20	49	45	81	99	42	33	65	27	150
45	79	72	84	90	..	45	13	32	19	15	15	30	28	14	34	48	53	52	20	C	..	85·5	..	60·8	..	93·3	59·4	..	141·2	21	17	36	35	65	..	37	26	53	22	134

TABLE II.—MEASUREMENTS AND INDICES OF SKULLS FROM THE NORTH ISLAND.

	Sex.	Age.	Capacity in c.cs.	Diameters of Brain-case. Longitudinal. Ophryo-occipital.	Glabello-occipital.	Nasio-occipital.	Glabello-iniac.	Basi-bregmatic Height.	Transverse. Maximum.	Asterionic.	Stephanic.	Minimum Frontal.	Biauricular.	Temporal.	Circumferences of Brain-case. Horizontal. Total.	Post-auricular.	Pre-auricular.	Median. Total.	Frontal.	Parietal.	Occipital.	Lambdo-iniac.	Inio-opisthic.	Length Foramen Magnum.	Basion to Nasion.	Transverse. Total.	Supra-auricular.	Infra-auricular.	Foramen Magnum. Length.	Width.	Basi-alveolar Length.	Diameters of Face. Transverse. Biorbital, External.	Biorbital, Interal.	Bijugal.	Bizygomatic.	Vertical. Ophryo-alveolar.	Nasio-alveolar.	Spino-alveolar.	Diameters. Of Nasal Region. Nasio-spinal Height.	Width Anterior Nares.	Length Nasal Bones.	Width Nasal Bones.	Of Orbit. Width.	Height.	Interorbital Distance.	Of Palate. Length.	Width.	Auriculo-orbital Distance, Right.	Auriculo-orbital Distance, Left.	Mastoid Height.	Zygomatic Projection.	Facial Angle.	Indices. Cephalic.	Vertical.	Frontal.	Of Foramen Magnum.	Orbital.	Nasal.	Gnathic.	Palato-maxillary.	Lower Jaw. Height. Symphysial.	Molar.	Coronoid.	Condyloid.	Width. Bigonial.	Bicondyloid.	Bimental.	Of Ramus.	Gono-symphysial Length.	Condylo-coronoid Length.	Bigoniac Curve.
A.—From the South-west Coast.																																																																							
1	M.	Ad.	1,608	186	190	185	190	146	143	110	110	93	127	133	530	294	236	539	138	137	120	65	55	36	108	467	317	150	36	32	101	111	101	125	143	98	70	16	54	25	27	20	42	35	21	54	64	70	71	43	P+	69°	75·3	76·8	65·	88·9	83·3	46·3	93·5	118·5	..	..	..	..	..	..	..	..	..	..	..
2	M.	Ad.	1,535	178	181	178	170	137	144	110	115	93	120	134	514	284	230	511	130	134	112	71	41	36	99	447	315	132	36	32	93	101	92	110	129	99	74	20	54	23	28	14	40	37	18	50	62	67	67	44	P	70°	79·6	75·7	64·6	88·9	92·5	42·6	93·9	124·	..	..	..	..	..	..	..	..	..	..	..
3	M.	Ad.	..	182	182	177	182	142	141	110	111	95	126	132	515	264	251	515	140	120	118	65	53	36	101	458	316	142	36	29	100	104	96	121	137	..	..	..	52	25	..	..	41	34	21	51	64	72	74	..	P	74°	77·5	78·	67·4	80·6	82·9	48·2	99·	125·5	..	..	..	..	..	..	..	..	..	..	..
4	M.	Ad.	1,600	193	194	187	190	144	139	114	111	95	129	134	537	292	245	536	132	146	115	62	53	35	108	448	315	143	35	35	106	107	100	122	143	101	75	21	54	27	24	..	40	35	23	54	68	73	73	46	P+	74°	71·6	74·2	68·3	100·	87·5	50·	98·1	125·9	35	33	82	67	108	138	57	35	98	35	220
5	M.	Ad.	1,460	184	186	182	184	144	135	104	109	97	124	130	516	263	253	532	141	130	119	69	50	37	105	451	304	147	37	31	94	107	99	117	137	100	75	17	58	28	27	19	42	33	20	54	70	71	70	41	P+	70°	72·6	77·4	71·9	83·8	78·6	48·3	89·5	129·6	33	29	71	61	112	128	54	34	92	33	207
6	M.	Ad.	1,550	185	187	184	183	140	138	106	111	95	120	130	520	274	246	523	135	128	117	57	60	37	106	445	310	135	37	32	102	108	99	115	132	103	77	21	56	26	29	19	42	37	24	58	67	69	70	35	P	71°	73·8	74·9	68·8	86·5	88·1	46·4	96·2	115·5	35	27	68	64	96	124	48	35	93	34	210
7	M.	Ad.	1,455	181	184	180	178	132	140	111	108	91	120	132	513	275	238	504	125	132	110	61	49	35	102	437	302	135	35	31	..	109	100	118	132	..	..	..	51	25	28	15	42	34	20	..	..	70	73	42	P+	70°	76·1	71·7	65·	88·6	81·	49·	..	..	..	..	..	..	..	..	..	..	..	..	..
8	M.	Ad.	1,608	183	188	185	182	144	141	119	117	104	124	132	528	298	230	523	130	132	118	68	50	35	108	470	325	145	35	30	105	108	97	122	140	..	..	..	53	24	23	19	41	36	20	52	63	73	73	37	P	69°	75·	76·6	73·8	85·7	87·8	45·3	97·2	121·2	32	33	73	71	106	..	46	38	92	32	200
9	M.	Ad.	1,580	184	185	181	184	140	139	113	112	97	123	130	522	290	232	528	130	130	127	70	57	38	103	455	310	145	38	32	96	105	94	117	134	96	72	17	55	27	25	17	38	33	19	52	60	68	69	43	P	71°	75·1	75·7	69·8	84·2	86·8	49·1	93·2	115·4	34	28	70	59	94	..	45	29	84	31	190
10	M.	Ad.	1,545	180	184	182	184	146	142	103	112	94	123	133	519	270	249	522	135	139	113	50	63	35	109	464	319	145	35	32	104	109	98	119	141	105	74	19	55	25	..	..	40	36	22	54	70	75	74	41	P+	69°	77·2	79·3	66·2	91·4	90·	45·5	95·4	129·6	34	28	65	65	108	135	50	35	93	37	203
11	M.	Ad.	1,550	181	182	180	178	140	138	112	114	98	120	133	520	273	247	513	130	130	110	60	50	37	107	412	310	132	37	35	100	105	96	116	134	94	72	17	55	24	26	25	40	38	22	48	62	72	73	38	P	..	75·8	76·9	71·	94·6	95·	43·6	93·5	129·2	30	..	70	60	100	122	48	36	92	22	207
12	F.	Ad.	1,345	177	177	174	177	134	133	99	108	93	119	130	500	272	228	493	123	122	115	60	55	32	101	422	290	132	32	28	..	101	93	116	128	..	..	..	50	25	..	..	38	33	19	..	60	67	69	36	P+	..	75·1	75·7	69·9	87·5	86·8	50·	..	..	..	..	..	..	..	..	..	..	..	..	..
13	?	Ad.	1,375	179	179	177	176	135	136	111	109	87	121	129	508	278	230	508	130	130	115	68	47	32	101	445	310	135	32	30	98	100	91	113	129	91	68	16	52	24	..	..	37	33	18	51	62	70	70	43	P	73°	76·	75·5	64·	93·8	89·2	46·	97·	121·6	27	30	71	61	102	120	49	31	77	32	175
14	?	Ad.	..	174	176	174	173	133	133	113	105	90	123	130	495	270	225	489	115	120	111	60	51	33	110	429	290	139	33	31	103	103	96	120	138	90	64	11	53	27	28	10	41	33	18	49	62	69	68	36	P+	69°	75·6	75·6	67·7	93·9	80·5	50·9	93·6	126·5	30	29	65	72	103	126	46	35	80	34	184
15	..	10	1,295	163	164	163	152	128	133	95	104	90	106	118	471	262	209	472	118	129	106	63	43	31	88	404	285	119	31	27	84	92	83	97	109	81	58	13	45	19	21	13	36	34	17	42	54	60	62	..	C	75°	81·1	78·	67·7	87·1	94·4	42·2	95·4	128·6	..	..	..	..	..	..	..	..	..	..	..
B.—From the East Coast.																																																																							
1	M.	Ad.	..	195	196	192	192	151	144	110	114	98	122	..	543	300	243	552	135	145	129	70	59	34	109	470	320	150	34	31	105	108	98	120	140	98	73	18	55	26	26	18	43	33	21	58	62	70	71	42	P	72°	73·5	77·	68·1	91·2	76·7	47·3	96·3	106·9	..	..	..	..	..	..	..	..	..	..	..
2	M.	Ad.	1,333	178	182	179	180	136	132	108	103	93	120	128	505	280	125	504	120	126	117	64	53	38	103	434	297	137	38	31	100	104	96	115	133	99	70	19	51	27	25	20	40	33	21	53	61	69	67	39	P+	71°	72·5	74·7	70·5	81·6	82·5	52·9	97·1	115·1	34	27	62	63	104	123	46	33	87	36	190
3	M.	Ad.	1,410	178	180	178	176	135	137	101	108	91	120	130	506	270	236	499	130	123	112	57	55	34	100	437	302	135	34	27	96	99	90	110	124	91	68	15	53	23	26	14	39	33	20	48	62	71	71	38	C	75°	76·1	75·	66·4	79·4	84·6	43·4	96·	129·2	..	..	..	..	..	..	..	..	..	..	..
4	M.	Ag.	1,378	178	180	176	177	135	138	100	104	93	125	136	510	260	250	506	131	127	112	60	52	36	100	438	302	136	36	30	..	100	93	116	134	..	..	..	52	26	25	17	41	36	18	..	58	73	72	34	P+	80°	76·7	75·	67·3	83·3	87·8	50·	..	..	..	..	..	..	..	..	..	..	..	..	..
5	M.	Ad.	1,365	184	186	182	184	135	135	105	109	99	121	127	512	260	252	507	130	128	106	54	52	37	106	432	292	140	37	27	100	109	98	116	130	91	76	14	52	26	23	19	42	33	21	52	61	72	74	40	P	73°	72·6	72·6	73·3	73·	78·6	50·	94·3	117·3	..	..	..	..	..	..	..	..	..	..	..
6	M.	Ag.	1,605	182	184	182	182	140	144	105	115	98	126	138	516	274	242	512	130	122	117	60	57	35	108	448	308	140	35	34	..	107	98	117	138	..	..	..	54	26	18	..	40	36	19	..	..	76	76	35	P+	69°	78·3	76·1	68·1	97·1	90·	48·1	..	..	29	16	59	56	100	128	46	35	85	37	193
7	M.	Ad.	1,565	183	185	179	180	144	138	111	113	98	123	134	520	283	237	523	136	137	113	65	48	38	99	453	313	140	38	34	..	108	97	..	..	..	..	..	..	..	..	..	42	34	20	..	..	67	..	..	P	..	74·6	77·8	71·	89·5	81·	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8	F.	Ad.	1,350	174	175	172	168	131	136	103	107	94	120	128	495	265	230	495	120	130	119	68	51	33	93	425	290	135	33	32	89	105	95	111	129	91	66	16	50	23	24	13	40	33	18	49	61	67	70	33	P	71°	77·7	74·9	69·1	97·	82·5	46·	95·7	124·5	30	28	60	54	89	117	46	34	79	27	185
9	F.	Ad.	..	179	184	180	183	131	130	102	..	83	123	128	494	267	127	502	130	125	115	55	60	33	99	427	290	137	33	28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	70·7	71·2	63·8	84·8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
10	F.	Ag.	..	177	177	176	176	130	129	105	104	94	..	..	505	..	..	505	130	130	110	60	50	35	100	436	295	141	35	30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	72·9	73·4	68·2	85·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
C.—From the Neighbourhood of Auckland and the Bay of Islands.																																																																							
1	M.	Ag.	1,635	187	190	184	183	146	138	110	112	95	122	133	525	280	245	537	140	130	120	73	47	39	108	457	316	141	39	33	98	112	100	118	137	95	69	13	56	28	25	15	39	34	23	51	57	72	72	37	P	75°	72·6	76·8	68·8	84·6	87·2	50·	90·7	111·8	..	..	..	..	..	..	..	..	..	..	..
2	M.	Ag.	1,588	192	196	193	185	138	140	110	107	94	127	139	534	295	245	530	137	..	..	..	50	35	109	450	305	145	35	33	101	109	100	122	141	102	70	15	55	26	..	..	46	38	20	51	64	73	72	43	P+	72°	71·4	70·4	67·1	94·3	82·6	47·3	92·7	125·5	..	..	..	..	..	..	..	..	..	..	..
3	M.	Ad.	..	179	181	180	172	135	143	117	107	91	123	134	512	277	235	510	135	128	112	69	43	33	102	456	315	141	33	31	106	101	93	117	139	91	68	13	55	27	24	16	40	36	20	55	61	73	70	34	P+	67°	79·	74·6	63·6	93·9	90·	49·1	103·9	110·9	..	..	..	..	..	..	..	..	..	..	..
4	M.	Ad.	1,345	174	174	177	174	134	132	105	105	99	117	129	500	258	242	496	132	108	115	70	45	34	107	423	290	133	34	28	95	107	98	119	138	101	73	17	56	23	24	12	41	39	20	48	61	69	67	44	P+	71°	75·9	77·	75·	82·4	95·1	41·1	88·8	127·1	..	..	..	..	..	..	..	..	..	..	..
5	M.	Ag.	1,488	183	186	180	180	135	143	108	113	93	122	132	524	287	237	511	138	125	114	67	47	34	100	445	310	135	34	28	101	101	92	117	137	95	68	18	50	26	25	15	38	32	22	..	..	68	68	39	P+	70°	76·9	72·6	65·	82·4	84·2	52·	101·	..	..	..	..	..	..	..	..	..	..	..	..
6	M.	Ad.	1,450	189	190	186	184	128	138	109	106	90	125	134	528	278	250	520	132	132	123	66	57	32	101	436	292	144	32	30	103	100	91	119	134	..	..	..	55	28	..	..	40	32	19	53	65	73	72	..	P+	70°	72·6	67·4	65·2	93·8	80·	50·9	102·	122·6	..	..	..	..	..	..	..	..	..	..	..
7	M.	Ag.	1,460	190	190	184	190	140	137	107	111	95	130	138	532	267	265	526	135	130	121	65	56	36	104	449	303	146	36	31	97	108	98	122	..	..	..	..	55	25	..	..	42	36	19	50	61	74	74	43	P	76°	72·1	73·7	69·3	86·1	85·7	45·5	93·3	122·	37	27	71	58	103	132	53	35	89	39	200
8	F.	Ad.	1,230	173	174	171	171	125	126	94	103	87	110	123	480	258	122	487	129	116	115	60	55	33	94	404	287	117	33	32	93	95	84	108	120	79	54	11	43	24	..	..	36	31	16	49	58	64	66	32	P	76°	72·4	71·8	69·	97·	86·1	55·8	98·9	118·4	..	..	..	..	..	..	..	..	..	..	..
9	F.	Ad.	1,400	181	183	182	172	131	129	103	107	90	110	122	508	280	228	512	130	130	123	80	43	30	99	422	300	122	30	28	98	98	89	108	..	82	59	15	44	25	..	..	35	33	21	45	56	68	70	31	C	76°	70·5	71·6	69·8	93·3	94·3	56·8	99·	124·4	..	..	..	..	..	..	..	..	..	..	..
10	F.	Ad.	1,280	177	178	175	175	..	131	105	99	86	121	125	495	261	234	484	120	120	108	60	48	35	101	416	280	136	35	28	102	100	90	113	131	85	66	16	50	28	21	14	38	33	20	49	57	72	73	34	P+	74°	73·6	..	65·6	80·	86·8	56·	101·	116·3	..	..	..	..	..	..	..	..	..	..	..
11	F.	Ag.	1,188	178	179	176	179	130	126	117	102	92	116	123	494	251	243	491	128	120	109	60	49	33	101	411	281	130	33	28	103	106	97	121	132	96	68	16	52	27	23	17	41	35	21	57	63	71	71	..	P+	70°	70·4	72·6	73·6	84·8	85·4	51·9	103·	110·5	..	..	..	..	..	..	..	..	..	..	..
12	?	Ad.	1,235	184	184	180	180	134	132	105	100	88	119	130	510	260	244	507	130	118	124	74	50	33	102	424	292	132	33	27	96	96	89	112	127	..	..	..	50	24	21	16	39	33	17	46	59	72	73	38	P+	74°	71·7	72·8	66·7	81·8	84·6	48·	94·1	128·3	..	..	..	..	..	..	..	..	..	..	..
13	..	5	..	..	167	163	163	..	130	98	..	83	..	..	..	..	..	..	115	116	116	74	42	..	..	..	..	..	..	..	..	83	78	92	..	72	51	11	40	20	16	12	33	31	16	35	52	..	..	..	C	81°	77·8	..	63·8	..	93·9	50·	..	148·6	22	20	44	48	72	90	41	30	62	23	140

TABLE III.—MEASUREMENTS AND INDICES OF SKULLS FROM THE CHATHAM ISLANDS.

No.	Sex.	Age.	Capacity in c.cs.	Diameters of Brain-case. Longitudinal. Ophryo-occipital.	Glabello-occipital.	Nasio-occipital.	Glabello-iniac.	Basi-bregmatic Height.	Transverse. Maximum.	Asterionic.	Stephanic.	Minimum Frontal.	Biauricular.	Temporal.	Circumferences of Brain-case. Horizontal. Total.	Post-auricular.	Pre-auricular.	Median. Total.	Frontal.	Parietal.	Occipital.	Lambdo-iniac.	Inio-opisthic.	Length Foramen Magnum.	Basion to Nasion.	Transverse. Total.	Supra-auricular.	Intra-auricular.	Foramen Magnum. Length.	Width.	Basi-alveolar Length.	Diameters of Face. Transverse. Biorbital, External.	Biorbital, Internal.	Bijugal.	Bizygomatic.	Vertical. Ophryo-alveolar.	Nasio-alveolar.	Spino-alveolar.	Diameters. Of Nasal Region. Nasio-spinal Height.	Width Anterior Nares.	Length Nasal Bones.	Width Nasal Bones.	Of Orbit. Width.	Height.	Interorbital Distance.	Of Palate. Length.	Width.	Auriculo-orbital Distance, Right.	Auriculo-orbital Distance, Left.	Mastoid Height.	Zygomatic Projection.	Facial Angle.	Indices. Cephalic.	Vertical.	Frontal.	Of Foramen Magnum.	Orbital.	Nasal.	Gnathic.	Palato-maxillary.	Lower Jaw. Height. Symphysial.	Molar.	Coronoid.	Condyloid.	Width. Bigonial.	Bicondyloid.	Bimental.	Of Ramus.	Gonio-symphysial Length.	Condylo-coronoid Length.	Bigoniac Curve.
1	M.	Ad.	1,390	171	178	176	170	134	139	107	104	85	122	134	500	277	223	493	120	125	115	65	50	35	98	437	295	138	35	32	92	103	91	116	138	102	74	18	56	25	..	..	37	38	21	48	60	73	68	42	P+	66°	78·1	75·3	61·2	91·4	102·7	44·6	93·9	125·	..	..	..	..	..	..	..	..	..	..	..
2	M.	Ad.	1,435	186	192	186	192	128	140	108	97	85	130	138	520	280	240	512	130	118	127	67	55	38	104	440	295	145	38	31	102	106	98	128	138	112	80	21	59	28	..	..	42	38	20	54	68	72	74	43	P+	63°	72·9	66·7	60·7	81·6	90·5	47·5	98·1	125·9	..	..	..	..	..	..	..	..	..	..	..
3	M.	Ad.	1,470	190	198	192	196	142	142	109	113	102	126	136	540	287	253	538	142	128	120	70	50	36	110	457	316	141	36	31	108	118	109	128	143	..	..	..	58	28	..	..	47	38	22	55	64	75	76	42	P+	65°	71·7	71·7	71·8	86·1	80·8	48·3	98·2	116·4	..	..	..	..	..	..	..	..	..	..	..
4	M.	Ad.	1,523	183	186	183	180	139	145	110	106	100	130	142	528	280	248	519	132	123	123	65	58	37	104	458	310	148	37	32	..	110	100	124	142	..	..	..	58	30	..	..	42	33	23	..	65	72	73	40	P+	71°	78·	74·7	69·	86·5	78·6	51·7	..	..	..	..	..	..	..	..	..	..	..	..	..
5	M.	Ad.	1,485	177	185	182	182	140	144	113	111	95	128	138	520	283	237	512	130	120	120	70	50	35	104	451	308	143	35	31	100	111	100	124	143	112	77	21	56	27	31	16	41	37	23	53	64	71	69	47	P+	62°	77·8	75·7	66·	88·6	90·2	48·2	96·2	120·8	35	30	81	70	111	116	53	39	90	37	210
6	M.	Ad.	1,475	181	186	183	182	134	140	107	102	90	124	134	518	285	233	513	128	122	121	70	51	36	106	435	300	135	36	29	104	108	100	118	133	102	74	17	57	27	33	17	41	37	24	58	69	69	68	38	P	65°	75·3	72·	64·3	80·6	90·2	47·4	98·1	119·	44	41	78	74	107	134	51	36	96	..	215
7	M.	Ad.	1,285	175	185	181	177	130	140	112	100	90	132	138	505	274	231	498	135	105	115	70	45	36	107	445	298	147	36	27	106	110	103	126	140	108	79	19	60	27	25	19	42	40	22	57	68	71	72	45	P+	63°	75·7	70·3	64·3	75·	95·2	45·	99·1	119·3	..	..	..	..	..	..	..	..	..	..	..
8	M.	Ad.	1,380	177	182	180	173	140	144	108	110	91	125	138	518	292	226	516	128	112	139	100	39	32	105	457	318	139	32	30	104	106	98	119	134	103	75	21	54	25	29	19	40	35	23	60	70	67	67	46	P+	68°	79·1	76·9	63·2	93·8	87·5	46·3	99·	116·7	39	34	80	71	99	114	52	35	90	29	202
9	M.	Ad.	..	202	208	206	194	144	146	115	116	103	134	140	560	317	243	564	138	142	128	90	38	40	116	465	320	145	40	34	107	117	108	129	147	107	79	18	61	27	28	16	46	40	23	55	69	73	74	44	P+	70°	70·2	69·2	70·5	85·	87·	44·3	92·2	125·5	33	30	76	64	113	128	51	40	95	29	200
10	M.	Ad.	1,370	180	186	184	177	134	139	107	112	100	121	132	520	285	240	511	130	130	120	70	50	30	101	446	304	142	30	28	104	106	93	118	135	107	79	24	55	25	..	..	37	35	23	56	67	69	69	43	P	64°	74·7	72·	71·9	93·3	94·6	45·5	103·	119·6	..	..	..	..	..	..	..	..	..	..	..
11	M.	Ad.	1,590	191	198	195	196	132	150	107	109	98	138	143	550	300	250	532	139	131	125	60	65	34	103	459	310	149	34	31	101	105	96	124	144	110	80	21	59	29	..	..	43	37	18	54	67	74	73	39	P+	67°	75·8	66·7	65·3	91·2	86·	49·2	98·1	124·1	..	..	..	..	..	..	..	..	..	..	..
12	M.	Ad.	1,290	174	181	179	176	128	138	99	104	94	125	136	500	273	227	493	125	115	119	62	57	34	100	435	295	140	34	27	96	108	101	119	133	..	..	..	58	27	31	16	43	37	20	52	62	72	69	40	P+	63°	76·2	70·7	68·1	79·4	86·	46·5	96·	119·2	..	..	..	..	..	..	..	..	..	..	..
13	M.	Ad.	1,463	177	184	181	176	137	144	108	109	92	127	137	520	290	230	514	132	122	121	80	41	37	101	454	305	149	37	29	103	102	93	118	142	95	68	18	50	25	24	16	41	35	19	53	65	71	71	42	P+	68°	78·3	74·5	63·9	78·4	85·4	50·	102·	122·6	..	..	..	..	..	..	..	..	..	..	..
14	M.	Ad.	1,415	173	176	175	172	140	143	105	109	88	130	137	507	283	224	508	122	121	127	76	51	38	100	454	312	142	38	28	94	100	90	101	..	96	71	16	55	26	26	16	38	36	19	52	64	70	68	39	P+	68°	81·3	79·5	61·5	73·7	94·7	47·3	94·	123·1	..	..	..	..	..	..	..	..	..	..	..
15	M.	Ad.	1,490	184	186	182	175	133	145	108	119	95	120	138	526	280	246	521	130	124	132	86	46	36	99	497	316	181	36	34	96	106	99	120	..	94	67	17	50	25	23	14	42	36	22	53	60	70	69	38	P+	72°	78·	71·5	65·5	94·4	85·7	50·	97·	113·2	..	..	..	..	..	..	..	..	..	..	..
16	M.	Ad.	1,418	176	185	183	176	132	142	118	95	81	125	137	520	290	230	500	120	100	138	85	53	38	104	500	300	136	38	33	96	108	101	121	134	98	72	13	59	27	..	..	45	36	20	51	59	70	71	33	P+	66°	76·8	71·4	57·	86·8	80·	45·8	92·3	115·7	..	..	..	..	..	..	..	..	..	..	..
17	M.	Ad.	1,510	188	194	190	184	138	148	115	115	104	135	140	535	300	235	523	124	120	137	84	53	36	106	447	300	147	36	33	100	122	109	129	147	102	74	17	57	25	26	15	46	40	24	53	67	67	68	44	P+	66°	76·3	71·1	70·3	91·7	87·	43·8	94·3	126·4	35	36	82	69	110	126	54	34	91	29	210
18	M.	Ad.	1,580	184	190	188	180	142	142	113	106	98	131	140	525	282	243	526	135	115	127	80	47	38	111	465	318	147	38	35	106	106	96	121	144	108	79	18	61	26	27	16	42	36	20	59	70	77	76	40	P+	68°	74·7	74·7	69·	92·1	85·7	42·6	95·5	118·6	35	38	79	66	108	133	54	38	95	37	224
19	M.	Ad.	1,620	192	198	198	192	139	143	120	106	92	128	138	545	312	233	534	130	130	125	70	55	37	112	452	305	147	37	34	107	115	103	125	144	115	85	21	64	28	32	18	43	40	20	55	73	75	76	42	P+	68°	72·2	70·2	64·3	91·9	93·	43·8	95·5	132·8	32	32	70	62	95	115	51	36	88	37	206
20	M.	Ad.	1,440	184	..	182	..	139	141	114	110	99	129	136	530	278	252	516	130	120	124	70	54	36	104	456	310	146	36	35	105	..	97	124	145	105	79	20	59	25	26	18	41	37	20	56	66	74	72	36	P+	71°	..	..	70·1	97·2	90·2	42·4	101·	117·9	36	34	79	71	108	126	56	41	95	31	220
21	M.	Ag.	..	181	187	186	183	134	148	111	..	93	123	..	535	290	245	518	128	122	124	80	44	40	104	449	310	139	40	37	103	107	97	124	142	97	74	14	60	26	27	..	42	37	19	52	62	73	74	39	P+	67°	79·1	71·7	62·8	92·5	88·1	43·3	99·	119·2	..	..	..	..	..	..	..	..	..	..	..
22	M.	Ad.	1,512	179	181	176	181	142	141	104	106	94	126	132	510	267	243	514	136	132	105	52	53	39	102	455	312	143	39	33	97	106	97	122	141	108	78	22	56	25	24	14	41	36	19	53	67	71	71	35	P	72°	77·9	78·5	66·6	84·6	87·8	44·6	95·1	126·4	39	30	72	68	114	133	51	37	96	36	210
23	M.	Ad.	1,650	186	190	190	181	138	145	117	114	96	132	142	538	292	246	528	140	130	121	70	51	34	103	463	320	143	34	32	105	107	99	124	144	98	76	14	62	28	26	19	44	37	16	55	71	72	71	43	P+	64°	76·3	72·6	66·2	94·1	84·	45·2	101·9	129·1	..	..	..	..	..	..	..	..	..	..	..
24	M.	Ad.	1,550	189	192	188	183	130	146	117	122	98	128	140	540	288	252	521	138	122	125	75	50	32	104	460	318	142	32	31	103	106	98	119	..	109	83	23	60	27	28	17	42	37	23	58	67	71	69	43	P	70°	76·	67·7	67·1	96·9	88·1	45·0	99·	115·5	37	30	75	63	109	118	51	34	90	36	205
25	M.	Ad.	1,500	177	180	176	173	136	144	99	121	94	127	137	520	274	246	509	130	120	125	80	45	33	101	462	320	142	33	32	103	109	99	121	139	102	79	23	56	23	30	16	41	35	23	56	67	69	70	40	P	67°	80·	75·6	65·3	97·	85·4	41·1	102·	119·6	42	30	71	71	113	121	51	37	89	34	200
26	M.	Ag.	..	192	198	196	196	140	..	111	..	100	126	..	..	..	..	544	144	128	125	68	57	35	112	485	328	157	35	32	107	108	102	..	..	119	86	17	69	31	..	..	45	43	25	57	70	..	72	46	P+	65°	..	70·7	..	91·4	96·	44·9	95·5	122·8	..	..	..	..	..	..	..	..	..	..	..
27	M.	Ad.	1,490	180	184	178	179	137	138	113	105	90	122	132	513	277	236	521	134	130	122	76	46	33	102	447	310	137	33	31	100	104	92	118	134	96	69	16	53	25	22	16	39	35	21	50	61	67	68	34	P+	70°	75·	74·5	65·2	93·9	89·7	47·2	98·	122·	..	..	..	..	..	..	..	..	..	..	..
28	M.	Ad.	1,375	180	183	183	169	127	141	113	114	90	122	131	512	286	226	502	126	127	117	67	50	34	98	437	295	138	34	28	96	103	95	115	130	..	..	..	59	25	26	15	38	36	19	49	54	68	68	35	P+	65°	77·	69·4	63·8	82·4	94·7	42·4	98·	110·2	..	..	..	..	..	..	..	..	..	..	..
29	M.	Ad.	1,380	176	178	176	171	137	135	107	108	94	125	131	503	271	232	498	122	128	113	60	53	35	100	443	300	143	35	27	100	104	94	115	134	99	74	22	52	25	25	16	39	35	20	54	64	69	68	36	P+	69°	75·8	77·	69·6	77·1	89·7	48·2	100·	118·5	30	32	71	60	94	126	50	40	93	34	210
30	M.	Ad.	1,338	173	177	175	170	133	138	104	107	87	126	132	500	279	221	490	119	121	115	65	50	35	100	434	290	144	35	27	97	104	97	117	134	106	73	14	59	31	27	17	40	37	18	53	64	69	69	41	P+	68°	78·	75·1	63·	77·1	92·5	52·7	97·	120·8	..	..	..	..	..	..	..	..	..	..	..
31	M.	Ad.	1,370	176	178	176	178	128	138	108	108	95	123	130	503	265	238	489	122	118	116	50	66	34	99	427	292	135	34	29	100	102	91	116	131	91	67	17	50	26	23	16	38	31	19	52	61	70	70	32	P+	70°	77·5	71·9	69·6	85·3	81·6	52·	101·	117·3	..	..	..	..	..	..	..	..	..	..	..
32	M.	Ad.	1,400	181	186	185	176	132	136	106	105	98	118	130	515	283	232	504	129	121	120	70	50	34	100	434	298	136	34	27	102	107	97	118	134	99	73	15	58	23	..	..	41	36	19	..	..	70	71	38	P+	65°	73·1	71·	72·1	79·4	87·8	39·6	102·	..	..	..	..	..	..	..	..	..	..	..	..
33	F.	Ad.	1,358	171	175	174	168	132	139	110	105	96	126	132	500	280	220	486	124	114	115	67	48	33	100	428	288	140	33	29	92	103	92	115	132	..	..	..	52	25	25	17	40	37	19	48	53	66	66	37	P+	69°	79·4	75·4	69·1	87·9	92·5	48·2	92·	110·4	..	..	..	..	..	..	..	..	..	..	..
34	F.	Ad.	1,300	172	176	174	162	128	136	109	103	88	118	128	490	282	208	480	119	122	110	61	49	34	95	410	280	130	34	32	93	99	90	108	123	85	62	14	48	24	21	16	37	34	17	48	59	62	64	38	P	70°	77·3	72·7	64·7	94·1	91·9	50·	97·9	122·9	..	..	..	..	..	..	..	..	..	..	..
35	F.	Ad.	1,255	166	170	170	168	128	133	98	105	88	118	129	485	255	230	480	124	116	109	66	43	30	101	439	306	133	30	29	100	105	95	118	132	100	79	23	56	26	26	16	40	35	20	51	62	68	69	39	P+	68°	78·2	75·3	66·2	96·7	87·5	46·4	99·	121·6	31	25	72	64	103	118	49	38	89	28	200
36	F.	Ag.	..	175	177	177	167	123	137	100	104	97	118	131	500	270	230	482	120	112	118	73	45	33	99	323	293	130	33	27	95	102	92	111	125	91	67	14	53	23	..	..	39	37	19	47	57	68	68	32	P+	70°	77·4	69·5	70·8	81·8	94·9	42·6	96·	114·9	32	28	63	54	99	..	50	35	87	..	190
37	F.	Ad.	1,235	172	176	176	165	130	134	100	96	86	120	132	491	270	221	482	120	108	122	77	45	35	97	423	290	133	35	28	96	100	91	112	129	..	..	..	51	27	..	..	37	35	20	48	60	68	70	39	P+	70°	76·1	73·9	64·9	80·	94·6	52·9	99·	125·	..	..	..	..	..	..	..	..	..	..	..
38	F.	Ad.	1,185	167	170	169	165	123	130	99	96	86	113	125	480	265	215	468	113	121	104	56	48	33	97	402	272	130	33	27	91	103	97	113	128	96	66	13	53	25	25	15	40	38	19	48	63	64	64	35	P+	69°	76·5	72·4	66·2	81·8	95·	47·2	93·8	131·3	..	..	..	..	..	..	..	..	..	..	..
39	F.	Ad.	1,325	175	177	176	172	126	132	104	102	96	116	124	492	273	219	483	117	119	112	72	40	34	101	406	281	125	34	29	103	100	91	111	123	87	63	17	46	23	20	16	40	34	17	51	60	65	67	32	P	72°	74·6	71·2	72·7	85·3	85·	50·	102·	117·6	..	..	..	..	..	..	..	..	..	..	..
40	?	Ad.	1,318	177	179	178	170	131	138	109	106	88	121	131	504	284	220	495	117	123	118	80	38	33	104	433	300	133	33	31	100	103	94	113	127	93	70	19	51	24	24	16	40	35	19	53	63	65	66	38	P+	72°	77·1	73·2	63·7	93·9	87·5	47·1	96·2	118·9	..	..	..	..	..	..	..	..	..	..	..
41	?	Ad.	1,350	174	177	176	173	133	135	106	110	93	117	132	500	270	230	494	125	120	112	57	55	39	98	427	300	127	39	37	97	104	94	115	129	87	64	13	51	26	26	14	39	35	19	48	?	69	68	32	P	69°	76·3	75·1	68·9	94·9	89·7	51·	99·	..	..	..	..	..	..	..	..	..	..	..	..
42	?	Ad.	1,295	177	179	177	177	127	128	104	104	94	118	123	496	270	226	491	125	115	120	70	50	36	95	412	280	132	36	28	98	102	93	113	123	90	67	16	48	25	..	..	39	33	18	48	62	65	65	38	P	68°	71·5	70·9	73·4	78·	84·6	52·1	96·9	129·1	..	..	..	..	..	..	..	..	..	..	..
43	?	8	1,340	..	172	170	154	129	135	105	104	85	117	128	490	283	207	474	118	117	120	70	50	35	89	422	295	127	35	30	79	94	85	101	113	..	..	..	45	21	..	..	35	34	18	37	55	62	61	..	C	78°	78·5	75·	63·	85·7	97·1	46·7	88·8	152·4	..	..	..	..	..	..	..	..	..	..	..
44	?	7	1,188	..	164	162	153	122	131	96	100	87	110	125	464	263	201	465	120	100	119	75	44	34	92	414	290	124	34	31	84	93	86	..	..	76	54	12	42	23	20	16	36	34	18	38	56	..	61	..	C	76°	79·9	74·4	66·4	91·2	94·4	54·8	80·4	147·4	..	..	..	..	..	..	..	..	..	..	..
45	?	7	1,545	..	179	176	175	130	144	110	113	93	117	133	512	285	227	497	125	127	116	63	53	35	94	436	310	126	35	32	90	95	87	104	115	78	58	15	43	23	20	15	38	34	18	45	61	60	61	27	C	79°	80·4	72·6	64·6	91·4	89·5	53·5	94·7	135·6	26	21	52	46	84	..	45	30	70	24	164
46	?	6	..	..	172	170	..	129	139	104	111	88	117	..	..	..	..	..	..	..	..	..	..	..	85	..	..	..	40	36	80	91	83	98	109	..	55	10	45	22	..	..	33	33	18	40	55	60	59	..	..	..	80·8	75·	63·3	90·	100·	48·9	94·1	137·5	..	..	..	..	..	..	..	..	..	..	..
47	M.	Ad.	1,348	178	180	178	173	133	138	104	114	100	116	130	510	270	240	507	125	114	128	86	42	34	106	441	310	131	34	32	102	109	100	118	130	102	77	22	55	24	28	17	42	37	23	55	61	69	71	35	P	72°	76·7	73·9	72·5	94·1	88·1	43·6	96·2	110·9	37	28	68	59	100	123	48	33	80	32	188
48	M.	Ad.	1,420	181	184	181	174	133	138	116	103	89	116	126	502	282	220	505	120	130	125	72	53	34	96	421	291	130	34	29	99	102	96	110	124	97	68	18	50	22	27	17	40	37	19	53	63	63	66	36	P+	68°	75·	72·3	64·5	85·3	92·5	44·	103·1	118·9	32	28	61	52	95	113	52	34	87	26	208
49	?	14	1,448	176	178	177	171	137	138	105	112	93	117	130	498	280	218	511	125	125	114	60	54	37	100	429	302	127	37	27	89	100	91	108	120	100	71	18	53	22	27	14	39	35	19	47	62	65	65	35	C	72°	77·5	77·	67·4	73·	89·7	41·5	89·	131·9	32	25	54	51	94	104	47	32	80	30	175
50	?	14	..	169	171	170	152	124	128	99	..	..	106	118	475	274	201	474	120	120	108	70	38	35	91	397	280	117	35	34	88	..	..	..	109	85	64	16	48	20	..	..	35	34	16	47	56	61	61	27	C	72°	74·9	72·5	..	97·1	97·1	41·7	96·7	119·1	27	23	56	54	85	105	47	31	75	28	170

TABLE IV.—MEASUREMENTS AND INDICES OF VERTEBRAL COLUMNS

A.—Mysore

	I. (Male). Diameters. Vertical. Anterior	Posterior	Horizontal. Transverse	Sagittal	Vertical Index	II. (Male). Diameters. Vertical. Anterior	Posterior	Horizontal. Transverse	Sagittal	Vertical Index	III. (Male). Diameters. Vertical. Anterior	Posterior	Horizontal. Transverse	Sagittal	Vertical Index	IV. (Male). Diameters. Vertical. Anterior	Posterior	Horizontal. Transverse	Sagittal	Vertical Index
Cervical 2	..	..	20	17	..	..	..	19	16	..	..	..	23	19	..	..	..	20	17	..
3	16	15	24	19	..	14	14	25	17	..	12	13	25	18	..	13	15	21	18	..
4	14	15	25	18	..	12	13	28	17	..	12	13	25	18	..	13	13	..	..	..
5	14	15	21	19	..	11	12	29	16	..	12	13	27	17	..	12	13	..	..	..
6	14	15	28	19	..	10	12	27	17	..	13	13	29	18	..	12	13	20	17	..
7	16	15	28	17	..	13	15	29	..	..	14	15	34	19	..	15	15	32	17	..
Dorsal 1	17	19	32	17	..	..	17	..	..	..	15	17	36	19	..	17	18	35	18	
2	..	..	..	..	..	18	18	31	18	..	17	17	36	21	..	18	18	31	19	
3	19	19	32	19	..	18	18	30	20	..	18	19	34	23	..	19	19	33	20	
4	20	19	31	22	..	18	18	28	20	..	17	19	34	25	..	19	20	31	23	..
5	20	20	31	25	..	18	18	29	22	..	17	20	34	26	..	20	21	31	25	
6	20	21	33	27	..	19	19	30	24	..	18	20	35	27	..	21	23	32	25	
7	20	22	34	27		19	20	31	26	..	19	20	39	30	..	21	23	33	27	
8	21	22	36	28		20	21	32	28	..	20	20	41	31	..	22	23	34	28	
9	21	22	40	30	..	21	22	35	29	..	20	21	44	33	..	21	22	36	29	
10	21	23	43	31	..	22	23	39	29	..	20	22	48	35	..	21	24	40	30	
11	21	21	48	32	..	22	25	42	30	..	21	24	[illegible]	36	..	24	27	42	30	
12	24	27	48	33	..	25	28	43	30	..	22	27	52	37	..	26	30	44	31	
Lumbar 1	24	30	49	35	125·[illegible]	26	31	47	33	119·2	23	27	51	39	117·4	26	30	48	34	115·5
2	25	30	51	36	128·[illegible]	26	29	52	33	111·5	25	29	56	40	104·[illegible]	25	30	50	36	120
3	26	30	53	37	115·1	27	23	56	35	104·7	25	25	58	41	100	26	27	52	38	103·8
4	26	29	57	38	111·5	25	25	56	37	106	26	22	58	39	84·6	26	24	58	39	93·3
5	26	25	56	40	96·2	25	23	57	37	92	28	22	[illegible]	35	78·6	26	24			92·3
Sacrum, Lgth.	..	..	106	..		..	..	106	..	..	..	..	97	..		..	..	..	..	..
" Arc	..	..	111			..	..	113	..	..	..	..	111	..		..	..	..	..	..
" Bdth.	..	..	110	..		..	..	119	..	..	..	..	123	..		..	..	108	..	

	V. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	VI. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	VII. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	VIII. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index
Cervical 2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			18	15	..
3	..	..	..	..	..	..	..	..	..	..						7	6	20	16	..
4	..	..	..	..	..	..	..	..	..	..					..	5	7	21	16	..
5			..	..	..			..	..	..						5	8	23	16	
6	..	..	..	..	..			..	..	..						6	8	26	17	
7	..	..	..	..				..	..	..						8	9	23	17	
Dorsal 1																15	17	31	19	..
2			..							..						..	..	..		
3																18	18	21	21	
4																18	18	21	22	
5																18	18	25	24	
6																19	19	25	26	
7																19	19	27	27	
8																20	20	31	28	
9																20	21	34	28	
10																20	22	37	29	
11																20	25	41	32	
12											21	28	18	38		24	27	41	34	
Lumbar 1	20	25	45	35	125	18	26	51	34	141·1	17	28	48	37	161·7	21	28	41	37	110·7
2	22	25	48	35	115·6	22	27	53	36	122·7	21	28	51	38	133·3	20	28	46	37	107·7
3	21	25	51	35	104·2	21	27	55	37	112·[illegible]	21	27	54	39	117·4	20	26	49	38	100
4	21	24	52	37	100	25	23	57	39	92	21	21	[illegible]	41	100	28	25	52	38	89
5	25	22	52	36	88	21	20	58	38	84·[illegible]	25	21	55	37	81	25	22	52	35	78·6
Sacrum, Lgth.	..	..	101				..			..		..	113							
" Arc	..		108	..		..	..	..	..	..		..	120							
" Bdth.	..		110			108				..		..	130							

	IX. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index	X. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index	XI. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index	XII. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index	XIII. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index
Cervical 2		..	18	16		..	..	19	16	..										..		..	20	16	..
3	12	12	20	17		12	14	21	16	..											12	12	23	18	..
4	12	12	21	16		12	14	22	16	..											11	12	24	16	..
5	11	12	21	15		12	13	23	16	..											10	12	25	14	..
6	10	12	21	16		13	13	25	16												11	12	30	18	..
7	13	12	26	15		14	15	27	15												13	13	31	16	..
Dorsal 1	14	15	29	16		15	16	31	15							16	15	33	18		15	16	33	16	
2	15	16	29	17		17	18	24	17	..						17	18	31	19		17	17	32	17	
3	16	17	25	19		18	18	27	18												..	..	..	..	
4	18	18	27	21		17	18	21	20												17	18	30	19	
5	19	19	[illegible]	22		18	19	28	21							18	19	20	21		17	18	29	21	
6	19	19	27	23		19	20	28	22							19	20	21	22		18	18	28	22	
7	20	20	29	25		18	20	29	22							19	20	32	24		19	20	30	23	
8	21	21	30	25		20	21	31	21							19	20	33	25		20	21	32	26	
9	21	21	33	25		20	21	32	25							20	21	34	26		21	21	36	27	
10	21	23	31	24		20	22	35	26		14	21	47	30		19	21	38	27		21	21	40	28	
11	23	24	30	30		21	21	35	[illegible]		20	23	40	31		20	25	40	28		22	24	43	29	
12	23	26	33	31		22	26	30	[illegible]		21	25	42	31		25	26	45	28		21	26	45	30	
Lumbar 1	23	27	46	31	117·4	22	28	41	32	127·2	25	26	44	31	103	15	25	45	30	166·7		..	..		
2	23	27	50	33	117·4	21	25	46	[illegible]	116·7	21	26	47	33	108	24	25	47	32	110·[illegible]			..		
3	23	26	50	31	113	22	28	44	41	112	25	25	49		100	25	27	50	34	108			..		
4	21	21	52	36	100	27	27	52	[illegible]	100	25	23	50	36	92	25	26	51	35	101	26	22	52	33	84·6
5	25	21	50	35	81	28	23	51	37	82·1	25	23	52	36	92	26	24	55	35	92·3	25	23	15	35	88
Sacrum, Lgth.			103	..				107					107					114					85		..
" Arc			111	..				113					113					116					97		..
" Bdth.			125	..				124					124					123					103		..

B.—Mongoloid

	I. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	II. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	III. (Male). Anterior	Posterior	Transverse	Sagittal	Vertical Index	IV. (Female). Anterior	Posterior	Transverse	Sagittal	Vertical Index
Cervical 2					..	..							19	18				30	18	
3			..		..	..	..				15	15	21	18		13	15	22	18	..
4									..		14	14	23	18	..	13	11	22	17	
5											14	15	25	19	..	13	11	23	17	
6											15	15	28	21		13	14	27	18	..
7				..				..			16	15	29	20		11	15	31	18	
Dorsal 1	17	18	38	18			17				17	17	31	21	..	15	16	33	19	
2	20	20	35	20			18				19	18	33	22	..	17	17	22	19	
3	20	20	34	22		16	18	30	19		19	14	32	23		14	18	30	21	
4	20	21	33	23		17	18	28	20		20	19	32	25		19	19	29	22	
5	20	21	33	25		18	18	28	22		20	21	31	27		19	20	29	23	
6	20	22	31	27		18	19	28	24		20	22	33	28		19	21	30	24	
7	21	23	35	29		19	20	30	26		20	22	35	29		20	21	31	26	
8	22	23	37	30		19	20	33	27		21	22	37	31		21	21	31	28	
9	22	[illegible]	39	31		20	21	37	28		21	23	37	32	..	22	22	33	29	
10	23	24	45	33		21	21	40	28		22	23	41	33		23	23	37	30	
11	21	23	49	33		22	25	44	29		23	25	46	35	..	24	28	41	32	
12	26	31	51	35		23	27	46	31		24	27	49	35	..	25	31	47	38	
Lumbar 1	26	32	53	38	121·1	24	27	47	32	112·5	24	29	51	39	120·8	27	31	39	40	111·8
2	28	32	57	40	114·3	24	27	50		112·5	25	30	51	42	120	28	31	51	39	110·7
3	29	30	54	41	103·1	24	25		41	104·2	24	29	57	42	120·8	29	30	55	39	103·1
4	30	28	60	42	93·3	25	[illegible]	55	35	92	24	27	58	41	112·5	30	28	56	39	93·3
5	29	26	58	30	80·7	26	23	51	33	80·8	25	21	58	40	96	31	26	51	39	83·9
Sacrum, Lgth.	..		104	..				93					108		.			120		.
" Arc	.		118	..			.	102	..				110		.			129		
" Bdth.	.	.	112	.			.	108	.		.	.	111		..		.	127	..	..

	A. I. (Male)	II. (Male)	III. (Male)	IV. (Male)	V. (Male)	VI. (Male)	VII. (Male)	VIII. (Female)	IX. (Female)	X. (Female)	XI. (Female)	XII. (Female)	XIII. (Female)	B. I. (Male)	II. (Male)	III. (Male)	IV. (Female)
Cervico-vertebral index	101·3	110	106·3	106·2	.	.		102·7	105·3	107·9	.		107		..	100	115·8
Dorso-vertebral index	106·3	104·5	111·6	105·1	.	.		105·7	101·1	108			101·3	107·8		104·9	106·6
Lumbo-vertebral index	113·4	105·4	95·3	101·7	105·2	108·8	116·4	97·7	105·9	106·3	99·2	113	.	101·2	100	113·9	100·7
Sacral index ..	103·7	112·3	126·8		108·9		106·2	.	121·1	115·9	115·9	107·9	118·8	107·7	116·1	105·6	105·8

ART. II.—*Further Coccid Notes: with Descriptions of several New Species, and Discussion of various Points of Interest.*

By W. M. MASKELL, Registrar of the University of New Zealand, Corr. Mem. Royal Society of South Australia.

[*Read before the Wellington Philosophical Society, 13th December, 1893.*]

Plates III.-VIII.

SOME of the insects dealt with in this paper are not inferior in peculiarity and complexity to those which I have at various times reported. I venture to think also that the discovery in Australia of *Icerya ægyptiaca* and of a very near variety of *Icerya rosæ* is of general interest. Four at least of the forms belonging to the genus *Icerya* are now known to inhabit Australia, and it may be worth while to investigate the question whether that country is not the original habitation of the genus. That, however, would require to be done by some Australian observer, and is beyond my power.

I am constrained to refer to a point in connection with the classification which I have laid down for the family *Coccidæ*, on account of a remark in a paper by Mr. J. G. O. Tepper, of Adelaide, published in the "Transactions of the Royal Society of South Australia," vol. xvii., part 2, December, 1893. The paper is on South Australian species of *Brachyscelinæ*, and at page 269 Mr. Tepper observes that "Mr. Maskell added the genera *Frenchia* and *Carteria* to the Brachyscelidæ, and described and figured *Sphærococcus* and *Cylindrococcus* as of uncertain position, but has lately formed a new sub-family *Idiococcinæ* for their reception. On account of a general similarity of habit, I consider that they should also be included in the family. The first and two last form woody galls similar in structure to those of *Brachyscelis*."

There is an inaccuracy in the last sentence of this passage which requires correction. *Sphærococcus* does not at all always form woody galls. The galls of *S. leptospermi* are woody, and those of *S. froggatti* and *S. pirogallis* may be called so too, but *S. acaciæ* and *S. bambusæ* produce cotton and wax.

However, the main point is that Mr. Tepper would upset my classification on account of "general similarity of habit." I cannot by any means accept the suggestion. It is just this sort of judgment by mere external appearance which it has been my aim and endeavour to destroy and root out during the eighteen years of my study of Coccids. A reliance upon the appearance of a Coccid to the naked eye or under a Coddington or Browning lens is calculated to lead to innumerable mistakes and confusion. The proper way to study this family is to give to every species very close and minute investigation, and rather to wait weeks or months before naming a species than to define it on the hasty examination of a few minutes. Now, not only will Coccids as between themselves easily mislead a believer in "similarity of habit," but they will induce him to include amongst them forms which are not Coccid at all. For example, *Lecanium baccatum* has almost every external character of a *Kermes: Prosopophora dendrobii* is outwardly very much like a Lecanid; or, to take a still clearer case, it is just the judging by external characters which has led some observers to place *Planchonia* in the Lecaniodiaspinæ, and make terrible confusion. These are all Coccids; but "similarity of habit" would make us mix all sorts of families together. Cynipids make woody galls, so do some Chalcids, so do some Psyllids. And the force of this is clearly shown in Mr. Tepper's own paper, where he includes as a Coccid a form which he names "*Ascelis* (?) *multitudinea*," and which is most certainly the gall made by a Psyllid of the genus *Trioza*. Neither the naked eye nor a lens can distinguish this gall from that of a Coccid, yet it is certainly not so.

Everybody is liable to make absurd mistakes. In 1878, just because I did not take sufficient trouble, I included a Psyllid and two Aleurodids amongst Coccids: and Signoret himself wanted to make a new Coccid genus, *Spondyliaspis*, out of an Australian Psyllid making a waxy scale. There is not the slightest fault, therefore, to be found with Mr. Tepper for his error about *Ascelis*. But when it comes to proposing a classification founded upon "general similarity of habit," a protest is necessary, and I am compelled to adhere to my system, under which neither *Cylindrococcus* nor *Sphærococcus* can enter the sub-family Brachyscelinæ.

Finally, I have myself to eat humble pie; and, bowing to the voice of the majority, to withdraw my nomenclature of the past as regards the names of groups and sub-families. In this paper, therefore, I write *Lecaninæ*, *Dactylopinæ*, &c., and trust that whatever good there may be in my work may not be obscured or neutralised by any orthographical crimes.

Group DIASPIDINÆ.

Genus Aspidiotus.

Aspidiotus casuarinæ, sp. nov. Plate III., figs. 1–3.

Female puparium dark yellowish-brown; circular, rather convex; pellicles yellow. Diameter about $\frac{1}{23}$in.

Male puparium brown, the posterior end whitish; form elongated, subcylindrical, slightly convex, not carinated.

Length about $\frac{1}{23}$in. The posterior extremity is usually open, so that the puparium seems as if formed of an upper and lower plate joined together for the greater part of their length, between which the insect lies.

Adult female yellow. The form is rather more elongated than usual in the genus, and there is a shallow transverse groove just below the rostrum. Abdomen ending in six narrow lobes with rounded ends, and between them a few very short hairs. The abdomen is somewhat tapering, and the margin above the lobes is slightly serratulate. There are no groups of spinnerets, but on all the abdominal segments are rows of large single orifices, very numerous; and on the last segment these rows converge to the terminal lobes. At the level of the rostrum are two small spinneret groups, each having about six orifices.

The male pupa may very easily be mistaken for the adult female of some other Diaspid. It is reddish-yellow or brown, somewhat elongated, subcylindrical with a tapering abdomen which ends in six small almost contiguous lobes, and there are a few converging rows of spinnerets as in the adult female (three on each side). But the presence of only a single pellicle on the puparium from which this form may be extracted denotes clearly the sex; moreover, on careful examination, the commencement of the eyes and the rudimentary elytra may frequently be detected. Length of insect about $\frac{1}{60}$in.

Adult male unknown.

Hab. In Australia, on *Casuarina equisetifolia.* My specimens were sent by Mr. G. H. Brown, from Albury.

This species, in the transverse groove of the female, approaches *A. eucalypti,* Mask., but it is more elongated in form, and the abdominal lobes and spinnerets differ: so also does the male puparium.

Aspidiotus cladii, Maskell. N.Z. Trans., vol. xxiii., 1890, p. 3.

I frequently receive specimens of this insect, chiefly from Victoria or South Australia (indeed, probably none have come from New South Wales). The very rich colours of the puparia vary to some extent: some are dark-brown, others almost blood-red; but the convex form and the orange-coloured pellicles are present in all. The pellicles are frequently raised in a small boss, which, indeed, sometimes has almost the appearance of a little blunt horn on the top of the puparium.

The pellicles are by no means always centrally situated, and, if regard were had only to the female puparium, one might consider the insect as a *Diaspis.* But the male puparium is very certainly smooth and not carinated, and consequently the species must remain attached to *Aspidiotus.*

Genus Chionaspis.

Chionaspis brasiliensis, Signoret.

In reporting last year this insect from India, I stated that the adult female was "brown." Mr. E. E. Green informs me that in life the colour is rather "yellow, deepening in older specimens to orange; in some individuals suffused with purplish-brown." He also considers the live male as red in colour, but two of the specimens I had before me were alive, and were certainly, to my eye, yellow, as I stated in my paper.

Colour is a very fallacious test, as I have before several times remarked.

Genus Mytilaspis.

Mytilaspis formosa, sp. nov. Plate III., figs. 4–6.

Female puparia congregated in groups and patches on the leaf with much white cottony fluff: the surface of the food-plant is very pale straw-colour, and the groups of puparia appear also yellowish, as the yellow pellicles show through the cotton. The puparia are, as a general rule, irregularly placed, but it is by no means uncommon to find them arranged radially, that is, with a common centre, towards which the larval pellicles point, and from which the fibrous portions spread out like a fan. A group so arranged, with the golden pellicles appearing through the white cotton, is very elegant. Length of the puparium averaging $\frac{1}{17}$in. The form is elongated, usually straight, slightly dilated towards the end.

Male puparia congregated in the same groups with the females, and of similar colour; distinguishable mainly by the presence of only one pellicle. Form flattish, cylindrical, not carinated; length about $\frac{1}{27}$in.

Adult female dark-orange or golden-brown; elongated as usual in the genus; length about $\frac{1}{40}$in., but shrivelling at gestation. Abdomen ending in a circular curve, much broken by small denticulate projections. There are two median sub-cylindrical lobes with rounded terminations, and with the margins very minutely serrulate; these lobes are not adjacent, and between them are two short fine spiny hairs: on each side, separated by a short distance, is another smaller lobe. The posterior segments of the abdomen bear a few spines. Pygidium bearing five groups of spinnerets; upper group with five orifices, upper laterals 14 to 18, lower laterals 20 to 24. There are many larger single orifices; and near the extremity, above the lobes and on the dorsal surface, are eight pairs of compound spinnerets, from which spring cylindrical hyaline tubes, extending beyond the margin. These tubes are not serrated at the extremity, and do not resemble the "plates" of *Parlatoria*, but rather the long hyaline tubes of the Acanthococcids.

Adult male not known with certainty.

Hab. In Australia, on *Eucalyptus* sp., probably *E. orbifolia*, as the leaves are short, almost circular, and whitish-yellow. This plant is a native of Western Australia. My specimens came from Mr. J. W. Douglas, who received them "indirectly from Baron Von Mueller"; locality not stated.

Subsequently I received from Mr. French a leaf of *Eucalyptus corynocalyx*, from Renmark, South Australia, with many puparia, both male and female, which seemed to be of this species; but every individual had been parasitised and destroyed. On a withered specimen of a male I noticed a rather long spike.

M. formosa, in its colours and the arrangement of the puparia, is very elegant, and well deserves, I think, the name I have given to it.

Mytilaspis spinifera, sp. nov. Plate III., figs. 7–9.

Female puparium snowy-white, pellicles light-yellow. The larval pellicle is longitudinally corrugated, the second pellicle smooth and subcircular; the white fibrous secretion widens very rapidly, with a terminal subcircular margin, so that the whole puparium is broadly pyriform; the two pellicles together occupy less than half the length. Total length about $\frac{1}{16}$in.

Male puparium white, with yellow pellicle; flattish, subcylindrical, not carinated. Length about $\frac{1}{24}$in. In some specimens observed, half a dozen male puparia were congregated under and partly hidden by that of the female.

Adult female orange-yellow, darkening with age. Form elliptical, with the thoracic and abdominal segments rather distinct. Usually there is a slight covering of white meal on the dorsum. Abdomen ending in a curve, broken by small serrations. There are two median lobes, not adjacent; each lobe has a cylindrical shaft terminated by a cone. Between the lobes are two short fine hairs, and on the curve of the abdomen at each side are six or eight spines and from two to six oval pores. Ventrally there are five groups of spinnerets: upper group with 2 to 6 orifices, upper laterals 8 to 10, lower laterals 10 to 15. Dorsally there are great numbers of smaller spinnerets, which are congregated in large marginal groups on each segment of the thorax and abdomen, and are interspersed with small conical spines; and on the thoracic segments the spines are not only marginal, but extend in transverse rows across the body: there are also a few on the cephalic extremity. Moreover, on the dorsal surface there are six larger spines, one on each side at the level of the rostrum, and two on each side near the spiracles. The spiracles are rather large, and close to each is a group of four spinnerets.

Larva yellow, elliptical; length about $\frac{1}{60}$in. The dorsum is longitudinally corrugated. Antennæ of six joints, of the normal Diaspid form. The abdomen terminates with two moderate setæ.

Adult male unknown.

Hab. In Australia, on *Acacia pendula.* My specimens were sent by Mr. W. W. Froggatt, from Urana, New South Wales.

I believe this to be a quite distinct species, which I place in the genus *Mytilaspis* on account of the non-carinated male puparium. The abdominal extremity, the very numerous spinnerets and small spines, and the six large dorsal spines appear to be clear distinctions.

Mytilaspis convexa, sp. nov. Plate III., figs. 10–12.

Female puparium dirty greyish-white, somewhat expanded posteriorly, very convex: the second pellicle is generally so much raised up that its posterior edge forms quite a ridge over the secreted portion. Length of puparium averaging about $\frac{1}{23}$in.

Male puparium similar in colour to that of the female, convex, elongated, subcylindrical; not carinated. Length about $\frac{1}{25}$in.

Adult female of normal form; colour brown; length about $\frac{1}{30}$in. Abdomen ending in two median lobes, not adjacent, broadly rounded with short straight sides, the posterior margins very minutely serrulate. At each side, and separated from the median lobes by two spines, is a smaller broadly-rounded serrulated lobe. Margin of the abdomen broken by many small serrations, and bearing several short spines. No groups of spinnerets, and not many dorsal single orifices. The rudimentary antennæ are rather large.

Adult male unknown.

Hab. In Australia, on *Acacia* sp. Mr. Olliff sent me specimens from Sydney.

The non-carinated male puparium fixes the genus of this insect. The absence of spinneret-groups is abnormal. I think *M. drimydis*, Mask. (N.Z. Trans., vol. xi., 1878, p. 196), is the only other species with this peculiarity.

Mytilaspis grandilobis, sp. nov. Plate III., figs. 13, 14.

Female puparium snowy-white: the real form is elongated and mussel-shaped, or slightly pyriform; but it is frequently obscured by white cottony fluff. Length averaging about $\frac{1}{14}$in.

Male puparium snowy-white, semi-cylindrical, with parallel sides; not carinated; length about $\frac{1}{23}$in.

Adult female yellowish or orange; form normal of the genus, with sometimes rather conspicuous segments. Length about $\frac{1}{20}$in. before gestation. Abdomen ending in a curve, broken by many minute serrations, near which are some large oval pores: on the margin are several longish spiny hairs, single, or in pairs, or in threes. There is a very slight median depression, and two very conspicuous median conical lobes not adjacent, with rounded tips and very minutely serrulated sides. There are five groups of spinnerets: upper group with eight to ten orifices; upper laterals fourteen or fifteen; lower laterals sixteen to twenty-four. There are many single dorsal spinnerets on every thoracic and abdominal segment, and on the margins of the same a few spiny hairs.

Adult male unknown.

Hab. In Australia, on *Banksia* sp. My specimens were sent by Mr. French from an unnamed locality near Melbourne. The male puparia were very numerous on the leaves sent. Many of the females had been parasitised, as shown by small round holes in the puparia, and the insects in these cases were swollen and deformed.

This species is very easily distinguished by the two large and conspicuous abdominal lobes, which are more prominent than in any others of the genus. The non-carinated male puparium fixes it in *Mytilaspis*.

Genus FIORINIA.

Fiorinia rubra, sp. nov. Plate III., figs. 15–18.

Female puparium really greyish or brownish-white, but on account of the large size of the second pellicle, which nearly fills it, only a small portion of the fibrous secretion is visible beyond the pellicles, and the whole has therefore a dark-orange or reddish appearance. The pellicles together are elongated-elliptical, and the fibrous secretion at their extremity is usually broadly rounded, the whole puparium seeming therefore rather broadly pyriform. Length averaging about $\frac{1}{30}$in. The second pellicle occupies nearly the whole of it.

Male puparium elongated, narrow, flattish, not carinated; distinguishable partly by exhibiting only one pellicle, partly by its greater length, which averages $\frac{1}{23}$in.

Adult female dark-orange, elongated; length about $\frac{1}{40}$in., rather less than that of the second pellicle. Abdomen terminating in two broad lobes, of which the inner margins are nearly straight and almost adjacent, the outer margins rounded, sloping outwardly, and minutely serrulate: at each side of them, and at only a short distance, is a smaller denticulate lobe. The abdominal margin is broken by many serrations, between which are several spines, about nine on each side. There are no groups of spinnerets, but many single large dorsal orifices.

Adult male unknown.

Hab. In Australia, on *Acacia* sp. Mr. Olliff, of Sydney, who sent me the specimens, was only able to tell me that the tree in question is known by the name of "Raspberry-jam wood," and is a native of Western Australia.

This insect is not far removed from *F. grossulariæ*, Mask. (N.Z. Trans., vol. xvi., 1883, p. 123), but differs in having no groups of spinnerets.

Genus Poliaspis.

Poliaspis exocarpi, Maskell. N.Z. Trans., vol. xxiv, 1891, p. 17.

I have received specimens of this from Mr. French on *Santalum* sp. from Port Darwin, in the extreme north of Australia. Notwithstanding the difference of food-plant or of climate, I am unable to distinguish these insects from the original specimens received from Mordialloc, Victoria.

Group LECANINÆ.

Subdivision LECANIEÆ.

Genus Lecanium.

Lecanium (?) sp. Plate IV., figs. 1, 2.

Female insect (second stage ?) dark-brown in colour, with a redder tinge on the abdomen. Form elongated and proportionately narrow, convex, sub-cylindrical. Length about $\frac{1}{9}$in. Antennæ of six joints, of which the third is much the longest, and the sixth is rather longer than either the fourth or fifth; on the last joint are several hairs. Feet rather long and slender; the tarsus is rather longer than the tibia; on the extremity of the tibia are two hairs, and there is a long hair on the trochanter; the digitules are all fine knobbed hairs, the upper pair rather long. Abdomen tapering posteriorly, as if prolonged in two narrow processes, the ends of which almost touch each other, their internal margins forming the abdominal cleft, at the top of which are the usual lobes, rather large and long, and bearing short setæ; the anal ring appears to have several hairs. Mentum monomerous. Dorsal epidermis smooth, but the margins exhibit numbers of minute curved marks, interspersed with circular and tubular spinnerets and some small spiny hairs, which seem to be most numerous on the cephalic region.

Hab. In Australia, on *Casuarina* sp. My specimens were sent by Mr. Olliff, from Sydney.

I am not at all sure that any of my specimens (five) are adult females. The six-jointed antennæ and the tarsi longer than the tibia are characters usually denoting an immature stage. Nor can I certainly fix them in the genus *Lecanium*. They greatly resemble, in their narrow subcylindrical form and in the convergent extremity of the abdomen, the figure of *Signoretia luzulæ*, Dufour, given by Signoret in his pl. viii., fig. 1 (pl. vi. of 1871). *Signoretia* in the adult stage constructs a very definite sac of white cotton, and the spinnerets and spines of the species now under discussion seem to point to a similar procedure. On the whole, I leave the insect for the present as a Lecanium, with the expectation that the full-grown form will be found to inhabit a sac; and I shall not be at all surprised if it should turn out to be a *Pulvinaria*.

Lecanium nigrum, Nietner, "Enemies of the Coffee-tree," 1861; Green, Ind. Museum Notes, 1889, p. 117, and pl. vii.; Douglas, Ent. Mo. Mag., April, 1891, p. 95. Plate IV., fig. 3.

Lecanium depressum, Targioni, Stud. sulle Coccin., 1867, and Catal., 1868; Signoret, Ann. de la Soc. Ent. Franc., 1873, p. 439 and pl. xiii.; Douglas, Ent. Mo. Mag., vol. xxiv., 1887, p. 27; Maskell, N.Z. Trans., vol. xi., p. 206, and vol. xxv., p. 220. Plate IV., fig. 4.

Lecanium begoniæ, Douglas, Ent. Mo. Mag., 1892, p. 209. Plate IV., fig. 5.

The first of these three has been reported from India and Demerara; the second from hothouses in Europe and New Zealand, from Australia, and from the Sandwich Islands; the third from Demerara. They are thus evidently natives of tropical, or at least hot, countries, and seem widely distributed.

I have arrived at the conclusion that they are all practically identical, or, at most, varieties of one species. Priority of nomenclature compels me to adopt *L. nigrum* as the type, although really no scientific description of that insect appeared before that of Mr. Douglas, in 1891. Nietner gives no details; and Mr. Green, though giving several figures, attaches thereto scarcely any description. On the other hand, Targioni, in 1867–68, is equally unsatisfactory regarding *L. depressum;* but Signoret gave sufficient details in 1873, and in reality deserves to be credited with the type. *L. begoniæ* is only described fully by Douglas.

I may observe that the remarks about to be made are founded on specimens received by me, of *L. nigrum* from Mr. Cotes, of *L. depressum* from Dr. Signoret, and of *L. begoniæ* from Mr. Douglas, so that I can have little doubt as to identification. Strictly, these observations ought to have been made in my paper of 1892, when I reported *L. depressum* from Sydney and Honolulu, for I had then in my possession the same material, but having many other things to think of I overlooked the point.

The main reason why I consider the three insects named as belonging to one species is the character of the epidermal cells; and it is necessary to begin by quoting the expressions thereon of the authors mentioned, who have spoken of them. Previously, however, we may discard an external character referred to by Signoret—"Dorsum slightly elevated, with two small depressions in specimens from Italy, and two carinæ in specimens from France"—because evidently this is not a constant character. As regards the cells of the epidermis,—

Signoret says of *L. depressum*, "Exhibiting a great number of tessellated irregular plates forming a marquetry pattern; each plate has a darkish band round it, with a clearer but still rather dark surface-space, and a central clear space with a small orifice." And in his pl. 13, fig. 11*a*, he delineates the cells as irregularly polygonal.

Green, Targioni, and Nietner make no mention of the cells of the epidermis.

Douglas says of *L. nigrum*, "Under the microscope the whole surface is seen to be covered with a tessellation of closely approximate small yellow dots and punctures"; but he does not make any observation as to their form.

Douglas says of *L. depressum*, "Surface covered with a reticulation of irregular shallow cells with a pale centre or ocellus."

Douglas says of *L. begoniæ*, "Covered with contiguous, minute, oval, yellowish dots."

It seems clear here that Mr. Douglas agrees with Dr. Signoret as to the irregular form of the cells in *L. depressum*, but that he considers those of *L. nigrum* and *L. begoniæ* to differ in being more "dot-like" and oval. Indeed, he remarks that the two last insects seem to be very similar to each other.

But, on further consideration, it seems doubtful whether Mr. Douglas made any examination of the epidermis except an *external* one (that is, viewing the insect *in situ*, without preparation)—for although, examined in this manner, a certain (though by no means a great) difference seems to exist between the cell-forms, yet closer observation by transmitted light shows that in reality they are identical. The cells of *L. nigrum* and *L. begoniæ*, which at first sight appear more or less oval, are then seen to be very clearly polygonal and irregular, and to form what Mr. Douglas says of *L. depressum*—a "reticulation." In some specimens of *L. begoniæ* I find the cells perhaps rather smaller than usual; but, as a rule, in all three insects the average (longest) diameter of a cell seems to be about the same—$\frac{1}{500}$in. The outer band and the central orifice are visible in all. Perhaps the cells of *L. begoniæ* may be the darkest in colour.

Looking, therefore, at the epidermis, it appears sufficiently clear that the three insects are identical, whilst in size, colour, and generally convex form they also agree. Mr. Douglas, indeed, says that some of his specimens of *L. depressum* were greenish-yellow instead of brown; but the difference is not important.

With regard to the antennæ, I do not find any difference between *L. nigrum* and *L. depressum*: the figures given by both Signoret and Douglas agree, and so do my own specimens. Both have eight joints, of which the third is the longest. There is a difference, however, in *L. begoniæ*, where there are only seven joints. But Mr. Douglas specially remarks that in the fourth joint there is "a constriction simulating a joint," and this "false joint" (as I have called it in other Lecanids) seems quite enough to raise doubts as to any definite separation of the insect from the others.

As regards the feet, Signoret says of *L. depressum* that the digitules of the claw are dilated, and "one larger than the other." Douglas says nothing of the foot of *L. depressum*. As to *L. nigrum*, he says "digitules long, broad, much dilated"; and of *L. begoniæ*, "digitules normal." I have not been able to detect unequal digitules in *L. depressum*, and possibly Signoret's specimen was exceptional in that respect.

Taking, therefore, these important features—the epidermis, the antenna, and the foot—it seems fairly clear that there is no real difference between the three insects named—at least, as far as concerns the adult female. The females of the second stage appear to be equally similar. I have not observed the larvæ or the males, nor, I think, has anybody except Mr. Green, who gives figures of the adult male, and of its pupal waxy test, of *L. nigrum*. Possibly *L. begoniæ* may be erected into a variety on account of its antenna, and *L. depressum* on account of unequal digitules: but these are only very doubtful differences, and the three must be considered as really one species. Priority, as above-mentioned, determines that species to be *L. nigrum*, Nietner, although Signoret, who first gave anything like a scientific description, might be thought to have a claim for *L. depressum*.

Lecanium mori, Signoret. Maskell, N.Z. Trans., vol. xvii., 1884, p. 29; Scale Insects of N.Z., 1887, p. 82.

I reported this insect in 1884 on *Alsophila colensoi*, but did not give any detailed description. As it has been sent to me during the past year on various other ferns, and as Signoret in his original description (1873) made no mention of the larva or the second stage, nor of the male, it is worth while to enter here into some particulars concerning the species.

Adult female reddish-brown, or sometimes dark-brown, the median dorsal region darker in colour than the margins; form elliptical, dorsum convex, margins slightly flattened; length averaging about $\frac{1}{9}$in., but specimens may reach $\frac{1}{5}$in. Antennæ of seven joints, of which the first two are short, the third and fourth longest and subequal, the fifth and sixth shortest and subequal, the seventh as long as the fifth and sixth together; on the first are two short hairs, on the second two long ones, on the third none, on the fourth four, on the fifth and sixth one each, and on the seventh several. Feet slender; the coxa bears two long hairs, the trochanter one very long; the tarsus is curved and nearly as long as the tibia; the digitules of the claw are rather dilated. Abdominal cleft and lobes normal. The margin of the body bears a row of fine hairs, and at each spiracular depression there are three or four strong spines with a group of circular spinnerets at their bases.

Second stage female yellow or light-brown, elliptical, flat, rather translucent; length about $\frac{1}{16}$in. Antennæ of six joints, of which the third is the longest; the last joint bears several longish hairs. The margin of the body has a row of fine hairs, as in the adult.

Larva yellow, flattish, elliptical, active; length about $\frac{1}{45}$in. There seems to be no particularly distinctive character about it, but the fine marginal hairs are present.

Adult male unknown; the male pupa inhabits a white, waxy, subelliptical test.

Hab. In Europe, on mulberry (if we may judge by the name); in New Zealand, on *Alsophila colensoi, Nephrolepis cordifolia, Asplenium flaccidum,* and other ferns.

Those who are inclined to separate species on account of external appearance, varying food-plants, or even locality, might attempt to distinguish the New Zealand specimens from the European ones; and, indeed, I have never seen this insect on mulberry, but always on ferns. But the anatomical characters of the antennæ and feet, in addition to the elliptical outline and dorsal convexity, are so absolutely identical in both that I cannot dissociate them. These characters, which led me in 1884 to attach the *Alsophila* scale to *L. mori,* are found precisely similar in 1893 on *Asplenium* and *Nephrolepis.*

Genus Pulvinaria.

Pulvinaria maskelli, Olliff, Agric. Gazette of New South Wales, vol. ii., p. 667; vol. iii., p. 176. *Signoretia atriplicis,* Maskell, N.Z. Trans., vol. xxiv., 1891, p. 23. Plate IV., fig. 8.

Although I find a few minute characters in my specimens of *S. atriplicis* which seem different from those of *P. maskelli* (the comparison being made between prepared specimens of both), yet on the whole I believe the two to be identical, and I shall therefore abandon mine, both generically and specifically, in favour of Mr. Olliff. The specimens which I first received came from Wentworth, New South Wales, on *Atriplex* sp., and were sent by Mr. French. There were about twenty adult females in the first parcel, and nearly as many more in a second. All of these were so much covered with cotton that I could not decide upon attaching them to the genus *Pulvinaria*, in which the insect is usually exposed at one end of a cottony ovisac. The only difference between *Pulvinaria* and *Signoretia* lies in this arrangement of the cotton, and may be paralleled perhaps by the distinction drawn between *Eriococcus* and *Gossyparia*. Mr. Olliff, who received his specimens (more numerous than mine) independently from the same locality and on the same plant, attached them to the genus *Pulvinaria*, and in his figures shows the insect exposed at the end of an ovisac. The specimens also which he has sent to me are quite clearly exposed, and are *Pulvinaria*.

It will be seen from the description to be given presently of *Pulvinaria tecta* that specimens of that insect are frequently so covered with cotton as to be invisible, whilst others are exposed. I have seen also sometimes, but not often, insects of *P. innumerabilis*, Rathvon, and *P. betulæ*, Linn., almost, if not quite, covered.

As regards the differences mentioned above between my specimens and those of Mr. Olliff, I find them to be such as the following: In mine the last female antennal joint is less than the seventh, and the joints of the foot bear no hairs; in Mr. Olliff's the last joint is longer than the seventh, and the feet have a few hairs. For the males mine have the abdomen shorter than the spike, and the tibia is much less than three times as long as the tarsus; while in Mr. Olliff's the abdomen is longer than the spike, and the tibia is more than three times the length of the tarsus. These microscopic differences may be considered as indefinite. In my paper of 1890 (Trans., vol. xxiii., p. 32) I remarked that a student of Coccids "must be prepared at any time to find distinct departures from generic types, and to consider any character whatsoever as elastic and variable." In view of the locality in which both sets of specimens were collected, and of the identity of the food-plant, I shall consider my species identical with that of Mr. Olliff.

A somewhat embarrassing point arises, however, as to nomenclature. The paper in which I reported *Signoretia atriplicis* was read in October, 1891, while Mr. Olliff's description appeared in November of the same year. Circumstances made it impossible for my paper to be printed before May, 1892, and in the technical sense of publication I suppose Mr. Olliff has priority. Had he not attached my name to the species nothing need now be said; but, whilst quite appreciating the honour thus done me, I must venture to ask whether the proper name of the insect should not be *Pulvinaria atriplicis?*

Pulvinaria maskelli, Olliff, var. **spinosior,** var. nov. Plate IV., figs. 6, 7.

Insects forming a white, cylindrical, narrow ovisac, which sometimes attains a length of $\frac{1}{2}$in., with a width of scarcely $\frac{1}{8}$in. This ovisac is very finely striated or corrugated transversely.

Adult female dark-brown or red-brown, placed at one end of the ovisac and raised up *a tergo*. The normal form before gestation is elliptical, and the length about $\frac{1}{5}$in. to $\frac{1}{4}$in., but at gestation it becomes much shrivelled and wrinkled, and therefore considerably smaller. The median dorsal region is somewhat convex, the margins a little flattened. Antennæ of eight joints, of which the third is much the longest, the sixth seventh and eighth the shortest and subequal. There is a longish hair on each of the first and second joints, and several shorter ones on the others, especially on the eighth. Feet rather strong, with several hairs on each joint; tarsal digitules long knobbed hairs, digitules of the claw very widely dilated. Epidermis bearing many small slender tubular spinnerets. On the margin of the body there is a row of conspicuous, rather thick, longish spines, and these may sometimes in life be seen to bear short waxy tubes. Abdominal cleft and lobes normal. Mentum apparently monomerous; rostral setæ short.

Second stage not observed.

Larva red, flattish, elliptical, slightly tapering posteriorly, active: length about $\frac{1}{45}$in. Antennæ of six subequal joints, the sixth bearing several hairs, of which one is very long. Feet slender: the digitules are all fine hairs. Abdominal cleft and lobes normal, terminal setæ very long: between the lobes is in life a short pencil of white cotton on short hairs, and on being slightly pressed the abdominal extremity protrudes in a circular reticulated form. On the margin of the body is a row of short conical spines: the four spiracular spines are rather long.

Male unknown.

Hab. In Australia, on *Frenela (Callitris) robusta,* the "Murray Pine." My specimens were sent by Mr. French, who received them from Mrs. A. Molineaux, of Adelaide, but the exact locality was not named. The tree is a native of South Australia.

This species is so very closely allied to *P. maskelli*, the "saltbush scale," from Wentworth, New South Wales, that I cannot consider it as more than a variety, and even that only doubtfully. The differences are in the narrowness and proportionate length of the ovisac and the larger and more conspicuous spines on the margin of the adult female; and the former of these may simply be due to the character of the plant on which the insect lives. Mr. Olliff, in his account of *P. maskelli*, does not mention any waxy tubes as springing from the marginal spines of that species in life.

Pulvinaria tecta, sp. nov. Plate IV., figs. 9–14.

Adult female producing a quantity of white, or slightly yellowish, cotton, which forms a more or less globular mass, frequently reaching a diameter of more than $\frac{1}{3}$in., but often many of these are aggregated in a large mass, covering the twigs very thickly. It is difficult at first sight to detect the insect, which seems almost entirely covered by the cotton, but on careful scrutiny it may be discovered partially embedded, or even sometimes almost fully exposed. The cotton is full of eggs and larvæ.

Female insect varying in colour from reddish-brown to greenish or yellowish brown. Form elongate-elliptical, slightly concave beneath and convex above, with often a longitudinal median dorsal carina. There is frequently a slight constriction on the cephalic region, rather anterior to the rostrum. Abdominal cleft normal, the dorsal lobes rather small. Antennæ slender, of eight joints, of which the two first are short and wider than the rest, the sixth and seventh very little longer and slender, the third fourth and eighth the longest and subequal. The second and fifth joints bear each one long hair; the eighth has several moderately long. The feet are slender, the tibia very little longer than the tarsus: the tarsal digitules are long fine knobbed hairs, the digitules of the claw usually the same, sometimes a little dilated. The anal ring bears several hairs. On the margin of the body is a row of moderately-long blunt spiny hairs. The epidermis is often marked with numbers of small oval clear spots, which are not visible until after treatment with potash. The dorsum is covered with a pubescence of very short fine hairs. Length of insect averaging $\frac{1}{5}$in. before gestation.

Second stage not observed.

Larva red, or yellowish-red, flattish, elliptical, active: length about $\frac{1}{40}$in. Antennæ slender and rather long, of six joints, the first two very short, the third and sixth the longest: on the last joint, besides the ordinary hairs, is one very long and another rather less so. Abdominal cleft conspicuous; the lobes small, each bearing a long seta: between the lobes are a few short fine hairs which bear a pencil of white cotton, and on being very slightly pressed the extremity of the abdomen protrudes in a circular reticulated form, as shown in the figure.

Male unknown.

Hab. In Australia. My first specimens were sent by Mr. Olliff, on a twig of orange, from Sydney; a second lot came from Mr. Froggatt, on *Acacia* sp., also from Sydney; and later, Mr. French sent me some on *Daviesia corymbosa*, from Anderson's Creek, near Melbourne. The cotton on the Sydney specimens is pure white, and that from Melbourne tinged with yellow: the insects otherwise agree.

The appearance of this species, or rather of its cotton, is somewhat striking, as it is very thick and abundant, and covers the twigs profusely. I cannot say that it entirely corresponds with the usual type of *Pulvinaria*, because it is by no means easy to distinguish clearly the insect, so much is it surrounded by the cottony mass; yet I cannot declare that it is entirely embedded. If it were so, it would probably have to be placed in the genus *Signoretia;* but it seems to suit *Pulvinaria* best. It is another instance of a species on the borderline of two genera.

Genus Signoretia.

Signoretia atriplicis, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 23.

I have already remarked above (see genus *Pulvinaria*) that this appears to be identical with *P. maskelli*, Olliff, and the species has to be abandoned.

Signoretia luzulæ, var. **australis,** Maskell. N.Z. Trans., vol. xxv., 1892, p. 223.

I have been able, since reporting this insect last year, to examine further specimens, and can maintain its specific and generic position, although from the size of the sac and a few minute differences it may receive rank as a variety.

The Group **Hemicoccinæ**, Mask., and the genera **Asterolecanium** and **Planchonia.**

During the year 1892 I received from Mr. Olliff, of Sydney, some specimens which, after close examination, I place in the genus *Kermes*, and, as this is the first species of this genus which I have had occasion to describe in detail, I venture to repeat here the characters ascribed to the group *Hemicoccinæ* in my paper of 1883 (N.Z. Trans., vol. xvi.) and in my "Scale Insects of New Zealand," 1887:—

Adult females exhibiting the anal cleft and the lobes of Lecaninæ: naked or covered.

Larvæ presenting at the extremity of the abdomen the anal tubercles of Coccinæ.

From the foregoing characters the group is very evidently intermediate between Lecanids and Coccids.

When, in the years just mentioned, the formation of this group was proposed, I possessed specimens of three out of the eight species of the genus *Kermes*, which forms part of it: *K. vermilio*, Planchon; *K. bauhinii*, Planchon; and *K. galliformis*, Riley. Since then I have received from Mr. Newstead an African species, *K. quercûs*, Newst., ms., and now have another from Australia, which I propose to name *K. acaciæ*.

In 1883 I attached to the group the two genera, *Asterolecanium*, Targioni, and *Pollinia*, Targioni; and in 1881 (following Signoret) I had placed *Planchonia*, Sign., among the Coccinæ. Previously all these three genera had been included amongst a Lecanid section to which Targioni had given the name "Lecaniodiaspidæ." This name appeared to me to be so singularly inappropriate, seeing that none of the genera placed under it had any Diaspid character, and that their larvæ were certainly not Lecanid, that I declined to continue so confusing an arrangement; I placed under the Lecaniodiaspidæ such genera as *Ctenochiton*, *Ceroplastes*, &c., which fitted it, and divided the others according as their characters seemed to direct. One genus, *Lecaniodiaspis*, Targioni, I was obliged to leave alone, knowing nothing about it, nor do I know if anybody has ever since seen it.

The exigencies of my book on "Scale Insects of New Zealand," in 1887, unfortunately compelled me to extreme brevity. The work was intended primarily for the use of settlers in the colony, and much scientific detail would have been out of place: as it was, the book was scarcely published before I was told "there was too much Latin in it." Some friends of mine who of late years have taken up the study of Coccids, and who have had occasion to touch upon some of the genera just mentioned, have not given me credit for at least thinking there was some good reason for my action. My papers of 1881 and 1883 have been ignored, and my classification set aside, probably because in 1887 it was not reasoned out in detail. The old Lecaniodiaspidæ, including *Planchonia* and *Asterolecanium*, have been made to do duty still. The larval form of *Asterolecanium* has been unnoticed; the anal tubercles present in all stages of *Planchonia* have not been considered; and the confusion introduced by Targioni in 1868 has been perpetuated without discussion of important points. Mr. Ashmead, in his "Generic Synopsis of Coccidæ," 1891, adheres to Targioni's system: he is followed by Mr. Cockerell in "Science Gossip," 1893; and neither writer pays any attention to the anatomical characters of the insects. "Priority of authorship" has been taken as sufficient; the "rules of nomenclature," said to be binding on all zoologists, have been made to override commonsense, clearness, and convenience. I must demur to this, and cannot agree to leave in the Lecaniodiaspidæ genera which are not at all Diaspid nor in all stages Lecanid.

Signoret (Ann. de la Soc. Ent. de France, 1868, p. 82) says of the adult *Asterolecanium miliaris*, "This species is clearly Lecanid, the anal extremity being cleft, with anal lobes"; and he further remarks that it closely resembles *A. bambusæ* and *A. aureum*. In my paper of 1883 I drew attention to this point, stating very clearly that it prevented me from treating *Asterolecanium* like *Planchonia*, and placing it among the Coccids. But Signoret also states that the larva of *A. aureum* and the larva of *Pollinia costæ* have the anal tubercles of Coccids; consequently it seemed to me equally impossible to leave these genera amongst the Lecanids proper, and so, in 1883 and 1887, I grouped *Pollinia* and *Asterolecanium* with *Kermes*.

Professor Targioni has, I believe (although I have not seen his paper), lately, in 1893, made further observations on *Asterolecanium aureum*, and concluded that it is really a *Planchonia*. If that is so, it must have the anal tubercles of a Coccid. Possibly it may be found some day that *A. miliaris* and *A. bambusæ* are in like position. As to *A. quercicola*, I have long had doubts about it, and, indeed, whenever anybody has sent me specimens under the name of *Asterolecanium* I have always found them turn out to be *Planchonia fimbriata*, Fonscol. Perhaps, therefore, the whole genus may have to be abandoned some day, and *Pollinia* and *Lecaniodiaspis* may share the same fate. But (and this is the important point for the present) until Signoret's statements quoted above remain uncontradicted there is a genus, in which the larva is Coccid and the adult is Lecanid, called "*Asterolecanium*," and this must therefore be placed in a group with *Kermes*, intermediate between Lecanids and Coccids. *Planchonia* is altogether Coccid. The two genera must therefore be separated, and under no possible conditions can either of them be placed with the *Lecanio-diaspinæ*. Reasoning such as this I believe to be the only true basis of proper classification, and on it I have founded my own system since 1881.

To sum up: *Asterolecanium* must remain with *Kermes* and include (at present) *A. miliaris* alone, or possibly also *A. quercicola*, though this is very doubtful. *A. aureum* and probably *A. bambusæ* must be attached to *Planchonia*, and in all likelihood to *P. fimbriata*. If, hereafter, *A. miliaris* and *A. quercicola* are found to be clearly Coccid, then *Asterolecanium* will disappear altogether. As for any fancied "priority" which the name may be supposed to have over *Planchonia*, that may be entirely disregarded, because it would be, as a generic name in the Coccid group, misleading and nonsensical. Formal fetters must not bind reasonable beings too tightly.

Genus KERMES.

Kermes acaciæ, sp. nov. Plate IV., figs. 15–18.

Adult female dull dark-red, with a yellowish tinge; almost globular, with a small orifice beneath for attachment to the plant. Antennæ and feet entirely absent. Abdominal cleft nearly obsolete, but distinguishable by a small cut in the edge of the basal orifice, extending as a shallow, narrow depression a short distance along the dorsum until it ends in a minute black spot. At this spot there is a very small orifice with two very minute lobes. The epidermis is somewhat wrinkled, and externally appears smooth. After treatment with potash it is found to be covered with great numbers of minute conical-pointed pustules set close together. I am not quite satisfied that these curious appendages are not on the inner surface only of the skin. In various spots, also, the epidermis is evidently thickened, although on the external surface no ridges are noticeable. Diameter of the insect averaging about $\frac{1}{5}$in.

Female of the second stage semi-globular, yellow or brown. Diameter about $\frac{1}{16}$in. My specimens are not in sufficiently good order for minute examination.

Larva yellowish-brown, active, flattish, elliptical: length about $\frac{1}{70}$in. Abdomen ending in two conspicuous anal tubercles, each bearing a long seta and two spines. Antennæ of six short joints, subequal, the last bearing several hairs, of which one is very long. Feet moderate, the tibia shorter than the tarsus: digitules fine hairs. On the head, between the antennæ, are four short hairs, and on the margins of the body a row of conical spines. The anal ring appears to have six hairs.

Hab. In Australia, on *Acacia* sp. My specimens were sent from Sydney by Mr. Olliff.

I have marked this as a new species, although in some of its characters it resembles *K. vermilio*, Planchon, and *K. bauhinii*, Planchon, both European insects. Yet it differs from both. *K. vermilio* is supposed to be the representative of the insect which, under the name of *Kermes*, or *Coccus ilicis*, produced in former times a rich-red dye. *K. acaciæ* differs in failing (as far as I can judge) to produce any colour, either in alcohol or in potash ; also, the posterior extremity of the larva has more prominent tubercles than *K. vermilio.* On the other hand, it differs from *K. bauhinii* in colour, that species being jet-black ; but the larval tubercles are similar : but *K. bauhinii* preserves its feet and antennæ. In external colour, in size, in the absence of feet and antennæ, and in the spines and hairs of the larva, *K. acaciæ* resembles *K. vermilio*, and if the tubercles were less distinct, and it produced a dye, I should consider it as perhaps a variety of that species. For the present I leave it as distinct, mainly on account of the conical pustules of the epidermis, which are entirely absent from my specimens of *K. vermilio*, sent me in 1881 by Dr. Signoret.

Group COCCINÆ.

Subdivision ACANTHOCOCCINÆ.

Genus Planchonia.

Planchonia bryoides, sp. nov. Plate V., figs. 1–9.

Adult female covered by a test which is, for the main portion, composed of convex, yellow, elliptical, nearly smooth and homogeneous wax, on which is usually a thin layer of white granular particles; but there is a marginal fringe of triangular segments, rather wide at the base, and pretty long, usually of a pink or red colour, and these segments frequently also extend over the dorsal region, so that the test has the appearance of a small pink, or whitish, patch of moss; there is, besides, frequently a quantity of black fungus obscuring the whole. The resemblance to reddish moss is often so striking that the thing may easily at first sight be taken to be vegetable; but in many cases the median dorsal smooth yellow wax is visible with only a marginal triangular fringe, and indeed it can always be detected by close observation. There is a small orifice at the posterior end of the test, and the triangular segments on the dorsum seem to be always directed away from it. In the earliest adult stage the test is elliptical, prolonged at the cephalic end in a more or less sharp point: the leaf-like processes appear afterwards. The average length of a test, including the fringe, is about $\frac{1}{13}$in.

Test of the second stage elongated, convex, elliptical, orange-coloured above, flat and reddish beneath. There seems to be no fringe.

Test of male waxy, semi-cylindrical, yellow or pinkish. Length about $\frac{1}{16}$in.

Adult female brown, pegtop-shaped, with abdomen prolonged in a very short conical "tail," which is terminated by two small anal tubercles, each of which bears a long seta. The anal ring, which is situated just above the tubercles, seems to have six short hairs. Antennæ and feet absent. Epidermis covered with great numbers of double or figure-of-eight spinneret orifices: these are of two distinct sizes, and I do not know whether perhaps the larger may secrete the triangular leaf-like processes, while the smaller form the smooth dorsal wax, for the larger ones are rather more numerous near the margins. The insect at first fills the test, but shrivels at gestation.

Female of the second stage not observed.

Larva brown, elongated, elliptical, slightly tapering posteriorly; the abdomen is conspicuously segmented, and ends in two conspicuous anal tubercles bearing long setæ. Antennæ of six joints, of which the third is the longest, the last three short and confused: indeed, I am not sure that there may not be seven joints. Feet offering no distinctive character. The whole dorsum bears transverse rows of large figure-of-eight spinnerets. A larva extracted from the body of the mother is very soft and whitish, with a length of about $\frac{1}{60}$in.; after emergence it becomes darker, and attains $\frac{1}{50}$in.

Adult male unknown.

Hab. In Fiji. My specimens were sent to me by Mr. R. L. Holmes, of Bua, on pieces of bark of some plant of which he did not give me the name.

This is certainly an elegant little species, and from its leaf-like processes the name which I have attached to it seems to be appropriate. I think it a good instance of the absurdity of including such genera as *Planchonia* amongst the "*Lecaniodiaspidæ*," as there is not the slightest Lecanid or Diaspid character about it.

Planchonia fimbriata, Fonscolombe.

Boyer de Fonscolombe, in 1834 (Ann. de la Soc. Ent. de France), described, under the name "*Coccus fimbriatus*," an insect which Signoret, in 1868, attached correctly to the genus *Planchonia*. Since then several species of that genus have been reported from different countries and on different plants. My studies of actual specimens, and of the published descriptions of authors, lead me to the conclusion that, with the exception of *P. bryoides*, just described (which is markedly distinct), they all really constitute one species, with perhaps some varieties, differing principally in the external colours. The synonymy of the species will therefore be as follows, giving Fonscolombe the priority as regards the specific name:—

P. fimbriata, Fonscol., 1834 = *P.* (*Asterolecanium*) *quercicola*, Bouché, 1851 (perhaps): = *P. arabidis*, Lichtenstein, 1876 = *P. hederæ*, Licht., 1880. Test yellow, fringes white or pinkish.

P. fimbriata, var. *epacridis*, Maskell, 1881. Test partly green, partly yellow; fringes white.

P. fimbriata, var. *styphelia*, Maskell, 1891. Test whitish, or with a greenish tinge; fringes white or pink.

P. fimbriata, var. *pustulans*, Cockerell, 1893 = *P. oncidii*, Cockerell, 1893. Test yellow or greenish-yellow; fringes pink or whitish-pink.

I have not yet been able to examine specimens of *arabidis* and *hederæ*, but in the descriptions I can see nothing to distinguish them from the type. As for *P.* (*Asterolecanium*) *quercicola*, I believe it to be identical with *P. fimbriata* from two specimens which I possess, but have already remarked on this point in the present paper.

Size is of very little or no importance. The var. *pustulans* is possibly usually larger and var. *epacridis* smaller than the type, but I lay no stress on this.

The anatomical characters of the females of all these insects are identical in all stages. All are without feet and antennæ, and all have marginal rows of figure-of-eight spinnerets. The only adult male yet described is that of var. *styphelia*. It is of course possible that future discovery may detect such differences in the males as may induce specific separation, but I doubt it, because the differences amongst males of a genus are very seldom important or clear.

Since writing the above I have received from Sydney, on *Leptospermum*, some specimens of the second stage of var. *styphelia*. These entirely confirm the view just taken, as I can see nothing in them sufficiently valid for specific separation from the type or from the var. *epacridis*.

Subdivision DACTYLOPINÆ.

(Comparison with *Acanthococcinæ*. Plate V., figs. 10–22.)

In vol. xxv. of the Transactions, 1892, p. 232, I described, under the name of *Dactylopius nipæ*, an insect from Demerara on *Nipa fruticans*. Mr. Newstead had received, unknown to me, specimens of the same species, and has published a description of it in the Entom. Monthly Magazine, August, 1893. I shall presently notice two or three small discrepancies between the two accounts of the insect; but one of them raises a point on which it may be useful to make a few remarks on the *Dactylopinæ* in general.

The distinction which, partly following Signoret, I have always drawn between the subdivisions *Acanthococcinæ* and *Dactylopinæ* is based upon what I believe to be the true scientific method of Coccid classification—namely, anatomical features. It depends principally upon the characters of the antennæ, the anal ring, and the anal tubercles of the adult female. In my paper of 1891 (N.Z. Trans., vol. xxiv., p. 30) I drew attention to one feature of the antennæ which might be very useful as a guide to students; and in my "Scale Insects of New Zealand," 1887, pl. ii., I gave characteristic figures of anal rings in the two subdivisions. There is therefore no need to enter now again into a discussion of these points. But, with regard to the anal tubercles, the remarks of Mr. Newstead (*loc. cit.*) lead me to treat these organs with some detail.

After stating that in *D. nipæ* the tubercles are "very large," he says, "in the form of the antennal joints it is clearly Dactylopid, but the very conspicuous anal lobes are abnormal." I do not think so, for reasons to be mentioned presently.

In absolute strictness, I suppose that we ought not to look upon the tubercles of, say, *Eriococcus* and *Dactylopius* as morphologically distinct at all. In both cases they seem to be only processes visible on each side of the abdominal extremity, near to the anal ring; and they always bear a more or less numerous arrangement of hairs or spines. Carrying this view a little further, we might say that they correspond sufficiently with the abdominal lobes of the Lecanids. But, when we come to attempt a clear and convenient classification, we find that the forms possessing antennæ with short terminal joints and anal rings with eight hairs exhibit almost always tubercles differing considerably from those of the forms with long terminal joints and anal rings with six hairs. Absolute and severe uniformity is not to be expected when we are dealing with Coccids; yet the rule is as just stated. After nearly twenty years of experience, during which I have examined many hundreds of specimens of both kinds, I cannot say that there is any real difficulty in separating them. Some of the *Acanthococcinæ*—*e.g.*, *Rhizococcus casuarinæ*, Mask., or *Eriococcus turgipes*, Mask.—have comparatively small tubercles: some Dactylopids—*e.g.*, *Dactylopius nipæ*, Mask., or *Ripersia fagi*, Mask.—have comparatively large ones: but there is no mistaking their character. *Ripersia fagi*, Mask., is one of the Dactylopids I know of with perhaps the largest tubercles: *Rhizococcus grandis*, Mask., has perhaps the smallest tubercles of the Acanthococcids. Yet there is a very long way between the two.

The form of the tubercles in a Dactylopid is usually rounder and less cylindrical than in an Acanthococcid; their spines and setæ, where present, are more scattered; and the margins are less irregular. As a rule, also, they appear to be less chitinous. After treatment with potash (as described in my paper of 1891, p. 3), it will usually be found that the feet, antennæ, and rostrum of a specimen remain of a much darker colour, with more solid appearance, than the rest of the body; so also do the abdominal lobes of a Lecanid and the anal tubercles of an Acanthococcid; but the tubercles of a Dactylopid seem generally to be less hard. There are exceptions, as in *Ripersia fagi*, where the tubercles remain slightly darker than the body, but these are few. Even in *Eriococcus* *turgipes* the tubercles, though small, are conspicuously dark and hard.

Some Dactylopinæ have the anal tubercles reduced nearly to a mere dot; in others they seem altogether obsolete. Examples may be seen in *Dactylopius adonidum*, *D. calceolariæ*, *Ripersia tomlinii*, *Pseudococcus asteliæ*, &c., and perhaps the time will come when somebody will separate under new subgenera the species with very minute from those with more noticeable tubercles.

The tubercles of *D. nipæ* are fairly large for the genus, and they approach those of some *Ripersiæ*; and it was partly on this account (in addition to the cottony processes) that in 1892 I stated that it might almost be a *Ripersia*, if other characters did not forbid it. I cannot detect any Acanthococcid feature in the insect. The figures which are given in Plate V. with this paper will illustrate the differences of anal tubercles just mentioned. They are taken at random from specimens in my possession, and are drawn on the same scale for comparison.

Dactylopius nipæ. Maskell, N.Z. Trans., vol. xxv., p. 232; Newstead, Ent. Mo. Mag., Aug., 1893, p. 187. Plate V., fig. 19.

The differences between the characters of this insect as given by Mr. Newstead and myself may be tabulated as follows:—

Newstead.	Maskell.
Antennæ always with seven joints.	Antennæ seven or eight joints.
Digitules of the claw slender.	Digitules of the claw slightly dilated.
Rostrum (mentum) dimerous.	Rostrum (mentum) trimerous.
Anal tubercles very large.	Anal tubercles very minute.

The first two of these may be considered as of no importance, being frequently variable.

As regards the third, I have re-examined three specimens, nd in all I find the mentum trimerous.

On the fourth character I have just made in the last few pages some detailed observations. I consider the tubercles of *D. nipæ* fairly large for the genus, but certainly extremely minute and inconspicuous as compared with those of any Acanthococcid.

Dactylopius bromeliæ, Bouché. Signoret: Annales de la Soc. Ent. de France, 1874, p. 310. Bouché: Naturgesicht, 1834, p. 20. Plate VIII., figs. 15, 16.

Adult female pale reddish-brown, elliptical, acuminate in front, slightly convex, active, segmented; length about $\frac{1}{12}$in. Dorsally there is a slight covering of white meal, and on the margins are, probably, some short cottony processes. Antennæ of eight joints, of which the second and third are equal, and longer than the fourth, fifth, sixth, or seventh; the eighth is about equal to the fourth, fifth, and sixth together; the hairs on the joints are short. Feet having the tibia twice as long as the tarsus; digitules fine knobbed hairs; the hairs of the foot are longer than those of the antennæ. Epidermis bearing great numbers of circular spinnerets interspersed with spiny hairs. Anal tubercles very minute, with long setæ; anal ring compound, with six long hairs.

Hab. In India, on mulberry. Mr. Cotes has sent me specimens without definitely naming a locality; he only says that it is prevalent in the silk districts of Bengal.

I have been particular in giving some of the characters of this insect, because it has not hitherto been reported, except by Signoret and Bouché. The former had it on *pine-apple* from Zanzibar; the latter on *Canna*, *Hibiscus*, *&c.*, probably from South America. I am unable to say whether in Bengal the mulberry may be its proper food, or whether it migrated to that tree from tropical plants growing in the neighbourhood. My specimens correspond so very nearly with the description given by Signoret that I am compelled to identify them as *D. bromeliæ.* There is an insect described by Mr. Douglas (Ent. Mo. Mag., July, 1889, p. 317), under the name *D. theobromæ*, which seems to be also exceedingly near this species; but there are a few differences in the antennal joints which may separate it, though I incline rather to consider it as a variety only.

Dactylopius calceolariæ, Maskell.

I have received from the Rev. Mr. Colenso, of Napier, specimens of this insect, surrounded by much cotton, on leaves of *Cordyline australis* at that place. Mr. Colenso informs me that they are doing much damage to the trees, which are of large size. The insects affect chiefly the bases of the leaves, where, on account of their sheltered position, it would be difficult to get at them.

Mr. Cockerell has sent me a drawing of the foot of a *Dactylopius* found on sugar-cane in Northern Mexico which exactly corresponds with the foot of *D. calceolariæ.* I see no reason why the species should not be identical, as I reported *D. calceolariæ* on sugar-cane from Fiji in 1889.

Dactylopius poæ, Maskell.

Mr. W. Smith, of Ashburton, has sent me specimens of this species taken from ant-nests at Mount Somers, Canterbury, but I am inclined to think that their habitation was merely an accidental one. There are four known subterranean Dactylopids in New Zealand—*Dact. poæ, Dact. arecæ, Ripersia rumicis,* and *Ripersia formicicola.* Only the last of these seems to be connected specially with ants—at least, it is the only one of which it is stated that the ants when disturbed carry it away for shelter with their own eggs. In the case of the others, I take it that, living as they do naturally underground, they would sometimes be found close to or within an ant's nest amongst the roots of plants.

Dactylopius eucalypti, Maskell.

Mr. Tepper, in the South Australian publication, "Garden and Field," November, 1892, says that this species in that part of Australia is on *Eucalyptus rostrata*, not on *E. amygdalina*, which is apparently not a South Australian tree.

Dactylopius affinis, sp. nov. Plate VIII., figs. 17, 18.

Adult female pinkish or yellowish, without any dark dorsal band, powdered with thin white meal on the dorsum; form elliptical, rather flat, distinctly segmented; length from about $\frac{1}{8}$in. to $\frac{1}{7}$in. At each side of the body are a number of projecting cylindrical slender cottony filaments, the length of which varies in different specimens. Sometimes these are very short and scanty, at others nearly half as long as the width of the body. Two on the cephalic extremity are always the shortest, and two on the abdominal extremity are always the longest, with a short pencil of cotton between these last. At gestation the insect forms a small thin white posterior ovisac.

Antennæ of eight joints, of which the eighth is the longest, then the third, second, and first; the fourth, sixth, and seventh are the shortest and equal to each other; the fifth is longer than the fourth, and nearly as long as the first. All the joints bear several hairs. Feet moderately long and slender, very slightly pubescent; tarsus scarcely more than a third of the length of the tibia; digitules four, slender. Mentum conical, dimerous. Epidermis bearing a few minute hairs and a number of small circular spinnerets. Anal ring compound, with six hairs. Anal tubercles small and inconspicuous, setiferous, and bearing several glandular pores.

Larva yellow, elongated, flattish, active; length about $\frac{1}{33}$in. Antennæ of six joints, the first five short and subequal, the last as long as any three others. Feet moderate; the tibia shorter than the tarsus. Anal tubercles inconspicuous. Mentum conical, dimerous. Eyes conspicuous, brown.

Male unknown.

Hab. In Australia, on tubers of *Dahlia* and potato, underground. Specimens sent by Mr. Olliff, from Sydney.

It has been necessary to enter into minute details of the structure of this insect, as in many respects it is very closely allied to known species. It is very near to *D. adonidum*, Linn.; *D. citri*, Boisduval; *D. cyperi*, Sign.; *D. pteridis*, Sign.; *D. vitis*, Niedielski; *D. longifilis*, Comstock; and others.

But the proportions of the antennal joints and of the feet have been taken as the distinguishing features of the above-named species, and none of them agrees with *D. affinis*. Thus, in *D. adonidum*, the second and third joints are equal, and the fifth is shorter than the sixth; in *D. citri* the antennæ are somewhat similar, but the tarsus is almost as long as the tibia; and so on. Moreover, the habits of all these insects are aerial, whereas *D. affinis* appears to be, at least principally, subterranean. At some future time it may be found advisable to unite, under the common designation of the "mealy-bugs proper," all the insects of this genus presenting a fringe of cottony processes, and make them varieties of *D. adonidum*. But for the present they may remain separate.

Dactylopius lobulatus, sp. nov. Plate VI., figs. 1–3.

Adult female yellowish-brown or sometimes reddish-brown, covered dorsally with white cotton, and having a marginal fringe of white cottony processes which are somewhat longer on the abdominal segments. Length variable; the specimens seen average about $\frac{1}{11}$in. Antennæ of eight joints, of which the last is fusiform and the longest, the sequence of the rest being second, third, sixth, fourth, fifth, seventh, first. Feet rather long; femur strong; trochanter bearing one long hair; tibia cylindrical, with several fine hairs, and with two spines at the extremity; tarsus tapering, pubescent; the tibia is two and a half times as long as the tarsus; upper digitules short fine hairs, the lower pair only very short fine bristles lying along the claw. Mentum conical, dimerous; the abdomen is truncate, and terminates in four inconspicuous anal tubercles, each bearing conical spines and short setose hairs; anal ring large, compound, with six hairs. Epidermis bearing some very small circular spinnerets and some short fine spiny hairs: the spinnerets and hairs are more numerous near the margins.

Larva and male not observed.

Hab. In Australia, under loose strips of bark of *Eucalyptus globulus*. My specimens were sent by Mr. Froggart from Bendigo, Victoria. *E. globulus* is a Tasmanian tree.

This insect belongs to the series of *D. adonidum*, and may be distinguished from that species and from *D. affinis* chiefly by the proportions of the antennal joints and by the anal tubercles. These last are not conspicuous in the natural state, appearing only as small rounded bosses on the margin (just as in *D. nipæ*, *D. cocotis*, *D. albizziæ*, &c.), but after preparation of the insect they preserve a dark solid appearance, being seemingly more chitinous than the rest of the body. I have already remarked upon a similar feature when treating above of *D. nipæ*. Very possibly *D. lobulatus* may hereafter take rank only as one of the many varieties which may be attached to *D. adonidum*.

Subdivision IDIOCOCCINÆ.

Genus Sphærococcus.

Sphærococcus leptospermi, sp. nov. Plate VI., figs. 4–14.

Insects inhabiting woody galls, which are merely swellings of the twigs of the plant. These galls vary in size (in the specimens seen) from $\frac{1}{3}$in. to 1in. in length, and from $\frac{1}{4}$in. to $\frac{1}{2}$in. in thickness, apparently according to the size of the twig they are on. In young unharmed specimens the gall, though rough like the tree-bark, is usually closed and firm all round, but when old or parasitised there is a longitudinal slit on one side, and the adjacent parts of the gall are soft and rotten. Frequently one of these old galls will have in it many large parasitic (seemingly dipterous) grubs. In a few cases I have found two adult female Coccids inhabiting the same gall.

The interior of the gall is smooth, with a layer of white cotton, which is usually very thin, but which in some specimens becomes rather thick, and forms a sort of cushion for the insect. The larvæ congregate round the mother and fill the gall.

The adult female fills the gall, and is as a rule of a dark greenish-grey colour, which becomes dark-brown and almost black with age. The general form is elliptical; the length averages about $\frac{1}{4}$in., but varies a good deal. The antennæ are obsolete, but appear to be represented by very minute tubercles, which, however, I have only been able to detect on insects before gestation; in the latest stages I cannot make them out. The feet are entirely absent. The rostrum, which is rather large, is situated almost in the middle of the ventral surface. I have not been able to satisfy myself as to the mentum, which seems to be monomerous. The four principal spiracles are large and conspicuous, the rest small. There are a great number of circular spinneret-orifices on the dorsal epidermis, and others, smaller and fewer, on the ventral. The anal ring is small and hairless, and the anal tubercles obsolete. At and after gestation the skin becomes much wrinkled, and the insect is then nothing but a bag containing a large number of eggs and larvæ.

Larva, reddish-brown, active, elliptical; length about $\frac{1}{23}$in. In the early part of this stage the form is proportionately narrow and elongated; the antennæ are moderately long and slender, with five distinct subequal joints, the third joint rather the shortest. The feet are slender, with the tibia shorter than the tarsus; claw slender; digitules all fine hairs; the mentum seems monomerous; the abdomen tapers to a truncate extremity, where there are two very small anal tubercles, each bearing a very long seta. Later in the larval stage the form becomes shorter, thicker, and more conspicuously segmented; the antennæ are short and squat, and their joints more confused; the feet are a good deal thicker; the abdomen is short, and the setæ likewise.

The male appears to undergo all its transformations in the gall with the female. In the earliest stage it seems impossible to detect the difference between the male and female larvæ, but later on this becomes apparent. I possess a specimen which is evidently a male just entering upon the pupal stage. The elongated larval form is still noticeable; the antennæ and feet remain, and also the abdominal skin. But within, the new pupal formation is quite noticeable, with a slender, conical, segmented abdomen, and the beginnings of the future elytra appearing on the thoracic margins. The male pupa, after emerging from the larval skin, forms a small white cylindrical cottony sac; and I have found several of these in a gall with the adult female and larvæ, and with nearly adult males in them.

The adult male is deep-red in colour, the wings slightly iridescent. Length of the insect about $\frac{1}{20}$in. The form of the head and thorax offers nothing peculiar; but the abdomen is excessively elongated, the segments very long, narrow, and tapering. The last segment is about half as long as any of the others, and is wider and more elliptical; it terminates in the sheath of the penis, which, viewed dorsally, is cylindrical and straight, but viewed sideways is curved in a double hook; this sheath is very short. There are four short hairs on each side of the base of the sheath, but no long setæ. The antennæ have ten joints, all moderately long and subequal except the first, which is short and tubercular. Feet moderately long and slender.

I have no doubt as to the affinities of this insect, which, from the hairless anal ring, the absence of tubercles, feet, or antennæ, and from other characters, is clearly Idiococcid. In establishing last year the genus *Sphærococcus* I had no males to guide me, and could give no generic characters for that sex. I shall still hesitate to do so, for, although the male of *S. leptospermi* and also that of *S. froggatti* (described below) have excessively elongated abdominal segments, the male of *S. pirogallis* (below) does not exhibit so marked a feature. It may seem a simple thing to many people to establish generic characters on points which they have observed in some single species, or even some single specimen, which they have found. I wish very much that this habit (pernicious enough, in all conscience, amongst lepidopterists and coleopterists) could be sternly repressed in the study of Coccids. In the present instance I will not define generically the male of *Sphærococcus* until we possess more information.

Sphærococcus melaleucæ, sp. nov. Plate VI., figs. 15–20.

Insects covered by small globular waxy tests, which are attached by one side to a twig. The tests are intensely black, and are rough, with numbers of small protruding conical processes, of which some are longer than others. Diameter of test averaging $\frac{1}{10}$in.

Adult female dull pinkish-red: form convex, elliptical, tapering slightly posteriorly; diameter about $\frac{1}{20}$in. The cephalic and thoracic segments are the widest and are smooth; the abdominal segments are narrow and are very closely marked with convoluted corrugations, which give a rough appearance to the abdomen. Antennæ very short, subcylindrical, with five subequal joints, the last being somewhat globular; on the last joint are several longish hairs. Feet absent. Mentum apparently dimerous; rostral setæ very long. The four thoracic spiracles are rather large, and close to each one there is a group of circular spinneret-orifices. Dorsal epidermis bearing some small circular spinnerets. Anal ring simple, hairless. Anal tubercles absent, and there are no terminal setæ or hairs.

Larva, second stage and male not observed.

Hab. In Australia, on *Melaleuca linariifolia.* Mr. Froggatt sent me specimens from Penshurst, New South Wales.

This appears to be quite distinct, in the roughness of the small conical processes on the test and in the curiously-corrugated segments of the abdomen.

Sphærococcus froggatti, sp. nov. Plate VII., figs. 1–7.

Insects inhabiting galls of a brownish- or reddish-yellow colour; these galls are apparently really somewhat cup-shaped, attached by their bases to a twig, but they are very short, and bear on their widest ends a number of long curling cylindrical slender processes (sometimes much longer than the gall), so that the general appearance is that of a reddish feathery mass, which might easily at first sight be taken for a flower. The galls which I have seen vary in size, some (including the processes) having only a diameter of $\frac{1}{5}$in., whilst others reach more than $\frac{1}{2}$in. The texture of the gall is woody, and in the cup-like portion wrinkled and corrugated, the processes being smoother. The processes seem to be more or less hollow, but I cannot detect any males or any stage of the females in them. The reddish colour fades away into yellow towards the end of a process.

The adult female occupies the cup-like portion of the gall. Its real colour is red, but it appears bluish-grey from being powdered with white meal, and with much white meal also in the cavity of the gall. The form is subglobular, tapering somewhat posteriorly; the segments are obscure; the length varies, but may average about $\frac{1}{13}$in. The antennæ are almost atrophied, and appear to have only two very short joints, of which the second bears a few hairs. The mentum is dimerous. Feet entirely absent. There are four large spiracles. The epidermis bears a number of circular multilocular spinnerets interspersed with very fine spiny hairs, and on the last abdominal segments the spinnerets are more numerous and the hairs longer. Anal tubercles entirely absent; anal ring simple.

Female of the second stage not observed.

Larva yellow, flattish, elliptical, active; length about $\frac{1}{30}$in. Antennæ of six joints, the first much broader than the rest, all subequal in length, the last bears some hairs, of which one is rather long. Feet short; the femur is rather thick and swollen; tibia shorter than the tarsus; claw slender; digitules all fine knobbed hairs. Mentum conical, dimerous. The margin of the body bears a row of longish spines. The anal tubercles are reduced to mere dots, and the setæ are no longer than the marginal spines.

Male not observed by me. Mr. Froggatt has sent me a sketch of it, and says that it is red, with antennæ of nine joints, all with long hairs; wings opaline; abdomen very elongated, with the first three joints short, the rest long and tapering, and terminating in a pointed short spike. This male would thus resemble generally the male of *Sphær. leptospermi*.

Hab. In Australia, on *Melaleuca linariifolia*. Mr. Froggatt has sent me many specimens from Flemington, near Sydney, and I have much pleasure in dedicating to him this species, which, in the very peculiar and elegant form of the gall, seems to be entirely distinct.

Sphærococcus pirogallis, sp. nov. Plate VII., figs. 8–19.

Insects inhabiting small pear-shaped woody galls attached by very short stalks to a twig. The colour of these galls varies with age: in the earliest state they are usually bright-green, and are then frequently combined in a small mass. As they grow they become slightly tinged with red, then completely red, then a dark reddish-grey, and finally dull-grey speckled with small black spots: in this last state they are usually separate, but sometimes two are still joined together. Being frequently congregated in bunches containing very numerous individuals and covering the twigs, they may very easily (especially in their red condition) be taken for fruits or flower-buds, and they have very little resemblance at first sight to the work of an insect: in fact, they look then as much like bunches of very small red-currants as anything else, and in their last grey state they are very like little seed-vessels. The average length of a fully-formed gall, inclusive of the little stalk, is about $\frac{1}{4}$in. The gall is hollow: the exterior surface minutely wrinkled, the interior smooth: the walls are thin, and in an old specimen they are seen to be double. At the thin end of the pear, at the point where it expands from the stalk, is a minute orifice. This appears to exist at all ages, but it is not easy to detect it in the earlier states, and possibly it may more generally not be open until late. At the larger end, inside, there is a small circular saucer-shaped projection in which the female insect lies: the diameter of this saucer (at full growth) is about $\frac{1}{30}$in. The saucer, the insect, and the interior surface of the gall are frequently powdered with thin white meal.

The male pupæ occupy the same gall as the females.

The larvæ (presumably) escape through the small orifice, and wander over the twigs to find a suitable resting-place. In the earliest, soft, green galls examined the small saucer was seen to be very rudimentary, the hollow interior of the gall being mainly occupied by the second stage of the female; and in some of the specimens arrived at the red state the already adult female was seen in the saucer with the exuviæ of the second stage still attached. In the hard grey fully-formed galls there were found sometimes only females full of eggs, sometimes also at the same time a small cylindrical mass of white cotton, coiled up in a circle, in which were embedded as many as thirty male pupæ, very symmetrically arranged with their tails turned towards the large end of the gall, and thus surrounding the already-impregnated female.

The adult female is red, darkening with age, subcircular, slightly concave beneath and not very convex above, lying in the saucer-like projection within the larger end of the gall, and attached to it by the rostrum, which is situate on a rather thick and prominent ventral boss. Diameter of the insect about $\frac{1}{35}$in. Antennæ very minute, the joints much confused and very short: there may be five or six joints, without any hairs. Feet entirely absent. Rostrum rather large and irregular; the mentum is rounded, and appears to be dimerous. Anal tubercles absent. Anal ring simple, hairless. Dorsal epidermis bearing many small circular multilocular spinnerets, which are most numerous near the margins. There are also many long spiny hairs, which are scanty on the median region, but numerous and conspicuous round the margin; and not far from the abdominal extremity there is a region where long hairs are arranged in a wide ring. There are four large thoracic spiracles.

The second stage of the female (which, as observed just now, seems to commence the gall) is subglobular, of a rich-red colour, the abdominal region very slightly protruding and tapering; the longitudinal diameter of the insect is about $\frac{1}{90}$in. Antennæ very short and rather thick, with four joints, of which the first and fourth are longer than the other two; the fourth is globular, and bears a few hairs, of which one is rather slender. Feet rather long, the femur thick, and the tibia and tarsus slender; on the trochanter is a long hair; the tarsus is as long as the tibia; claw slender, digitules long fine hairs; there is one very long knobbed hair on the tarsus above the digitules. Abdomen terminating in two very minute tubercles with long setæ. There is a row of rather strong spines on the ventral margin of the body.

Larva not observed by me, but Mr. Froggatt tells me that it is pale-pink in colour, flattish and elliptical; antennæ very short and stout, with four joints; feet slender, claw long. He gives the length of the larva as about $\frac{1}{35}$in. This would make it nearly three times as long as the second stage—an abnormal condition amongst Coccids.

The male pupa is found, as stated above, in the gall of the female, embedded in white cotton, each pupa occupying a cell in the cotton; and all pointing in the same direction, the arrangement being very similar to that of cartridges in a bandolier; and the cotton is curled in a ring to fit the interior of the gall. The pupal skin is white, the red body of the insect showing through it. The form is elongated, slender, tapering posteriorly to a sharp point; the separation of the head and thorax can be detected. Length of the whole about $\frac{1}{16}$in.

Adult male bright-red, the antennæ and feet yellow; wings slightly iridescent; eyes four, two dorsal and two ventral, smooth and black; ocelli two. Antennæ of eight joints, the first two short and thick, the rest slender and moderately long, the length of each decreasing slightly from the third; all the joints bear several hairs. Feet slender, pubescent; the tibia is strongly spurred; claw small and slender; digitules fine hairs. The abdomen is not very long; the segments seem to be only two or three, slender and tapering, and terminate in a circular orifice through which protrudes the penis, an organ which is slender and very elastic. In a male just before emergence from the pupal cell it protrudes as a slender seta nearly as long as the body, but it is capable of being retracted almost entirely within the abdomen, and also of being extended until it reaches a length three times that of the whole body. When fully extended it is seen to consist of eight or nine joints, and to terminate in a slightly clavate divided tip bearing a few short hairs.

Hab. In Australia, on *Leptospermum flavescens.* Mr.

Froggatt has sent me a large number of specimens, and says that the insects "simply cover the bushes in several localities about Sydney."

This very distinct species presents a number of most interesting problems for the consideration of a student of Coccids. The little galls, so exactly like very small fruit or seed-vessels, would not be thought to be the habitation of insects by anybody but an entomologist. I have seen as many as two hundred of the little pears in one bunch on a twig scarcely more than 1in. long. The most curious points connected with the species are the growth of the gall, the position of the female, and the generative organ of the male. The larva appears merely to begin with the formation of a minute green pimple on the twig, and I presume that the duration of this stage is a very short one, for even the most rudimentary galls which I have been able to examine had within them females in the second stage. The characteristic pear-shape of the adult gall is not noticeable usually until it has reached the dark-red state, which is late in the second stage of the female; and the small orifice at the base, although probably present all through, is also scarcely noticeable up to the same period. The texture of the young gall is more clearly vegetable than in the old state, and the interior is more solid, with scarcely any hollow space. The complete woody, hollow, thin-walled, pear-shaped gall does not seem to be perfected until the female insect has reached the adult stage.

As regards the larvæ, I imagine that the sexes must separate very early: the female larvæ must escape through the orifice in order to seek new homes on the twig, while the male larvæ remain in the gall, and there undergo their metamorphoses. But here a difficulty arises, for in all the galls in which I have found the cottony "bandolier" with male pupæ there were also adult females containing eggs. It is clear that these could not be the mothers of the male pupæ, and possibly, therefore, the male larvæ, after emerging from their own maternal home, find their way into another, for the purpose of pupating in common.

I take it that the small orifice serves a double purpose. At the time when the female becomes adult it provides access for the very long male penis, which can thus reach the female at the far extremity without the necessity of the insect entering the gall, and later it serves as the door of exit for the larvæ, and for the adult males. These latter, having their heads in the pupal state turned towards the orifice, can emerge easily. If, however, they had to enter in order to reach the female they would find it difficult to turn in the gall, and so they insert merely the long penis with which they are furnished.

The most peculiar, and at present unaccountable to me, feature of the species is the position of the adult female in the gall. The food of a Coccid is usually the juices of the plant on which it lives, extracted *directly* from the plant by means of the rostral setæ. Properly, therefore, the female *Sphærococcus pirogallis* ought to be found attached within the gall to the twig itself, the gall being merely a covering for it, as in other species. Instead of that, we find it occupying a little saucer at the far end of the gall, and in such a position that the rostrum is attached to the saucer itself; consequently its nutriment must be drawn (if drawn at all) from the gall which it has first made, and then feeds on. There are Coccids (*e.g.*, *Porphyrophora*) which in the adult female stage seem never to feed at all; but then these possess no rostra or setæ. *Sphærococcus pirogallis* has a rostrum, a mentum, and the usual setæ: it, therefore, presumably uses these organs for feeding-purposes. But, if so, why is it placed in a saucer as far away as possible from the plant? It has been suggested to me that possibly there may be a flow of fluid between the two walls of which the gall is formed, and that this fluid, touching the base of the saucer, may be accessible to the setæ of the insect. But I can detect no sign of any fluid in the adult galls, the whole interior of which is powdered with dry meal, and the walls of which seem quite dry. As for the manner in which the gall acquires its pear-shape, how the stalk is formed, how the orifice is made and kept open, how, in fact, the gall-formation is controlled by its builder, which is placed in the most inconvenient position for the purpose, are questions which I am by no means able at present to answer.

There are four excellent papers on insect-galls by Mr. Butler in "Knowledge," July to October, 1893; but these do not deal with Coccids at all, nor do they elucidate the peculiarity just mentioned of *S. pirogallis*.

Subdivision MONOPHLEBINÆ.

Genus ICERYA.

Icerya ægyptiaca, Douglas; *Crossotosoma ægyptiacum*. Douglas, Ent. Mo. Mag., March, 1890, p. 79. Plate VIII., figs. 1–3.

The second-stage female of this species is dark orange-red covered with white wax, and exhibits rudiments of waxy marginal processes like those of the adult. The form, when extracted from the wax, is elliptical and slightly convex. The antenna has nine joints, all subequal in length except the last, which is rather longer than the two preceding together; on all the joints are several longish hairs. The feet are strong, the tarsus much curved; on the trochanter is a long hair; digitule of the claw only a short bristle. Abdomen terminating in a nearly smooth curve, from which spring six longish setæ; anal ring large and simple. The epidermis bears small circular multilocular spinnerets which are scanty on the median region but numerous near the margins, as in the adult; they are interspersed with short fine hairs with tubercular bases.

Hab. In Australia (Botany Bay), on *Goodenia ovata.*

Mr. Froggatt, in September, 1893, sent me a number of Coccids collected by him near Sydney. Amongst them were several specimens which were very clearly some species of *Icerya*, and on examining them I was much surprised to find that in all respects (except one) those of them which were adult were identical with Mr. Douglas's species originally reported from Egypt. The exception was the size: Mr. Douglas gives his as $\frac{1}{5}$in.; mine are all about $\frac{1}{10}$in.; but this discrepancy is of no importance in comparison with the other characters, which are identical. The dorsal white waxy matter, the irregular white fringe of projecting cottony processes, the form of the eleven antennal joints, the rostrum, the feet and digitules, the compound spinnerets, which are more numerous near the margins than on the median region, the terminal hairs and anal ring, the colour, and the larva agree entirely with specimens of *I. ægyptiaca* sent to me by Mr. Douglas. I have therefore no hesitation in considering these Australian insects as identical with those from Egypt. The difference of size is, as I said, unimportant; and, as none of my specimens has formed an ovisac, it is possible that they may not have reached their full development.

The question now arises, What is the native country of this *Icerya?* Neither Mr. Douglas nor Messrs. Riley and Howard (who treat of *I. ægyptiaca* in "Insect Life," November, 1890) suggests that it originated in Egypt. Mr. Newstead has had specimens from Madras, and it is interesting to note that these were accompanied by parasites. If the presence of parasites can be taken as an indication of endemic origin, this *Icerya* may perhaps be Indian. On receiving my specimens from Mr. Froggatt I was inclined to think, from the locality whence they came (Botany, near Sydney), that they might have been taken there on plants by passengers in steamers who might have stayed awhile at Cairo or Alexandria. But Mr. Froggatt afterwards told me that, although "the district was a settled one, with old orchards within a mile or so," the insects were found "quite in the bush, and pretty plentiful." No parasites accompanied the specimens, which were very lively, and, indeed, lived for a couple of weeks after they reached me. There is a rather large trade in horses from

Australia to India, and, on the other hand, a trade in tea from India to Australia; so that the transport of insects either way is probable enough, and either country may be the original home of *I. ægyptiaca*.

The second stage of this species has not hitherto been reported by Mr. Douglas or by Messrs. Riley and Howard.

Icerya rosæ, Riley and Howard, var. *australis*, var. nov. Plate VIII., figs. 4–8.

Adult female subglobular or very slightly elliptical, the ventral surface flat, the dorsum very convex: colour a deep rich brown, almost black, with a row of yellow spots on the margin and another row of similar spots midway: there would appear to be thus two spots on each segment on each side, but the segments are not very clearly defined; the general colour is often a lighter brown or even red in the early adult stage. The epidermis bears short scattered hairs, those at the abdominal extremity being rather the longest. There is some white cotton which forms a thin cushion beneath the insect and is also thinly scattered on the dorsal surface, but there is no posterior ovisac. Antennæ of ten joints (or sometimes eleven) subequal in length except the last, which is as long as any two others. Feet normal. Longitudinal diameter at full growth about $\frac{1}{5}$in. The twig on which the insect lives is covered with thin patches of white mealy cotton.

Second stage not observed.

Larva red, active, elliptical, flattish: feet and antennæ black. Antennæ normal, of six joints, as in *I. purchasi*. Feet normal. The abdominal extremity bears six very long setose hairs springing from small tubercular bases. The body is covered with many hairs, interspersed with longitudinal rows of multilocular spinnerets; these hairs are rather long all over, but the last three pairs on each margin of the abdomen are longer than the others, though not as long as the terminal ones, and are bent in an arch. Length of larva about $\frac{1}{33}$in.

Hab. In Australia, on *Hakea gibbosa*. Mr. Froggatt sent me a number of specimens from Sydney, and says, "Rare; only found on one plant."

This large and handsome species is so very near to *I. rosæ*, reported from Key West, Florida ("Insect Life," Sept., 1890), by Messrs. Riley and Howard, that I cannot consider it as more than a variety. The differences lie, first in the yellow dorsal spots of the adult female and in the ten-jointed antenna of that stage, and secondly in the arrangement of the hairs on the larva. As regards the adult antenna, I have carefully examined seven specimens, of which five had certainly ten joints, and the other two seemed to exhibit an eleventh. The type of *I. rosæ* is said (*loc. cit.*) to have the larva "sparsely covered with short black hairs": those of var. *australis* are numerous and long: the type has on the abdominal margin six arched hairs, longer than the dorsal ones and shorter than the terminal ones, and according to the figure (Ins. Life, p. 94) these are distinctly separate: in var. *australis* there are three sets of arched hairs in pairs. I do not feel inclined at present to consider these differences sufficient to require a new species for this insect.

A question arises now whether perhaps Australia may not be the original home of all *Iceryæ*. There is scarcely any doubt about *I. purchasi; I. koebelei* is certainly Australian; *I. ægyptiaca* and *I. rosæ* are found there: *I. montserratensis* seems to be possibly a variety: *I. seychellarum* has as yet been reported on sugar-cane only from Mauritius: and *I. palmeri* on grape from Mexico: but even these may after all turn out to be Australian also. I may mention that Mr. T. Cockerell has sent me specimens of an *Icerya* from New Mexico, with a long and narrow ovisac which is not grooved: I shall not be surprised if this is the adult form of *I. palmeri*.

Monophlebus crawfordi, Maskell. Plate VIII., figs. 9–14.

In 1892 (N.Z. Trans., vol. xxv., p. 243) I gave details of the characters which, in my opinion, separated the varieties *levis* and *pilosior* from the type, as far as regarded the adult females. Since then I have examined carefully specimens of larvæ, with the result that I find the following differences:—

M. crawfordi, type. Larva reddish-brown: length $\frac{1}{28}$in. to $\frac{1}{24}$in. Dorsum covered with many longish, thick, subclavate hairs, and bearing some (not many) circular multilocular spinnerets. Feet only moderately spinous: spines slender. Antennæ of six joints, which might, perhaps, be considered as five, the separation of the third and fourth joints being frequently inconspicuous.

M. crawfordi, var. *levis*. Larva reddish-brown: length averaging $\frac{1}{20}$in. Dorsum bearing great numbers of large circular multilocular spinnerets and many short fine spiny hairs. Feet scarcely spinous: spines slender. Antennæ as in the type, with uncertain separation of the third and fourth joints.

M. crawfordi, var. *pilosior*. Larva reddish-brown: length averaging $\frac{1}{25}$in. Dorsum covered with many longish subclavate thick hairs, with several slender spiny hairs, and very few circular large multilocular spinnerets. Feet moderately spinous. Antennæ as in the type and in var. *levis*.

The feet appear to be longest in var. *pilosior* and shortest in the type, but the difference is not very marked.

Taking into consideration the foregoing characters, the differences noted last year in the adult females, and the general features and modes of propagation and growth in all these forms, I am confirmed in my opinion that they are all only variations of one species. The larva of var. *levis* seems to be less near to the type than that of var. *pilosior*, but its adult form is nearer.

EXPLANATION OF PLATES III.-VIII.

Plate III.

Fig. 1. *Aspidiotus casuarinæ*, female, showing groove.
Fig. 2. " pygidium of female.
Fig. 3. " male puparium.
Fig. 4. *Mytilaspis formosa*, insects on leaf.
Fig. 5. " group of puparia.
Fig. 6. " pygidium of female.
Fig. 7. *Mytilaspis spinifera*, insects on leaves.
Fig. 8. " diagram of female, to show spines and spinnerets.
Fig. 9. " pygidium of female.
Fig. 10. *Mytilaspis convexa*, insects on twig.
Fig. 11. " puparium, side view.
Fig. 12. " pygidium of female.
Fig. 13. *Mytilaspis grandilobis*, puparia.
Fig. 14. " pygidium of female.
Fig. 15. *Fiorinia rubra*, insects on bark.
Fig. 16. " puparia.
Fig. 17. " adult female.
Fig. 18. " pygidium of female.

Plate IV.

Fig. 1. *Lecanium* (?), insect, dorsal view.
Fig. 2. " antenna.
Fig. 3. *Lecanium nigrum*, epidermal cells.
Fig. 4. *Lecanium depressum*, "
Fig. 5. *Lecanium begoniæ*, "
Fig. 6. *Pulvinaria maskelli*, var. *spinosior*, insects on twig.
Fig. 7. " " marginal spines.
Fig. 8. *Pulvinaria maskelli*, type, marginal spines.
Fig. 9. *Pulvinaria tecta*, insects on twig.
Fig. 10. " female and ovisac.
Fig. 11. " female, dorsal view.
Fig. 12. " antenna of female.
Fig. 13. " marginal spines and epidermal cells.
Fig. 14. " diagram of larval extremity.
Fig. 15. *Kermes acaciæ*, insects on twig.
Fig. 16. " female, ventral view.
Fig. 17. " epidermal pustules.
Fig. 18. " diagram of larval extremity.

Plate V.

Fig. 1. *Planchonia bryoides*, insects on bark.
Fig. 2. " test of female, type.
Fig. 3. " " "
Fig. 4. " test of male.
Fig. 5. " adult female.
Fig. 6. " extremity of female.
Fig. 7. " spinnerets.
Fig. 8. " diagram of larva.
Fig. 9. " antenna of larva.

Fig. 10. Types of anal tubercles, *Solenophora corokiæ.*
Fig. 11. " *Gossyparia cavellii.*
Fig. 12. " *Rhizococcus totaræ.*
Fig. 13. " *Rhizococcus grandis.*
Fig. 14. " *Eriococcus leptospermi.*
Fig. 15. " *Eriococcus turgipes.*
Fig. 16. " *Sphærococcus froggatti.*
Fig. 17. " *Orthezia urticæ.*
Fig. 18. " *Dactylopius adonidum.*
Fig. 19. " *Dactylopius nipæ.*
Fig. 20. " *Dactylopius acaciæ.*
Fig. 21. " *Pseudococcus nivalis.*
Fig. 22. " *Ripersia fagi.*

Plate VI.

Fig. 1. *Dactylopius lobulatus*, adult female.
Fig. 2. " antenna.
Fig. 3. " anal tubercles.
Fig. 4. *Sphærococcus leptospermi*, galls on twig.
Fig. 5. " gall, closed, natural size.
Fig. 6. " gall, showing enclosed insect.
Fig. 7. " adult female.
Fig. 8. " larva (late).
Fig. 9. " antenna of ditto.
Fig. 10. " male pupa (early).
Fig. 11. " adult male.
Fig. 12. " abdomen of male.
Fig. 13. " last segment of male, dorsal view.
Fig. 14. " " side view.
Fig. 15. *Sphærococcus melaleucæ*, insects on twig.
Fig. 16. " tests enlarged.
Fig. 17. " adult female.
Fig. 18. " abdominal extremity of adult female.
Fig. 19. " antenna.
Fig. 20. " spiracle.

Plate VII.

Fig. 1. *Sphærococcusfroggatti*, galls on twig.
Fig. 2. " galls enlarged.
Fig. 3. " adult female.
Fig. 4. " antenna.
Fig. 5. " larva.
Fig. 6. " antenna of larva.
Fig. 7. " adult male.
Fig. 8. *Sphærococcus pirogallis*, galls on twig.
Fig. 9. " galls, young and old.
Fig. 10. " gall enlarged.
Fig. 11. " gall open, to show saucer and female, and male pupæ.
Fig. 12. " end of gall, showing saucer.
Fig. 13. " adult female.
Fig. 14. " female of second stage.
Fig. 15. " antenna of second stage.
Fig. 16. " foot of second stage.
Fig. 17. " male pupæ in band of cotton.
Fig. 18. " adult male.
Fig. 19. " abdomen and penis of male.

PLATE VIII.

Fig. 1. *Icerya ægyptiaca*, female of second stage.
Fig. 2. „ antenna of second stage.
Fig. 3. „ extremity of second stage.
Fig. 4. *Icerya rosæ*, var. *australis*, insect, side view, partly diagrammatic, to show spots.
Fig. 5. „ „ antenna of female.
Fig. 6. „ „ foot of female.
Fig. 7. „ „ diagram of larva, to show dorsal and marginal hairs.
Fig. 8. „ „ antenna of larva.
Fig. 9. *Monophlebus crawfordi*, type, dorsal hairs of larva.
Fig. 10. „ „ foot of larva.
Fig. 11. „ var. *levis*, dorsal hairs of larva.
Fig. 12. „ „ foot of larva.
Fig. 13. „ var. *pilosior*, dorsal hairs of larva.
Fig. 14. „ „ foot of larva.
Fig. 15. *Dactylopius bromeliæ*, adult female.
Fig. 16. „ antenna.
Fig. 17. *Dactylopius affinis*, antenna.
Fig. 18. „ foot.

ART. III.—*Notes on New Zealand* Neuroptera.

By G. V. HUDSON, F.E.S.

[*Read before the Wellington Philosophical Society, 20th September, 1893.*]

1. **Stenosmylus incisus**, McLachlan.

Mr. Hudson had taken single specimens of this lovely insect at various localities in the vicinity of Wellington from the year 1886 down to the present time. The species occurs amongst ferns and undergrowth in dense forests, generally at the bottom of deep ravines.

2. **Stenosmylus citrinus**, McLachlan.

This closely allied, but much rarer, species appears to be restricted to the forest-gully at the back of the Khandallah Railway-station, where five specimens have occurred, four last November, and one in December, 1889. The precise locality of the type-specimen is not mentioned by Mr. McLachlan.

3. A new (?) species.

Apparently closely allied to *Stenosmylus*. Taken at the source of the River Pearse, on the track to the tableland of Mount Arthur (Nelson District), January, 1889.

4. Another new (?) species of *Stenosmylus* (?).

Taken in the Orongorongo Valley, Wellington, January, 1892. These are both represented by single specimens; but will be submitted to Mr. McLachlan as soon as others are captured.

5. Two species of *Coleoptera* (*Rhyncodes saundersi*, White, and *R. ursus*, White).

Taken at Lake Rotoiti (Nelson) and Wellington in forest, but only singly.

[Mr. Hudson expressed the opinion that the series shown appeared to connect the two species.]

Art. IV.—*Description of a Large Species of* Iulus.

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 9th October, 1893.*]

Iulus (Spirostreptus) fijiensis, Col.

Body cylindrical, stout, back very convex, smooth, glossy, hard, 6in. long, 1½in. across back from bases of legs on each side, dark umber-brown, somewhat mottled, darkest at ends; 5 blackish bands, nearly equidistant, the first about one-third length from head; segments imbricate, 58, about 1 line wide, but a little narrower at extremities. Head broad, rounded, smooth. Eyes composed of many facets, forming a broadly-deltoid dark-blue-black patch above at base of antennæ, its angles rounded, having a regular papillose appearance; facets subglobose in 8 rows, 9 facets broad at base. Antennæ 3 lines long, 7-jointed; joints subclavate, the terminal one very short, the second echinate, the third and fourth slightly hairy; tips of maxillary processes hairy. Legs, 2 to each segment, 3½ lines long, subterete, curved, 7-jointed, the terminal joint with a single acute sharp claw, and also 1–2 minute accessory ones or short stout hairs; colour paler-brown. Weight, ½oz.

Hab. Fiji; specimen obtained living at Dannevirke (Seventy-mile Bush), from a bunch of bananas imported.

Obs. I have had this fine myriapod in my possession for some time, having vainly endeavoured by inquiry, both North and South, to obtain some information respecting it, supposing, from its size and habitat, it must be known and described. I now, however, provisionally describe it—in part, as, from it having died with its head much incurved, I cannot well get at its mouth, &c., without breaking it up, and, having but a single specimen, I am unwilling to do so.

ART. V.—*Notes on Spiders.*

By Major-General SCHAW, C.B., R.E.

[*Read before the Wellington Philosophical Society, 11th October, 1893.*]

1. How do the ordinary spiders which make geometric webs convey their lines across streams of water? 2. Do they *see* the opposite shore, or what is their extent of vision?

To obtain answers to the above questions, a potato, with a slice cut off it to give it a level base, was placed on the bottom of a large dish of water. Two sticks were stuck into the potato, about 8in. long, and 2in. apart at bottom, 4in. at top.

First a large spider was placed on one of the sticks. He ran up and down the stick, and then remained quiet.

Then a very small spider was placed on the same stick. It ran straight at the large spider, which instantly grappled with it. The small spider escaped by dropping into the water (without any line attached, for which apparently it had no time). It was carried down to the potato by the force of its fall, and for more than a minute it travelled round and round the potato, under water; then it rose to the surface and lay still until blown to the stick, up which it ran nimbly, without having suffered apparently from its adventures under water or on its surface.

A medium-sized spider was then placed on the top of the stick. It dropped by a spun-out line to the surface of the water, felt it with its feet, and having thus ascertained, apparently, that it was imprisoned it climbed up its line again (the line seemed to be coiled up or carried up with it as it ascended). It then began to draw out line from the spinnerets with its legs, and to throw it out to leeward (there was a slight draught from the open window). The operation was very suggestive of throwing out a fishing-line. When about a foot of line had been thus thrown out floating in the air the creature ceased, and seemed to wait for it to catch on som thing. As there was nothing on which it could catch within 8ft. or 10ft. of it in the direction in which it was carried by the draught of air, I brought a vase of flowers on the table near enough to let the line touch some leaves, to which it seemed to adhere. Immediately the spider began to pull on the line, evidently to test if it was firmly attached, and it was just starting to climb out on to its bridge when unfortunately the large spider came blundering on to the scene, and ran up against the worker. There was a short conflict, and then they both ran away in opposite directions, the bridge having been broken in the *mêlée*. Shortly after the medium-sized spider had established a bridge between the two sticks, at about half their height. I presume this was done in the same way as the first longer bridge; this one was about 2½in. long. He then went to the top of one stick, attached a line there, ran down, crossed the bridge, and carried the line to the top of the other stick, tightened it in and secured it—just as a sailor would have hauled taut and belayed. Then he crossed this upper bridge, strengthening it by an additional line which he spun out as he went. The large spider then crossed the upper bridge, spinning out his own line as he went. Then the two spiders started to cross this bridge from the opposite ends, met in the middle, sparred with one another, and both retired.

These observations seem to show that the geometric spiders do not see, or see very imperfectly, but that they have the instinct to throw out a line when they find themselves on an isolated elevation; that they are very sensitive to draughts of air, and always lay out line to leeward. Apparently they trust to their good-fortune, when the line is floated out, that it may catch on something, and they are sensitive to the feeling of the line when it does catch. The hauling on the line to see if it is firmly enough attached to bear the creature's weight seems almost like reason, as does also the mode of forming a higher bridge by means of a lower one.

The fact that these spiders can walk on the bottom of a pool of water in case of need is remarkable, as it gives them another means of crossing narrow pieces of water. The spider could not walk on the smooth surface of the pan of water, but ran nimbly on the potato; so that a rough surface, to which it can cling, seems needful for the feat. Probably it carries a bubble of air down with it, and so can live for a time under water, and float up again before the air is exhausted.

ART. VI.—*Description of a New Species of* Ophiuridæ.

By H. FARQUHAR.

[*Read before the Wellington Philosophical Society, 1st November, 1893.*]

Plate IX.

THE genus *Amphiura*, to which the little brittle-star which forms the subject of this paper belongs, contains more species than any other genus of the *Ophiuroidea*, and is found in all parts of the world, and at all depths. It is not therefore surprising to find another species of this cosmopolitan genus inhabiting our waters. The only species hitherto known from New Zealand are *Amphiura parva*, Hutton (Trans. N.Z. Inst., vol. xi., p. 305, 1879), from Dunedin Harbour, and *Amphiura lanceolata*, Lyman ("'Challenger' Report," vol. v., *Ophiuroidea*, p. 133, 1882), dredged by the naturalists of the "Challenger" expedition, off the east coast of the North Island, in 700 fathoms water. I now add a third, discovered in my first attempt at dredging in Wellington Harbour, 20th January, 1892, and since then every haul of the dredge in deep water has revealed many specimens. They exist in great numbers in all the deeper parts of our harbour—from 10 to 15 fathoms —where the bottom is composed of soft, grey mud, from which they derive their nutriment by extracting the organic matter. I find them always associated with a small heart-shaped sea-urchin — *Echinocardium australe* (*E. zelandicum*, Gray)—which evidently delights in the same localities and conditions.

This species appears to have the peculiar habit of throwing off its disc and renewing it, which has also been observed by Professor Verrill in *Amphiura abdita** (Annals Nat. Hist., ser. 5, vol. ix., p. 476). All my specimens dredged from January to April had perfect discs, with fully developed scaling; but in a dredging taken on the 14th October, when a large number of specimens were obtained, three of them had no discs at all, the teeth and bases of the arms above being quite bare, showing where the disc had been. The other specimens had discs in different stages of development, some consisting merely of granular skin with impressions where the radial

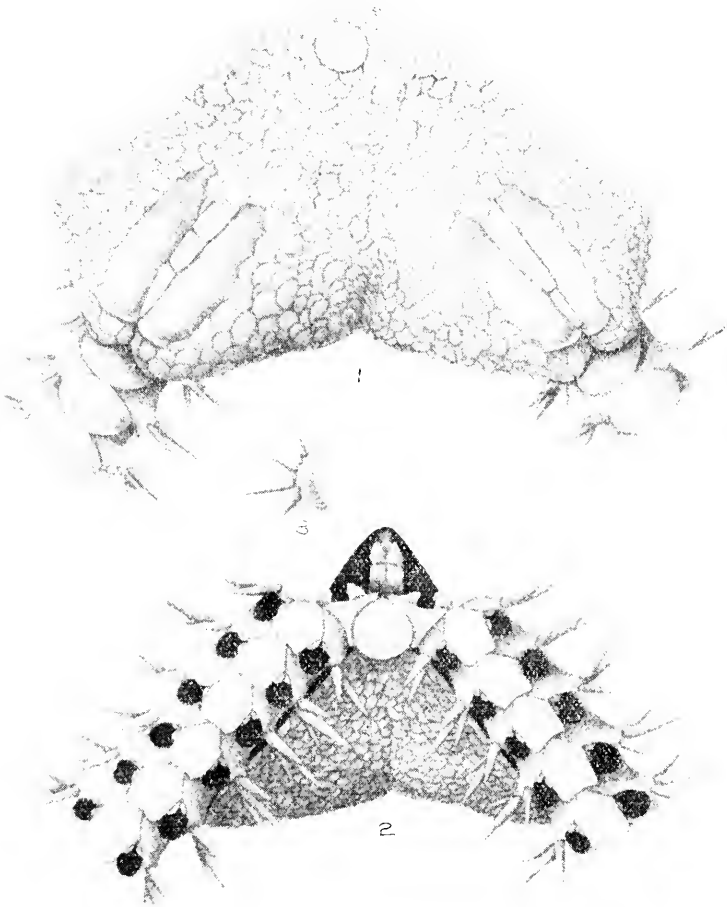
* It is well known that several other Echinoderms undergo evisceration and regeneration of the disc and visceral mass—as, for instance, *Antedon rosacea* (Ann. and Mag. Nat. Hist., of Sept., 1893, p. 197)—but it has not yet been proved whether this takes place spontaneously or is the result of accident. My observations on *Amphiura rosea* seem to indicate that this species does eviscerate spontaneously. Further observation will, however, be necessary to decide this point satisfactorily.

shields were forming, in others the scaling was more advanced and the discs full size. They were so delicate that it was very difficult to handle them without breaking them to pieces, and when taken out of spirit the discs collapsed completely, as if they were only covered with skin, the scaling not being sufficiently formed to give any support. One or two of the arms of several specimens had also been broken off and were partially restored.

Amphiura rosea, sp. nov. Plate IX.

Disc small, slightly tumid, roundly subpentagonal in form, with constrictions in the interradial spaces, covered above and below with rather coarse, circular, overlapping, very irregular scales, among which the primaries can usually be made out; scaling on the interradial spaces below more regular and finer than above. Radial shields long and narrow, bluntly pointed within, meeting without (in some specimens they do not quite meet), separated within by a wedge of two or three long narrow scales; they do not reach the edge of the disc, but are separated from it by a few irregularly-shaped scales. Two short, stout, bluntly-pointed, rounded mouth-papillæ at the apex of the mouth-angle, and one short, stout, and bluntly-pointed on either side at the base of the mouth-angle. Five roundish, flattened teeth, the ends truncated or bevelled, the uppermost longest and divergent, the lowermost smallest and sometimes pointed, resembling a mouth-papilla. Mouth-shields rather large, circular in form, usually with a slight peak within; madreporic shield distinct, and a little larger than the others. Side mouth-shields trigonal, with re-entering curves, the longest angle within where they do not meet. Arms long, slender, and regularly tapering. Upper arm-plates transversely oval. First under arm-plate irregularly hexagonal, small, often indefinite in shape, those beyond pentagonal, a truncated angle within, and a slightly re-entering curve and rounded angles without. Side arm-plates with prominent spine-crest, meeting neither above nor below. Arm-spines rather slender, cylindrical, tapering, divergent, four sometimes five near the disc and three on the outer part of the arms, the two lower ones rather longer than the upper. Two very minute tentacle scales, one on the under arm-plate, the other on the side arm-plate, sometimes only one on the under arm-plate.

Colour in life often a generally-rosy red; sometimes the disc is grey or purplish-grey, and brownish towards the centre above. The arms are often grey or reddish-brown near the disc—this colour extends to a greater distance from the disc on some of the arms than on others even in the same specimen—and light-red or white beyond. In a number of speci-



H. F. del. AMPHIURA ROSEA × 15

mens red is by far the prevailing colour. The red colour soon fades in dried specimens, and even more quickly in alcohol.

Diameter of the disc 6·3mm. Length of arm from centre of disc about 72mm. Width of arm close to the disc, without its spines, 0·9mm. Length of longest arm-spines about 0·6mm. Length of radial shield 1·52mm.; breadth 0·45mm. Length of upper arm-plate near the disc 0·47mm.; breadth 0·72mm. Length of lower arm-plate 0·5mm.; breadth 0·4mm.

This species, I should say, would find its place in the "Table of Species of *Amphiura*" given by Mr. Lyman in his *Monograph* ("'Challenger' Report," vol. v., *Ophiuroidea*, p. 123) near *Amphiura bellis*, to which it appears to be closely allied. It can, however, be readily distinguished from that species by the coarser and irregular scaling of the disc and the shape of the under arm-plates and mouth parts.

EXPLANATION OF PLATE IX.

Fig. 1. *Amphiura rosea*, above ×15.
Fig. 2. " below ×15.
Fig. 3. " arm-spines in profile ×15.

ART. VII.—*On the Anatomy of the Pig-fish* (Agriopus leucopœcilus).

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Communicated by Professor T. J. Parker.

[*Read before the Otago Institute, 9th October, 1893.*]

Plates X.–XIII.

A. EXTERNAL CHARACTERS.

THE height at the nape is considerable, and is due to two causes: 1st, the limb-girdles, but especially the pelvic, are carried downwards and forwards and lie lower than and partly beneath the operculum and branchial arches; 2nd, the muscular tissues containing the dorsal interspinous bones are well developed and lie higher than (and in front, over) the cranium. The limb-girdles form a strong pad covered with thick skin on which the compressed body may rest. The following are some of the measurements taken: Average height, 2·9in.; average height with dorsal, 4·6in.; head, 2·3in.; snout, $1\frac{3}{16}$in.; average total length, 9·5in.; orbit (vertical), 0·55in.; orbit (horizontal), 0·64in. The orbit, of considerable size, is more or less ovate, very rarely nearly circular—the two diameters differ by $\frac{1}{16}$–$\frac{1}{7}$in. The head possesses a small terminal mouth with thick upper and lower lips. When the mouth shuts, the nasal processes of the premaxillæ are retracted into a groove on the snout, and cause the contents of the adjacent olfactory sacs to be expelled. The elongated snout bears on each side a single olfactory aperture surrounded by a prominent rim. In two specimens I found a double aperture on one side.

Dorsal fin: Richardson and Günther give its formula as D 17/13. Of twenty-seven specimens, I found six with D 16/13, twelve with 17/12, and nine with 17/13. The membrane is deeply notched between the anterior spines, and the middle eight or nine soft rays are usually bifid.

Ventral (anal) fin: Richardson gives A 9; Günther A 10. I found seventeen specimens with A 9, six with A 10, and three with A 8.

Caudal fin: Richardson gives C $12\frac{7}{8}$. I found C $12\frac{8}{8}$, the anterior members being small nodules.

The pectoral fin has its eight rays generally unforked.

The pelvic fin has an extremely strong spine; its five soft rays are, according to Richardson, unforked; but I found only the 1st ray invariably so, and of thirty specimens, eleven had the 2nd ray forked, twenty-seven the 3rd, twenty-two the 4th, and six the 5th.

The gill-membrane is united with the adjacent integument, and the gill-opening is small and vertical. The head has no spinous points, but only superficial granulations, which are arranged in radiating lines on the parietal, preopercular, and posterior part of the suborbital, and in two main and several smaller lines in the hollow interorbital space. The clavicle shows a strong granular disc behind the gill-opening, and the supra-clavicle has a smaller granular surface near its upper end.

The body is clothed with thick, smooth, leathery skin, which can easily be stripped off, and contains no hard parts except lateral-line structures. The ground-colour is brown, marbled with black, sometimes in large specimens mottled with grey; a pale-pink hue often appears, and the fins are sometimes bordered with orange.

The lateral line is indicated as an interrupted groove crossing alternate light and dark vertical bands of skin, each lodging a distinct structure; the light bands have each a small flat elevation interrupting the groove and covering a bony tube: of these tubes there are about thirteen pairs. On each dark band a short transverse (vertical) groove runs downwards from the main lateral-line groove, and ends at the side of a fine papilla.

B. SKELETON.

1. *Cranium.* The cranial cavity is wide and slightly depressed, although the entire head is compressed. The cranial bones are mainly well developed, no distinction being seen in the adult between cartilage and membrane bones. The main cartilage is a median prenasal and nasal mass continued backwards as the interorbital septum. In the entire specimen the size of the cranium is exaggerated by two large parietal plates continuing the side-walls upward. The cranium adheres closely to the form of a regular box whose posterior almost vertical end has the atlas firmly attached to it by both the condyle and the circumference of the vertical ovoid foramen magnum. The latter is bounded below and laterally by the exoccipitals, and above by the epiotics. The basioccipital enters into the formation of the cranial floor, where it lodges the auditory vestibules in a pair of depressions; and it forms the lower third of the condyle, the remainder of which belongs to the exoccipitals. The cranial floor presents ventrally a well-marked median ridge formed by the vomer and the long parasphenoid which sheaths the basioccipital. The large shield-shaped supra-occipital is shifted forward to the centre of the cranial vault, and rests by two downwardly-directed processes on the sphenotics, while its incompletely ossified anterior border is continued forward beneath the frontals by cartilage, which splits in front into two parts, which turn downwards and backwards, to be continuous with the flat orbito-sphenoids. The latter form the lateral parts of the anterior cranial wall, which is inclined forward at an angle of 45°, and is incomplete mesially, where a sheet of soft tissue receives the posterior border of the interorbital septum.

The deviations from the typical form might be thus explained: The epiotics have met by strong processes above the foramen magnum, and have displaced forward the large supra-occipital; the latter has displaced outwards the parietals which form the upper part of the cranial side-walls and a small part of the roof. The "-otic" bones are carried outward and downward, and the sphenotic and pterotic (the latter transmitting the horizontal semicircular canal) form the lower part of the side-wall and the outer part of the floor. The prootic is entirely in the floor, which also includes the horizontal halves of the opisthotic and exoccipital; the vertical halves of these two latter enter into the cranial posterior wall, the former external to the latter.

Typical epiotic processes are represented by relatively small epiotic spines united with very large plates, which form the main parts of the parietals. Instead of a supra-occipital crest or spine, there is a faint groove, continued into a deeper groove on the arch of the atlas. Parotic processes (pterotic + opisthotic) are not present in their typical form, the post-temporal being interposed between these two, and so closely applied as to simulate a cranial bone; but the opisthotic has a short process, between which and the post-temporal there is a pit for articulation with the supra-clavicle. The lateral border of the pterotic forms eaves overhanging the hyomandibular articulation, the surface for which may be traced forward from the pterotic to a pit between the prootic and sphenotic.

The lower posterior angle of the cranial cavity is a cartilage-lined pit, formed mainly by the opisthotic, between the exoccipital and the pterotic, and overhung by the epiotic; it receives the lower end of the posterior semicircular canal which pierces the large epiotic. This bone and its fellow form the upper third of the posterior cranial wall and part of the roof, on both of which they meet by a median suture. The square prootic has its mesial border split longitudinally to form the roof and side-walls of the subcranial cavity for the ocular muscles. This cavity is closed in below by the parasphenoid, and extends back into the basioccipital; the prootics meet behind above this cavity, but in front are separated by the very small prepituitary Y- or rather T-shaped basisphenoid whose slender stem extends downwards between two processes of the parasphenoid. There is no alisphenoid bone; and the sphenotic entering into the posterior orbital boundary is almost covered by a lateral-line bone. The frontals are strong curved bones above the orbits, their anterior points flanked by the parethmoids between the orbits and the nasal cavities. The nasal cavities, separated by the supra-ethmoid and the underlying cartilage, communicate with the orbits by foramina between the parethmoids and the median cartilage. Dorsally, between the slender nasals and (between) the lachrymals, above the thin supra- or dermo-ethmoid, there is a long median space in which slide the nasal processes of the premaxillæ. The vomer consists of a slender ventral process and two short stout dorsal processes, and embraces the anterior end of the median prenasal cartilage. The lateral or suborbital chain is represented by five bones: first, the large, slightly mobile, fenestrated lachrymals; second, a small bone on the inferior border of the parethmoid; third, a long bone forming the inferior orbital boundary, having its lower posterior angle movably connected with the anterior border of the preopercular; fourth, a thin plate on the sphenotic; fifth, a nodular bone in a space between the parietal, pterotic, and post-temporal.

2. *The Jaws and Suspensorium.*—The short jaws are carried, with the lower end of the hyomandibular, far forward from beneath the cranium; and the rodlike symplectic, meta-

pterygoid, and quadrate are nearly horizontal. The pterygo-palatine region is imperfectly ossified, and there is no separate mesopterygoid. On the upper angle of the quadrate is perched a small ossification—"pterygo-palatine"—which is carried so far forward as to lose the typical articulation with the parethmoid. The hyomandibular is a stout plate, with a posterior process bearing the opercular. The premaxilla consists of a short alveolar plate, and a long semi-cylindrical nasal process bound immovably to its fellow of the opposite side. The maxilla does not enter into the gape: it has two mesial processes connected with their fellows of the opposite side respectively above and below the combined nasal processes of the premaxillæ; and the bone rotates around the lower process. In the lower jaw, the dentary forms a short V, with its broad apex (anterior) joined to its fellow of the opposite side by fibrous tissue; hence the posterior extremities of the rami can be approximated. The articular bears a saddle-shaped facet for the quadrate, and its anterior part projects as a lamina into a cavity in the dentary. Meckel's cartilage can be traced forward on the inner surface of the articular as far as this cavity. The articular bears on its base and inner surface a nodular angular connected by a strong ligament with the interopercular.

When the mouth opens, the dorsal angle of the dentary is rotated forward, carrying with it the premaxilla, whose nasal process, with its fellow, slides in the naso-prenasal groove. These processes are connected by soft tissue with the walls of the olfactory sacs; and by their movements produce an ebb and flow of the contents of the sacs.

3. *The Operculum.*—The pre- and inter-operculars are prolonged forwards like the suspensoria, and almost reach the articular head of the quadrate. The preopercular alone has a roughened skin-surface. The fan-shaped opercular is very mobile on the process of the hyomandibular, and it and the preopercular respectively hide the larger parts of the weak subopercular and the bladelike interopercular. The preopercular covers the posterior border of the hyomandibular, but not the symplectic; and receives the border of the quadrate into a groove on its upper border.

4. *Hyoid Apparatus.*—The short cornua are suspended by small interhyals from cartilage between the symplectic and the hyomandibular. All the ossifications are small; and the epi- and cerato-hyals bear equally between them the five thin branchiostegal rays. The couple of hypohyals are separated from those of the other side by two small bony nodules and by the head of the spatular urohyal.

5. *Branchial Apparatus.*—The very short branchial arches together form a very compact mass perforated by the pharynx,

and containing thirty-four ossifications. The first arch has the four usual elements. The pharyngobranchials of the second, third, and fourth arches are broad and articulated into one rough mass above the pharynx. The third hypobranchial has a small ventral hook partially enclosing, with its fellow, the ventral aorta, while the fourth arch has no hypobranchial.

The fifth arch consists on each side of a single lower pharyngeal bone with fine villiform projections. The copulæ are: First, a long cartilage-tipped ossification, lying mainly between the first hypobranchials. The second separates the second and third hypobranchials; its anterior third is cartilaginous. Sometimes there is a small nodule — copula 3 — separating No. 2 from No. 4, a diamond-shaped cartilage touching the third hypobranchials by its anterior borders, and the fourth ceratobranchials by its posterior edges. The parosteal gill-rakers, movably attached, are short and dagger-like, and occur as far back as the front border of the fourth arch.

6. *Pectoral Girdle.*—The pectoral girdle is very strongly developed; its ventral moiety is carried far forward to be vertically beneath the orbit, behind and below the urohyal, and its anterior edge is largely hidden by the operculum and branchiostegal membrane. The post-temporal, unforked and triangular, is firmly fixed by its sculptured surface to the auditory region of the skull: with the opisthotic it forms a good socket for receiving the head of the supra-clavicle. The latter, strong and rectangular, covers a long vertical process of the clavicle, and below enters a groove on that bone. The clavicle, the largest bone in the body, forms a curve with its convexity downwards and backwards. The anterior process of its forked dorsal end abuts against the opisthotic process. The outer surface presents a long ridge, expanded into a granular disc in its upper half. The inner surface also has a long ridge, which forms a strong connection with the upper anterior end of the pelvic girdle, and which in front forms a low rectangular area immovably articulated with its fellow of the opposite side. The clavicle bears two post-clavicles, the upper a small plate carrying the styliform lower bone. The scapula, perforated by a foramen, is a small rhomboid partially interposed between the posterior end of the coracoid and the clavicle. The hatchet-shaped coracoid covers immovably, by the anterior end of its flattened handle, the front of the clavicle, and its posterior border is not indented. The four brachials, carrying each two fin rays, are borne equally by the scapula and the coracoid.

7. *The Pelvic Girdle.*—The pelvic girdle (or basipterygium?) consists of a pair of very strong ossifications uniting by two symphyses, and interposed wedgelike, by a mobile connection, between the two clavicles. Each bone consists of two

triangles uniting in a thick bar, which meets its fellow in a strong symphysis. The posterior part of the bar bears a long process, extending both in front and behind, and meeting its fellow in a long second symphysis.

8. *Vertebral Column.*—The vertebral column consists of thirty-six undoubted vertebræ and a hypural, supporting twenty-nine or thirty dorsal interspinous bones, 8–10 ventral interspinous bones, and twenty-eight caudal rays. The short amphicœlous centrum is a well-ossified cylinder, with lateral strengthening ridges. The perforated neural processes bear small anterior zygapophyses. Behind each main hæmal process there is a small free subsidiary process. Above the level of the nerve foramen the atlas bears a riblike bone, the position of whose head seems to correspond to that of the epineural of Owen. Similar bones for the following vertebræ are attached to processes successively more distinct, and springing from lower levels, until on No. 5 they spring from the centrum. In No. 6 there appears a small bone attached by fibrous tissue to the middle of the undersurface of the riblike bone, usurping the position of the end of the latter over the cœlome. The ventral element is longer in No. 7, and nearer the centrum, which it reaches in No. 8, where it has the position of an ordinary true rib. In 9–12 the dorsal riblike bone is smaller, and is now clearly "intermuscular." Thus it would appear that the first five vertebræ have no true ribs, but only intermuscular bones. Now, compare the last dorsal and first caudal vertebræ (Nos. 15 and 16). The former has its transverse processes very low down, and connected below (as also occurs in 13 and 14) by a bony bridge separating the caudal artery from the vein. No. 16 has a complete hæmal arch, partially marked into two divisions for the artery and the vein. No. 15 has a pair of ribs, lying close together, parallel to the large hæmal spine of No. 16. This spine is grooved in front, and lateral markings seem to point to a homology to the ribs of 15. The hypural consists of a demicentrum with neural and hæmal canals, and two fanlike plates, of which the upper bears two partially ankylosed pieces like neural spines. The pterygiophores or interspinous bones of the dorsal have each a triangular body with two lateral supports, and a head consisting of a horizontal plate. This plate bears an articular surface, behind which arises a curved process entering the perfect ring of the head of the dorsal spine, and almost meeting a long process from the head of the preceding plate. This amounts to the interlocking of two rings. The four anterior pterygiophores form a sutured structure lying above the skull, but, by boiling, the parts are separable from each other and from the spines. The first, however, having

its head a perfect ring, is not separable from its spine. Each soft fin ray can be split into two halves after boiling. In the cleft of the head is a nodule (divisible into two by careful maceration) effecting the connection between the head of the fin ray and the interspinous bone, and lying on the sloping head of the latter behind the head of the predecessor. These nodules are therefore a second (distal) series of pterygiophores, and are probably homologous with the processes (of the interspinous bones) entering the rings of the dorsal spines.

The anal or ventral fin has elements similar to those of the soft part of the dorsal.

C. Alimentary Canal and Viscera.

The short gullet leads into a straight, narrow, rugous stomach. The U-shaped duodenum, wider than the stomach, receives the bile-duct near its proximal end; there are neither pyloric cœca nor pancreas. The ileum, of three turns, is separated from the rectum by an ileorectal valve. Of internal parasites, Echinorhynchus occurs oftenest. A species of Tetrarhynchus was found in all parts of the walls of the enteric canal, and also attached to these and to the mesenteries; two were found in the oviduct. A few specimens of a Nematode were also found. The food consists mainly of Crustacea, especially crabs; also univalves, mixed with a few leaves of Zostera. This and the slimy nature of the skin befit the character of a ground-feeder.

The liver is mainly a three-sided prism, with a corner in front bent over to represent a second lobe. The longitudinal bile-duct lies in the gastrohepatic omentum, and receives seven hepatic ducts in three sets, while its anterior end is continued as the cystic duct to the gall-bladder. The spleen is a dark reddish-brown ovoid body marked with black pigment-spots.

Reproductive Organs.—The testes, during the spawning-season, are large, lobulated, and of whitish colour; and the ovaries are very large and highly coloured. The single capacious oviduct has flabby walls; it is strengthened by an antero-posterior band crossing its cavity.

The well-developed swim-bladder consists of two chambers, anterior and posterior, incompletely separated by a transverse septum, which is perforated by a small circular aperture, and which bears a number of small pink spots—retia mirabilia. The large anterior chamber, unlike the posterior, is lined by a silvery tissue; and its anterior end is simply rounded off, without any connection with the auditory organs, being separated from the cranium by the degenerated pronephros—a very vascular lymphoid body. The mesonephros is represented by a pair of thin dark bands, of which the right is much the larger. The functional kidney is closely embedded in the posterior dorsal body-wall: the ureters can only with difficulty be distinguished from the gonaduct. In the male, a urinary bladder can always be seen on the right side; in the female it is obscured, except immediately after the spawning-season, when its external aperture may also be distinguished from that of the gonaduct.

D. CIRCULATORY SYSTEM.

Arteries.—The very short ventral aorta is continuous with a small median vessel supplying the branchial arches. On each side the first two efferent branchial arteries unite to form the first epibranchial, the second being formed by the third and fourth efferent vessels. The first efferent branchial has a large branch piercing the prootic, and apparently, with its fellow, completing a circle above the parasphenoid. The epibranchials unite to form the dorsal aorta, which very soon gives off, together, two subclavian arteries, and a large cœliaco-mesenteric artery running downwards and backwards past the right side of the stomach, to divide finally into two main trunks: of these, one supplies mainly the retia mirabilia of the air-bladder, but also, partly, the stomach; while the other gives off a gastro-hepatic branch, and then supplies all the other viscera. Above the posterior air-chamber the aorta gives off branches ramifying in the walls of that organ; also, a little farther back, the spermatic artery.

Veins.—The portal vein is formed by two main factors, one mesenteric, the other draining the retia mirabilia and the stomach. The caudal vein is apparently not connected with the cardinals except by renal capillaries. A median vein from the functional kidney receives the spermatic veins, and then divides into two cardinal veins, of which the right is the larger. The veins, like the arteries, of the posterior air-chamber are not connected with the mesenteric, but open into the cardinal veins, which, after forming each a sinus in the pronephros, meet the hepatic and large subclavian veins and open into the sinus venosus.

EXPLANATION OF PLATES X.-XIII.

Agriopus leucopœcilus.

(Cartilages are dotted and symphyses lined.)

PLATE X.

Fig. I. Side view: bones of head and limb-girdles.

PLATE XI.

Fig. II. Skeleton of head—dorsal view.
Fig. III. " ventral view.
Fig. IV. Internal aspect of limb-girdles.

Plate XII.

Fig. V. Internal aspect of suspensorium and lower jaw.
Fig. VI. " hyoid arch.
Fig. VII. Branchial arches.
Fig. VIII. Transitions of ribs and intermuscular bones: vertebræ 1 to 8.
Fig. IX. First caudal vertebra (hæmal spine containing coalesced ribs ?).
Fig. X. First spine of dorsal fin, with interspinous bone, inseparably connected by ring-joint.
Fig. XI. Interspinous bone; ring-head of spine; and cleft head of soft fin ray, with second or distal pterygiophores interposed.
Fig. XII. Sagittal section of swim-bladder, with perforated septum dividing it into two chambers.

Plate XIII.

Fig. XIII. Sagittal section of pig-fish: viscera intact.

A. Articular.
An. Angular.
B 1–4. Brachial ossicles.
Bpt. Basipterygium.
B.r.5. 5th branchiostegal.
BO. Basioccipital.
C. Clavicle.
CB. Ceratobranchial.
Co. Coracoid.
CH. Ceratohyal.
Cp 1–4. Branchial copulæ.
C.V.1. 1st caudal vertebra.
D. Dentary.
Dd. Duodenum.
D.f.r. Soft dorsal fin ray.
DS. 1–5. Spines, dorsal fin.
EB. Epibranchial.
EH. Epihyal.
EpO. Epiotic.
EO. Exoccipital.
F. Frontal.
G. Gonad (undeveloped).
HB. Hypobranchial.
HH. Hypohyal.
H. Heart (on auriculo-ventricular groove).
HM. Hyomandibular.
IH. Interhyal.
IOp. Interopercular.
IOS. Interorbital septum.
IS 1-5. Interspinous bones of dorsal fin.
K. Kidney.
L. Lachrymal.
Li. Liver.
LPC. Lower post-clavicle.
M. Maxilla.
Mc. Meckel's cartilage.
MP. Metapterygoid.
OO. Opisthotic.
Op. Opercular.
N. Nasal.
NO. Optic nerve.
nod. Nodules.
NOl. Olfactory nerve.
P. Parietal.
PB. Pharyngobranchial.
PE. Parethmoid.
Pr. Pronephros.
pect.r.1. Pectoral fin ray.
pelv.r.1. Pelvic soft ray.
PM. Premaxilla.
POp. Preopercular.
PP. Pterygo-palatine.
PO. Prootic.
PtO. Pterotic.
PS. Parasphenoid.
PT. Post-temporal.
PvS. Pelvic spine.
Q. Quadrate.
S. Symplectic.
SBA. Swim-bladder, anterior chamber.
SBP. Swim-bladder, posterior chamber.
SW. Swim-bladder (W marks position of septum).
SC. Supra-clavicle.
Sc. Scapula.
SE. Supra-ethmoid.
SO. Supra-occipital.
SO 2, 3, 4, 5. Suborbital chain.
SOp. Subopercular.
SpO. Sphenotic.
Sy. Symphysis.
UH. Urohyal (articulation fig. 6).
UPC. Upper post-clavicle.
V. Vomer.
Va 1–5; 6, 8. Vertebræ and ribs.

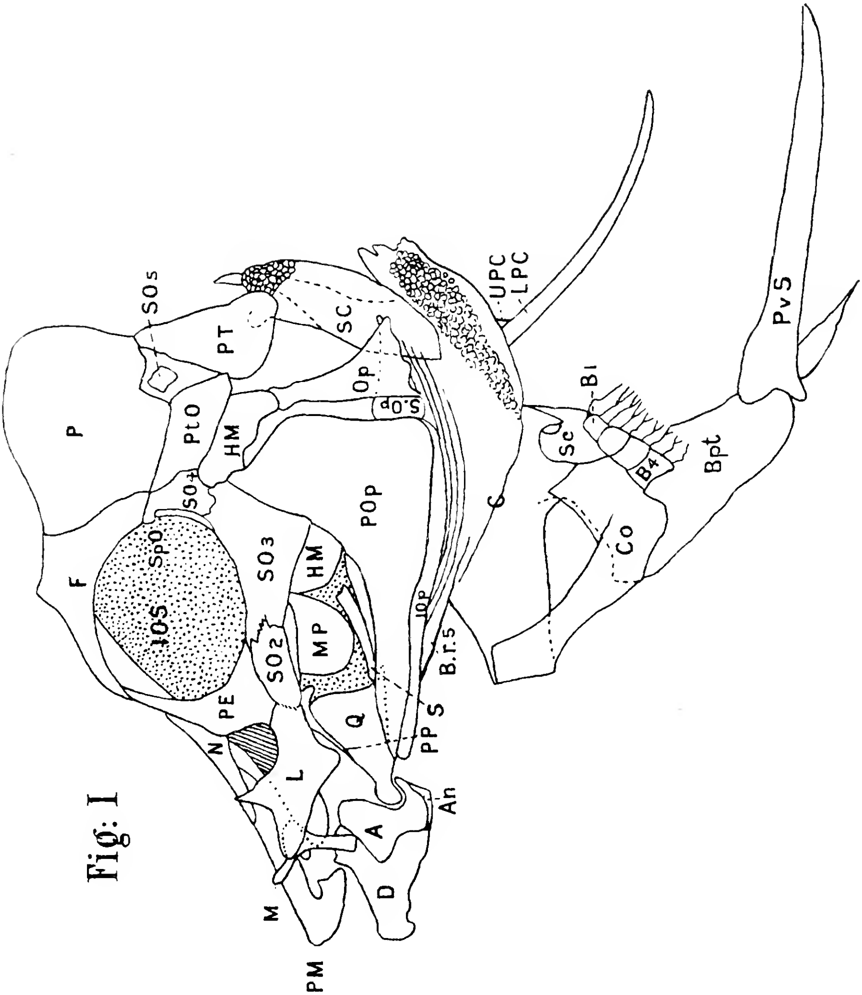


Fig: I

Pig-fish

A.S. delt. F.H.T. lith.

Fig II

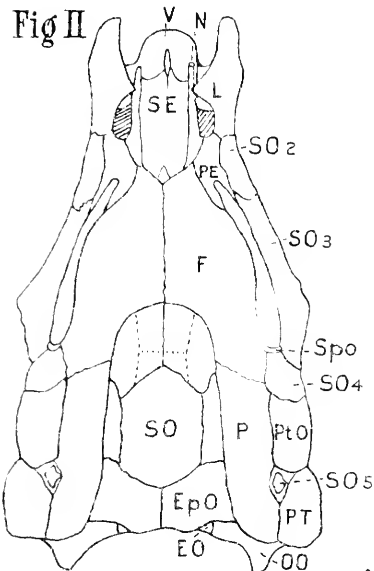


Fig III

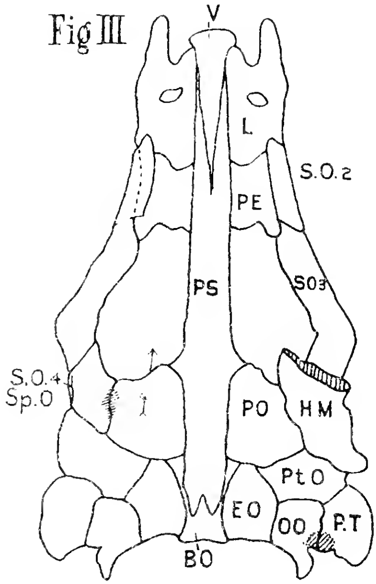
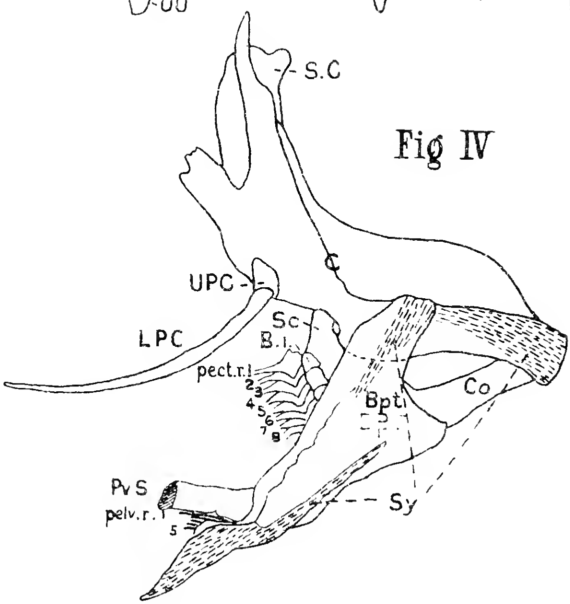
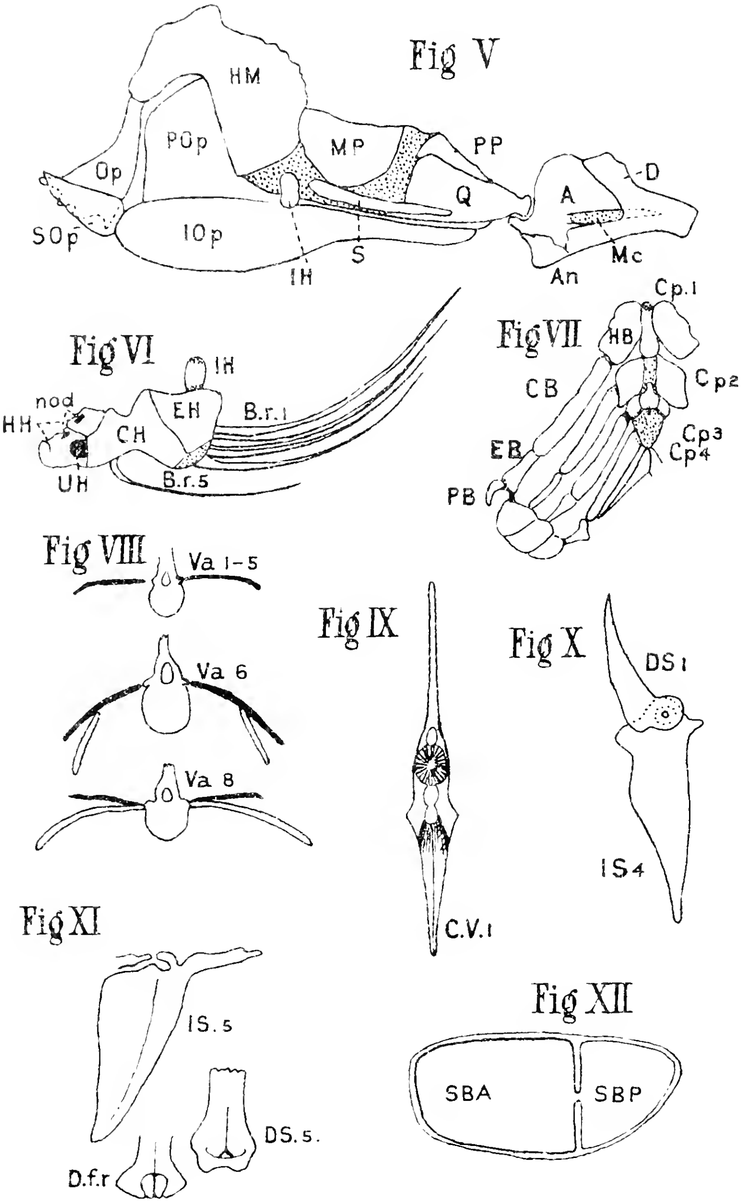


Fig IV



Pig-fish

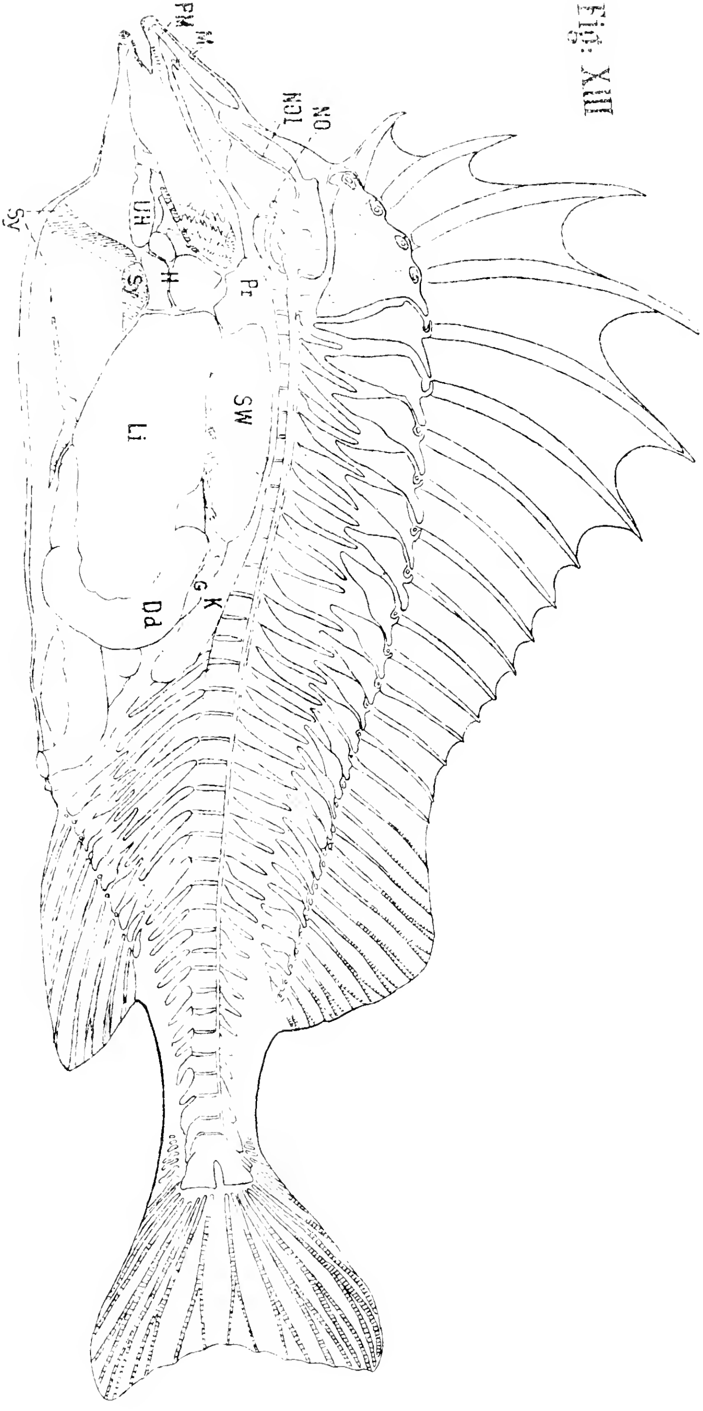
A.S. delt *F.H.T. lith.*



Pig-fish

A.S. delt. *F.H.T. lith.*

Fig: XIII



Pig-fish

Art. VIII.—*Further Contributions to the Knowledge of the Molluscan Fauna of New Zealand, with Descriptions of Eight new Species.*

By Henry Suter.

Communicated by Professor Hutton.

[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Plates XIV.-XXI.

1. Large Form of Potamopyrgus cumingiana, Fischer.

Very large specimens of this shell were kindly presented to me by Professor F. W. Hutton. They were collected in Lake Te Anau, and are 8mm. high by 4mm. diameter. The whorls, of which there are eight, are very strongly and broadly angled round the upper part, and the last three show traces of the rubbed-off spines, of which there were about sixteen on the body-whorl.

This species is very limited in its distribution on the South Island. I have much smaller specimens from Pelorus River and Collingwood only.

2. Latia and its Varieties.

Four species of this genus peculiar to New Zealand have been described—viz., *L. neritoides*, Gray (1849); *L. lateralis*, Gould (1852); *L. petitiana*, Fischer (1856); and *L. gassiesiana*, Fischer (1856). Mr. Charles Hedley kindly presented me with etchings of these shells, and I am therefore now in a better position to judge whether they are all good species or only varieties of *L. neritoides*, Gray, the first described of the lot. Gould himself says that his *L. lateralis* might probably be the same as *L. neritoides*, and Professor Hutton (Proc. Linn. Soc. N.S.W., vol. vii., 1883) holds that these two form only one species. To judge, however, from the figures, I am of opinion that *L. lateralis* and *L. gassiesiana* must be considered as varieties of *L. neritoides*, and very likely also *L. petitiana*, though the figure does not show a very marked difference from *L. neritoides*.

3. Ancylus dohrnianus, Clessin (1882).

The description and figures of this shell, which is said to come from New Zealand, were published in Conch. Cab. (2), Bd. I., Abth. vi., p. 54; pl. viii., fig. 8 (two). It resembles somewhat *A. irvinæ*, Petterd, from Tasmania, but the apex is quite different. Neither Professor Hutton nor myself have any knowledge of such an *Ancylus* ever having been found in this colony, and it may therefore help to swell the already long list of shells erroneously ascribed to New Zealand.

4. Gundlachia, sp. Plate XIV., figs. 1–5.

About two years ago I found in the River Avon, below the outflow of the Horseshoe Lake, a minute ancyliform shell, which I could not separate from *Ancylus woodsii*, Johnston (figs. 1, 2), from Tasmania. I then found only empty shells, but further collecting furnished a good number of them alive. On examining the shells I found, to my great surprise, that in several of them the base was more or less closed by a septum, as it is found in the Tasmanian *Gundlachia* (fig. 3). On consulting Johnston's papers on the Tasmanian fresh-water shells I found the statement that his *Ancylus woodsii* has "the animal and teeth almost similar to *Gundlachia petterdi*" (!), and that in the young state the shell of *Gundlachia* resembles the common *Ancylus*. I compared the dentition of our shell with that of a *Gundlachia* from Ohio, and there was almost no difference; therefore the shell from the River Avon must be considered as a *Gundlachia*. Figs. 4 and 5 show the form of jaw and teeth. The shell, on attaining its full development, will, no doubt, resemble the Tasmanian *G. petterdi*, but I have not yet succeeded in finding it. According to my own observation, and information received from Tasmania, *Gundlachia* seems to attain but seldom its full development, but grows and dies mostly in its ancyliform shell, without even attempting to form a septum. This is shown by the fact that here, as well as in Tasmania, *Ancylus woodsii* is abundant, and *Gundlachia* is rare in the same locality.

Professor Hutton told me that this *Gundlachia* in the River Avon might possibly have been introduced from Tasmania on aquatic plants used for packing trout-ova. This may be, but I rather doubt it, for the following reason: I have not found yet the shell in question from the outflow of Horseshoe Lake *upwards* to the fish-hatching establishment, a distance of several miles, but only *in* that outflow and *downwards* from its disemboguement in the River Avon. Very likely it is living in that lake, and was brought down to the river when the canal was cleared from weeds. The lake is not easy of access, and I have not had an opportunity of exploring it. The question whether it is an introduced form or not can only be settled with certainty when it is found in a locality where the above-mentioned mode of introduction is out of question.

The fact of *Gundlachia* occurring in New Zealand would not be astonishing at all, for we have, besides some genera of fresh-water shells, of the land-shells the sections *Flammulina*, *Gerontia*, *Phacussa*, *Allodiscus*, *Thalassohelix*, *Phrixgnathus*,

&c., in common with Tasmania, as shown by the writer quite recently.

5. Limnæa tenisoni, Clessin, sp. em. (*tennissoni*), 1886,

Was described and figured by its author in Conch. Cab. (2), i., Abth. 17, p. 371, pl. lii., fig. 11. Clessin's reason for placing this shell in the genus *Physa* I do not understand, for description and figure clearly show that it is a *Limnæa;* and I do not think that Clessin is unable to separate the two genera. Clessin's species seems to differ not very much from *Limnæa alfredi,* described and figured by the writer (Trans. N.Z. Inst., vol. xxii., p. 229, pl. xv., figs. 17, 17*a*), and I propose to make *L. alfredi* a variety of *L. tenisoni*, the latter having priority of publication.

Mr. Clessin and other European authors would greatly oblige the writer by sending him a copy, or at least a note, whenever they publish descriptions of new species of terrestrial and fresh-water shells from New Zealand; and they may expect reciprocity.

6. On some Species of Bullinus, Adanson, em. (*Bulinus*).

Bullinus novæ-seelandiæ, Clessin, sp. 1886, is another addition of Clessin's to our fauna, though the specific name is preoccupied by Sowerby. According to his description and figure (Conch. Cab. (2) i., Abth. 17, p. 372, pl. liv., fig. 7), it is, in my opinion, identical with *B. variabilis*, Gray. Most species of our *Bullinus* are so variable that the creation of new species is a very easy matter; but it is highly deplorable if this is done, as it seems to have been the case in several instances, based on a few specimens, and from one locality only, as there is no possibility to estimate the range of variability of the species.

By comparing many specimens, and from different localities, I came to the conclusion that *B. tabulatus*, Gould, sp. 1848, and *B. moesta*, H. Adams, sp. 1861, are one and the same species. The distinction of species by the keeling of the whorls is quite untenable, and every gradation of it may be observed.

Two species of *Bullinus* were brought to light by Mr. Charles Hedley—viz., *B. coromandelicus*, Dunker, sp. 1862, and *B. hochstetteri*, Dunker, sp. 1862, which were omitted from former lists of our mollusca. I have but little doubt that both must be considered as identical with *B. tabulatus*, Gould.

7. Athoracophorus, Gould, 1852. Plate XIV., figs. 6–9, and Plate XV., figs. 10, 11.

In the "Enumeration of the *Janellidæ*," published by Mr. Charles Hedley in the last volume of our Transactions, the generic name of *Janella*, Gray, 1850, was used, and arguments given for doing so. As *Janella*, Grateloup, is identical with *Niso*, Risso, the name can stand, but I think, with Pilsbry, that it is far better to reject any name which has been previously proposed in a generic sense, whether the first usage is valid or not. Mr. H. A. Pilsbry, in a letter to Mr. Charles Hedley, kindly communicated to me, gives the following weighty reasons: "We never know when a name supposed to be a synonym is going to be revived for a section, sub-genus or genus, on account of characters formerly overlooked; and when the name happens to be in a little-known group, unfamiliar to us—Diptera for example—who is to tell whether a generic name is really a synonym or not?" I, therefore, use now the name proposed by Gould.

A. papillatus, Hutton. As this species has only been figured by Simroth (*A. verrucosus*, Von Mart., Nova Acta, Bd. 54, pl. iv., fig. 11), and I had an opportunity of getting good specimens near Christchurch, I now give correct drawings of the animal, jaw and teeth of the radula (Plates XIV. and XV., figs. 6–11). I compared carefully Simroth's description of the animal and anatomy of *A. verrucosus*, Von Martens, 1889, with typical specimens of *A. papillatus*, Hutton, and the details of its anatomy published by Professor Hutton, and am convinced that both are one and the same species.

The var. *nigricans* and *fasciata*, Von Martens, I never observed in adult specimens of *A. papillatus*. Young specimens of this species I found always mixed of the typical form and var. *fasciatus*, whilst in adult specimens the colour-markings of the latter had fully disappeared, but they showed somewhat different colours. Some were of a yellowish-brown, but others were dark olive, the latter very likely corresponding with the var. *fasciatus* in the young. The variety *nigricans* is rare.

It seems to me that too much importance has been attributed to the colour and colour-markings of *Athoracophorus*, and this by scientists who have never seen the living animals, but only specimens more or less badly preserved in alcohol, which deteriorates the colour and form of the animals considerably. I have collected hundreds of *Athoracophorus* on both Islands of this colony, and can testify to the great variability of colour and colour-markings in the species.

A. marmoreus, Hutton, is no doubt the same as *A. marmoratus*, Von Martens, described by Dr. Simroth. The description and figure of the animal given by Simroth corresponds very well with Hutton's species, and in the main features of the genital organs, according to the publications of both scientists, they also seem to me to agree. I had no specimen of *A. marmoratus* at my disposal, as was the case with

A. papillatus, to compare its anatomy with all the details given by Dr. Simroth.

According to Simroth's able investigations (Nova Acta, Bd. 54, Die Nacktschnecken Neu Seelands, p. 71, &c.), and his utterances when speaking on the systematic position of the *Athoracophoridæ*, it will be necessary to class *A. papillatus* and *A. marmoreus* in different sub-genera. He says distinctly that the most striking differences between the two species in form and cross-section of the animals and genital organs would almost justify the creation of two genera.

The sub-genus *Pseudaneitea* has been proposed by T. D. A. Cockerell (P. Z.S., 1891, p. 217) for slugs of New Zealand and the Auckland Islands, resembling *Athoracophorus*, but showing a decided tendency towards the formation of a "mantle area" like that of *Aneitea*. The type and only species is *A. papillatus*, Hutton, sp. 1879 (=*verrucosus*, Von Martens, 1889). As sub-genus for *A. marmoreus*, Hutton, sp. 1879 (=*marmoratus*, Von Martens, 1889), must of course be taken *Konophora*, the former generic name proposed by Professor Hutton in 1879 (Trans. N.Z. Inst., vol. xi., p. 332).

Neojanella dubia, Cockerell (*l.c.*), is nothing else but *A. bitentaculatus*, Quoy and Gaimard. I could show Mr. Cockerell alcohol specimens of this slug which are lacking the "mantle area" and dorsal groove, yet they were distinctly visible when the animals were alive; and also specimens of *A. bitentaculatus*, with the back pale-yellowish, marbled all over with black or dark-bluish grey. The specimen described by Cockerell is a very large one (length 53mm.), and I know of no other locality than the south side of Cook Strait where *A. bitentaculatus* attains such a large size.

8. Bulimus antipodarum, Gray, 1843,

Is said to have been found at Kaitaia by Dieffenbach, and recent collectors (Gillies and T. W. Kirk) are reported as having found this shell at different places in the northern part of the Province of Auckland. Opinions are divided as to the validity of the species; some consider it as the young of *Placostylus bovinus*, others take it as a good species. I therefore thought it well worth to investigate the question, and wish now to say a few words on the subject. Looking at the figure of *B. antipodarum* given by Smith (Voy. "Erebus" and "Terror," ii., Moll., pl. i., fig. 5), and reading Gray's description (Dieffenbach's New Zealand, ii., p. 247), one must come to the conclusion that this shell cannot belong to the genus *Placostylus*, the aperture being quite different, but it agrees in every respect with *Cochlostyla*. This opinion was evidently held also by the author of the species, for he says that it is allied to *Bulimus fulgetrum*, Broderip, from the Philippine

Islands, which is a true *Cochlostyla*. Reading Gillies's remarks on *B. antipodarum* (Trans. N.Z. Inst., vol. i., p. 60) one gets the impression that he mistook young specimens of *P. bovinus* for Gray's species, and in this he was followed by others. Professor Hutton kindly allowed me to examine specimens in the Canterbury Museum, labelled *P. antipodarum*, and they proved to be young specimens of *P. bovinus*, but were in no way related to *B. antipodarum*. I am now of opinion that the shell found by Dieffenbach, and described by Gray as *B. antipodarum*, has very likely never been found again in New Zealand, and is in reality *Cochlostyla fulgetrum*, Broderip, introduced accidentally from the Philippine Islands. This suggestion is supported by the fact that *Cochlostyla daphnis*, Broderip, from those islands, has been found at Picton (Trans. N.Z. Inst., xxiv., p. 280).

9. Amphidoxa and Flammulina.

Albers founded the section *Amphidoxa* to receive two species —*A. marmorella*, Pf., and *A. helicophantoides*, Pf., from Juan Fernandez and Chili. Professor Hutton, in his Revision of the Land-shells of New Zealand, the foundation-stone of our present knowledge of these molluscs, classed nine of our shells under *Amphidoxa*, Albers, and gave descriptions and figures of the dentition of eight of them. The diagnosis given by Albers, and the figures of the species from Juan Fernandez, seem to fully justify Professor Hutton's view in adopting *Amphidoxa* for our shells, more especially for *A. crebriflammis*, Pf., *A. zebra*, Le Guillou, and *A. costulata*, Hutton. Professor Hutton, and the writer, never had an opportunity of comparing New Zealand specimens with *Amphidoxa* specimens from Juan Fernandez, and the dentition of the latter is still unknown.

Last year Mr. H. A. Pilsbry published "Observations on the *Helices* of New Zealand" (Nautilus, vi., Sept., 1892, No. 5, p. 54, &c.), which, coming from such an able conchologist, were greatly appreciated by scientists in Australasia. With regard to *Amphidoxa*, he says (*l.c.*, p. 56), "The true *Amphidoxa* has not been found elsewhere than upon the island Juan Fernandez and the neighbouring South American coast. I have compared specimens with the New Zealand shells, and find that there is not the slightest ground for supposing them congeneric." After such a verdict from a competent authority, Mr. Hedley and the writer, in the "Reference List of the Land and Fresh-water Mollusca of New Zealand" (Proc. Linn. Soc. N.S.W., vii., (2), p. 643), adopted the name *Flammulina*, proposed by Von Martens (Critical List of New Zealand Moll., 1873, p. 12), for the New Zealand species formerly included in *Amphidoxa*,—*F. zebra*, Le Guillou, being the type.

A short time ago I examined the dentition of thirty-two land-shells from Tasmania, and found them mostly to belong to the sections *Flammulina*, *Gerontia*, *Phacussa*, *Allodiscus*, *Thalassohelix*, and *Phrixgnathus*, hitherto known from New Zealand only. Afterwards I had an opportunity of examining the dentition of a land-shell from South Africa, a typical form of the section *Pella*, Albers, which, to my great surprise, showed the very same peculiarities in jaw and radula as are characteristic of our genus *Flammulina*. All this leads me to think that *Flammulina* and allied forms belong to the antarctic fauna, which at a very remote period may have lived on the supposed antarctic continent, and of which remnants are now found in New Zealand, Tasmania, South Africa, and—why not South America also?

I hope that some day the dentition of the *Amphidoxa* species from Juan Fernandez will be made known, and I should not be astonished to see them (and perhaps *Stephanoda* also) nearly related to those forms I now include in the genus *Flammulina*.

10. Thalassohelix igniflua, Reeve, and **Th. obnubila,** Reeve.

Professor Hutton was the first to recognise the absolute identity of the two species (Trans. N.Z. Inst., vol. xvi., p. 203). In the "Reference List" (*l.c.*, p. 636), by Mr. Hedley and myself, however, my friend made *Th. obnubila* a variety of *Th. igniflua*. This difference of opinion caused me to look once more at the specimens in my collection, and to compare them carefully with the diagnoses of the two species. It was easy to pick out a few specimens corresponding with each of the species mentioned, extreme forms; but, besides these, there were many intermediate forms, and I again came to the same conclusion as Professor Hutton, that they are all one and the same species, and that there is not even a possibility of making out a constant variety. *Th. igniflua*, the large, brighter, and smoother form, is found in open country, amongst shrubs, tussocks, &c.; whilst the smaller, dark-coloured, and strongly striated and plaited *Th. obnubila* occurs in the dark native bush. The differences in the shell seem to be due to the influence of the habitat only. The dentition is the same in both.

An example of similar variability is *Thalassohelix fordei*, Brazier, of Tasmania, of which no less than about *twelve* species have been made.

11. Endodonta, Albers. Plate XV., figs. 12–14.

The first New Zealand species of this genus made known to science is *E. cryptobidens*, Sut. (Trans. N.Z. Inst., vol.

xxiii., p. 89). Since then three more species have been recognised, all of which are species described long ago under the generic name of Patula, viz.:—

(*a.*) *E. varicosa*, Pfeiffer, sp. 1854 (fig. 12). I sent specimens of *E. timandra*, Hutton, to Mr. Edgar A. Smith, of the British Museum, to compare them with Pfeiffer's type of *H. varicosa*. Mr. Smith most obligingly informed me that they were not identical, but that Pfeiffer's *Helix varicosa* was undoubtedly also an *Endodonta*, having *one* tooth (overlooked by Pfeiffer and Reeve) situated on the body-whorl. It is a slender lamella, and might easily be overlooked.

(*b.*) *E. timandra*, Hutton, sp. 1883 (fig. 13), is very much like the foregoing, but is smaller, more openly umbilicated, has more riblets, and the armature of the mouth is different, there being *three* lamellæ, one on the body-whorl, one at the base of the columella margin, and one on the outer lip.

(*c.*) *E. jessica*, Hutton, sp. 1883 (fig. 14). On examining this shell, which is very nearly allied to the foregoing two species, I found it to have *six* teeth in the aperture, of which two are situated on the body-whorl, one at the base of the inner lip, and three on the outer lip.

According to my present knowledge, *E. timandra* is confined to the North Island, the other three to the South Island.

12. Charopa coma, Gray, var. *globosa*, Suter, 1892.

This variety is the same as var. *beta*, Pfeiffer, 1853; but, as varieties are to be named in the same way as species, and there exists already a *Charopa beta*, Pf. (= *barbatula*, Reeve), Pfeiffer's name can hardly stand. This variety is not identical with *Ch. lucetta*, Hutt. (= *stokesi*, Smith), as supposed by several conchologists.

13. Charopa caput-spinulæ, Reeve, sp. 1852. Plate XVI., figs. 15, 16 (= *epsilon*, Pfeiffer).

The dentition of this species has never been published before, and, as the radula is a typical form of *Charopa*, I give here a figure of it and of two jaws, showing the variability of the latter in the same species. The jaw is membraneous, and distinctly striated, not plaited. The radula has the formula 12—4—1—4—12. It is hardly necessary to describe it, the characters being mainly the same as delineated in former papers by Professor Hutton and myself for *Charopa*.

14. Tesseraria* **novoseelandica**, Pfeiffer, sp. 1854. Plate XVI., fig. 17.

The true systematic position of this little pupiform mollusc

* *Phenacharopa*, Pilsbry, 1893 (not *Tesseraria*, Haeckel, 1879 or 1880); *vide* Man. Conch. (2), vol. ix., p. 29.

has long been misapprehended, it generally being considered to be a pupa. It was reserved to Dr. Von Moellendorff, in Manila, to point out its true nature, and I am glad to say that Mr. Pilsbry agrees with the opinion of Dr. Von Moellendorff, and the writer. Having sent a small collection of New Zealand shells to Manila, Dr. Von Moellendorff wrote to me, under date 20th February, 1892: "What do you think of *Pupa novoseelandica?* Boettger has elevated it to the type of the sub-genus *Tesseraria.* I take it to be a Patulide, standing nearest to *Thera.* Is the animal already known?" I never fell in with a view more readily than with this. I had just then published the description and figures of the dentition of this species (Trans. N.Z. Inst., vol. xxiv., p. 300, pl. xxiii., figs. 53, 54), and pointed out that the radula of this *Pupa* differs considerably from all the others of the genus I have seen. I wrote to Dr. Von Moellendorff that I fully agreed with him, and, sending him a reprint of my paper, which contains also the dentition of the two species of *Thera*, was able to show him that his view was also borne out by the dentition. With his next letter he kindly sent me a modified diagnosis of Boettger's *Tesseraria*, of which I give here a copy:—

"*Tesseraria*, Boettger, sec. *Charopæ*.

"T. pupæformis, fere exacte cylindrata, apice obtuso, subrotundato, costulata, rufo-fusca, maculis stramineis præcipue ad suturam tesselata.

"Radula et maxilla persimilis illis *Theræ* stipulatæ et barbatulæ, Reeve.

"Type: *Endodonta* (*Charopa*) *novoseelandica*, Pfeiffer, 1854."

Animal (fig. 17).—When living in the Forty-mile Bush I made a sketch and short description of the animal, which I think may be of interest now.

The animal is nearly white, the eye-bearers greyish-black, clavate, long (about 3mm.), the tentacles white, short (about ½mm.), rounded in front. Mantle central; neck with two blackish stripes running backwards from the eye-bearers; tail sharp above, slightly tapering, no caudal pore. There is a distinct pedal line, to which run down the whole length of the foot shallow diagonal grooves. Sole white, with a slightly darker median disc, smooth all over. Length of body 9mm., breadth of sole 1¼mm.

15. Laoma leimonias, Gray, 1850. Plates XVI., fig. 18, and XVII., fig. 19.

No figure of the *dentition* of this mollusc has ever been published, as it seems rather difficult to get a shell with the animal. As it is the type of *Laoma*, Gray, it is most important that we should get acquainted with its dentition, and I therefore give here the figures of the jaw and part of radula.

The jaw is composed of twenty-five separate strongly-papillate plaits. The radula has the formula 25—1—25; the central tooth is minute, unicuspid, the laterals and marginals bicuspid. For details in the dentition of this and the following three species of *Phrixgnathus* I refer to former publications by Professor Hutton and myself.

16. Phrixgnathus pumilus, Hutton, sp. 1883. Plate XVII., figs. 20, 21.

The *jaw* of this species was not seen by Professor Hutton when he examined the dentition. It is distinctly papillate, the plaits are narrow towards the ends, very broad in the middle; but this may differ with the individual.

The central and lateral *teeth* are just as figured by Professor Hutton (Trans. N.Z. Inst., xvi., pl. ix., fig. Q). The marginals, which are figured here, are similar to the laterals, bicuspid, but shorter, quadrate.

17. Phrixgnathus microreticulatus, Suter, sp. 1890. Plate XVII., figs. 22, 23.

This species was described by the writer as *Hyalina microret.*, but on examining the jaw and radula I saw that it belongs to Hutton's *Phrixgnathus*.

The *jaw* is formed of about eighteen separate slightly-papillate plaits; the *radula* has the formula 27—1—27, the rachidian tooth unicuspid, the laterals and marginals bicuspid, the last exceptionally tricuspid.

18. Phrixgnathus allochroidus, var. **lateumbilicatus,** Suter, sp. 1890. Plate XVIII., figs. 24, 25.

This is another of my supposed *Hyalinæ*, which on examining the dentition turned out to be a *Phrixgnathus*; *jaw* with about twenty-one separate papillate plaits; formula of *radula* 14—1—14; central tooth tricuspid, with a median cutting-point, laterals and marginals bicuspid.

19. Ariophanta* novaræ, Pfeiffer, sp. 1862. Plate XVIII., figs. 26, 27.

As mentioned in my list of the introduced land and fresh-water mollusca of New Zealand (Trans. N.Z. Inst., vol. xxiv., p. 280), I suspected Mr. Musson's *Zonitoides nitida*, Müller, from Lake St. John, Auckland, to be not this species, but Pfeiffer's *Hyalina novaræ*. At my request Mr. Musson kindly sent me a number of shells and animals. I at once saw that

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* *Ariophanta*, Des Moulins, 1829 (*Nanina*, Gray, 1834; not Risso, 1826).

it could not be *Z. nitida*, but the specimens correspond with Pfeiffer's diagnosis of *H. novaræ*, with the only difference that some of Musson's specimens have ½–1 volutions more, and are therefore larger than the examples collected by Hochstetter. On examining the animal and dentition I saw that it is not a *Flammulina*, as first supposed, but an *Ariophanta*, the only species of this genus known to me to occur in New Zealand. It may therefore be of interest to have the dentition described and figured.

Jaw (fig. 26) membranaceous, smooth, upper margin arched, lower margin almost straight, with an indistinct median projection, ends tapering, faintly longitudinally and vertically striated.

Radula (fig. 27) tongue-shaped, formula 42—1—42, of which 10 to 12 are laterals; transverse rows of teeth straight. Central tooth long and narrow, with one long reflection, and a short, stout cutting-point, extending a little over the next row of teeth. Laterals broader, unicuspid, with a broad, blunt cutting-point of the same length as the central. A large number of intermediate teeth follow; they are oblique, with a bicuspid reflection, and one stout, oval cutting-point. Marginals sinuate, bicuspid.

20. Otoconcha dimidiata, Pfeiffer, sp. 1854. Plate XVIII., fig. 28, and Plate XIX., fig. 29.

Some time ago I found a single specimen of this curious mollusc at Port Hills, Lyttelton, the radula of which differs slightly from that described and figured by Professor Hutton (Trans. N.Z. Inst., vol. xvi., pl. ix., fig. Y). The specimen was rather a young one.

Jaw (fig. 28). It has hitherto been said that the jaw of *Otoconcha* is ribbed, and at first sight it would seem to be so. I have, however, quite a different opinion. The outlines of the jaw figured are decidedly those of an oxygnath jaw, which supposition is supported by the distinct longitudinal striation, which is very often seen in the jaw of the *Limacidæ*. The most irregular denticulation of the cutting-margin points to the fact that this jaw cannot be considered as ribbed, but as *channelled* by the action of the exceedingly strong cutting-points of the radula.

I therefore describe the jaw of *Otoconcha* as *oxygnath*, smooth, longitudinally striated, with a strong median projection inferiorly, *irregularly channelled*, the channels increasing in depth towards the cutting-margin, which is deeply and irregularly denticulated. Ends blunt.

The jaws of old animals represent only a narrow ledge with blunt denticulations on the inferior edge; perfectly worn out by the action of the teeth.

The *radula* (fig. 29) wants no explanation. The formula is 26—1—26, with five distinct lateral teeth.

I am still of opinion that *O. dimidiata* belongs to the genus *Vitrinoidea*, Semper, but I think it to be safer to retain the generic name proposed by Professor Hutton until I have been able to compare dentition and genital organs of our mollusc with those of a *Vitrinoidea* from the Philippine Islands. But the animal perfectly agrees with Semper's diagnosis of the genus; and there is one important fact which should be taken into consideration: *O. dimidiata*, when resting, brings its tail forwards beside the body and head, a position I have never seen taken up by any other mollusc. The figure of *Vitrinoidea albajensis* given by Semper (Philippinen, vol. iiii., Taf. viii., fig. 2) shows a very similar position of the animal, and it seems that Semper has also been struck by its peculiarity. The figures of the teeth given by Semper are quite insufficient for comparison.

New Species and Varieties.

1. Lagochilus fasciatum, n. sp. Plate XIX., figs. 30, 31.

Shell small, turbinate, subperforated, rufous, not shining, rather thin, with close membranaceous, white, slightly sinuated radiate plaits, about 11 or 12 per millimetre. They are crossed by numerous distinct spiral striæ. Spire conical, apex rather blunt, smooth. Whorls 6, rounded, the first five slowly and regularly increasing, the last rapidly growing in size. Periphery rounded. There is a distinct horny band below the periphery on the last whorl, as is sometimes seen also in *L. pallidum*, Hutt. Suture impressed. The notch in the peristome is slight, but quite evident at the point where the upper margin meets the whorl. Aperture almost circular, diagonal; peristome simple, straight, strengthened inside by a callous ring, the callosity extending over the body-whorl between the convergent margins. Umbilicus very narrow, previous, partly covered. Base rounded.

Operculum not seen.

Animal unknown.

Diameter, 2mm.; height, 2½mm.

Hab. Near Manaia, Waimate Plains, North Island, where it was collected by Mr. R. Murdoch, of Wanganui.

Note.—This species is near *L. hedleyi*, mihi, but may be distinguished from it by the more elevated spire, the less rounded whorls, the more numerous and equidistant plaits, the very distinct spiral striation, and the horny band on the last whorl.

It is smaller than *L. cytora*, the spiral striæ are much closer, and in the latter the radiate plaits are provided with a hair at the point where they cross the spiral striæ.

Genus FLAMMULINA, Suter.

2. Flammulina (Calymna) pilsbryi, n. sp. Plate XIX., figs. 32–32*b*.

Shell minute, discoidal, umbilicated, horny with radiate brown streaks, which usually form zigzag lines at the periphery, flowing more or less together. The colour-markings are very variable, sometimes there are only a few broad brown streaks on the upper side. Silky, very thin and semi-transparent; very closely and finely radiately striated, the striæ slightly arcuated and directed backwards, about 20 per millimetre, reticulated in the interstices. Spire flat, embryonic whorl spirally striated. Whorls 4, the last rapidly increasing, slightly rounded, the last not descending in front; suture not deep. Periphery rounded. Aperture slightly oblique, rounded, very little excavated by the body-whorl; peristome acute, straight, columella lip not expanded, margins approximating. Umbilicus conical, almost one-third of the diameter. Base rounded.

Diameter, greatest $2\frac{3}{4}$mm., least $2\frac{1}{3}$mm.; height, 1mm.

Hab. North Island: Forty-mile Bush (H. S.), Howick (Captain T. Broun), Waimarama (A. Hamilton). South Island: Hooker Valley, Riccarton Bush (H. S.), Capleston (Cavell).

Note.—Named in honour of Mr. H. A. Pilsbry, of Philadelphia, who has done so much to clear up the systematic position of our *Helicidæ*.

This shell is near *F. costulata*, Hutt., but is considerably smaller, much broader umbilicated, more depressed, and somewhat narrower striated.

Jaw membranaceous, arcuate, vertically plaited, the cutting-margin slightly denticulated, ends rounded, somewhat tapering.

Radula tongue-shaped, formed of about 100 straight transverse rows of teeth, 7—4—1—4—7.

Central and lateral teeth tricuspid, marginals broader than long, tridentate, the median tooth being the largest.

It is the typical dentition of *Flammulina*, as several times described and figured by Professor Hutton and myself, and figures are therefore hardly wanted.

3. Pyrrha subincarnata, n. sp. Plate XIX., fig. 33, and Plate XX., figs. 34 and 35.

Shell (figs. 33–33*b*) globosely depressed, subperforated, shining at the base, from horny to flesh-colour, young specimens horny all over, adult ones either reddish round the apex and the mouth or the flesh-colour may extend over the whole shell; rather thin, transparent; somewhat irregularly, closely, radiately striated, about ten riblets per millimetre, the interstices with fine growth-lines, but not reticulated. Spire depressed, conoidal; embryonic whorl slightly radiately striated; periphery angulated. Whorls 5, slowly and regularly increasing, flatly rounded, suture impressed, last whorl not descending in front. Aperture transverse, oblique, ovately-lunar. Peristome straight, thickened with a pinkish callosity, which unites the very slightly converging margins on the body-whorl; columella lip strongly callous at its upper end, slightly reflexed. Umbilicus perfectly closed by the columellar callosity in adult specimens; young forms are narrowly perforated or subperforated. Base rounded.

Diameter, greatest $8\frac{1}{2}$mm., least $7\frac{1}{2}$mm.; height, $5\frac{1}{2}$mm.

Hab. North Island: Toko, near Stratford (R. Murdoch).

Note.—This pretty little shell somewhat resembles the larger *Fruticicola incarnata* of Europe. It is smaller and more depressed than *P. cressida*, Hutton, less fragile, differently coloured, not reticulated between the riblets, and has a callous peristome.

Jaw (fig. 34) slightly arcuate, with an indistinct median projection inferiorly, with numerous vertical indistinct folds, ends rounded.

Radula (fig. 35) tongue-shaped, transverse rows of teeth straight, formula 29—1—29, of which 8 may be taken as laterals. Rhachidian tooth longer than broad, tricuspid, median cusp reaching to the end of the base and its broad, short, cutting-point over the next row of teeth; side-cusps with a small cutting-point on each. Laterals similar to the central; the marginal teeth are tridentate, with the base short and broad, median tooth long and stout, the others small; outer marginals minute, tri- and bi-dentate.

4. **Phenacohelix pilula**, Reeve, var. **unicolor**, n. v.

Shell the same as in the species, but without any markings, uniformly light-brown. Dentition unknown.

Hab. North Island: Taupiri Mount (A. T. Urquhart).

5. **Allodiscus smithi**, n. sp. Plate XX., figs. 36–36*b*.

Shell minute, discoidal, perforated, silky, pale-yellow with zigzag streaks of rufous; thin, diaphanous, closely ribbed, about twenty riblets per millimetre; they are slightly arched and somewhat sinuate at the periphery; interstices beautifully reticulated. Spire flat; embryonic whorl spirally striated; periphery rounded. Whorls 4, the first three slowly, the last more rapidly increasing, rounded; suture impressed; periphery rounded. Aperture oblique, lunar; peristome straight, acute, margins distant, but little converging, columella margin slightly reflexed above. Umbilicus previous, very narrow. Base rounded.

To judge from the number of whorls, the specimens are not adult.

Diameter. greatest 2¼mm., least 2mm.; height, 1¼mm.

Hab. South Island: Mount Somers.

I owe my specimens to the kindness of Mr. W. W. Smith, of Ashburton, in whose honour the shell is named. This shell is very distinct from all the other known species of *Allodiscus.*

Jaw horse-shoe shaped, composed of about twenty-eight vertical narrow plaits, indenting both margins; a slight median projection inferiorly; ends blunt.

Radula tongue-shaped, the transverse straight rows of teeth consisting of 15—1—15, of which four are laterals. Central tooth rectangular, longer than broad, tricuspid, the median cusp with its short cutting-point extending to the posterior end of the base; side-cusps short, sinuated, one minute cutting-point on each. Laterals broader than the rhachidian, tricuspid, but the inner cusp rudimentary and without cutting-point, median cusp with a short cutting-point overlapping a little the next row of teeth, outer cusp and cutting-point somewhat larger than in the central tooth. Marginals much broader than long, with a tridentate cutting-point and sometimes a minute denticle on the outer side of the base.

6. Allodiscus rusticus, n. sp. Plate XX., figs. 37–37*b*.

Shell small, subdiscoidal, perforated, not shining, pale-horny, thin, semi-transparent, with close radiate ribs, about eight per millimetre, slightly sinuated and somewhat directed backwards; interstices with fine growth-lines, not reticulated. Spire almost flat, embryonic whorl smooth; periphery rounded. Whorls 5, slowly and regularly increasing, flatly rounded; suture impressed, last whorl not descending in front. Aperture oblique, lunar; peristome simple, acute, columella margin slowly ascending, callous, not reflexed. Umbilicus very narrow, open, previous. Base rounded.

Animal unknown.

Diameter, greatest 4½mm., least 4mm.; height, 2½mm.

Hab. North Island: Thames (T. F. Cheeseman).

Note.—This species is very near *A. godeti*, mihi, but the spire is a little more elevated, the riblets are sinuated, directed backwards and low, whilst almost straight, elevated in *A. godeti;* in the latter the interstices between the ribs are reticulated, and the embryonic whorl is spirally striated. *A. rusticus* has much flatter whorls, and the suture less impressed.

7. Charopa anguiculus, Reeve, var. **fuscosa,** n. v.

The specimens obtained are not adult, but have only 4 whorls. The colour is uniformly fuscous, but in all the other characters they agree with Reeve's and Hutton's (Trans.

N.Z. Inst., vol. xvi., p. 163) descriptions of *C. anguiculus*. The interstices between the riblets are more distinctly reticulated in the variety.

Hab. North Island: Hunua Range (Captain T. Broun).

Genus LAOMA, Gray.

8. Laoma ciliata, n. sp. Plate XXI., figs. 38, 38*a*.

Shell minute, pupiform, perforated, pale-horny without markings, not shining, very thin and fragile, diaphanous, with oblique somewhat distant thin ribs, about six per millimetre, which are produced into a tooth-shaped membrane below the suture; a second row of ciliæ is on the body-whorl round the base, but they are mostly rubbed off; interstices with fine growth-lines. Spire elevated, first cylindrical, then dome-shaped. Embryonic whorl smooth, blunt. Periphery angled and sinuated. Whorls 6, the first three very slowly, the others more rapidly increasing in size; they are slightly convex above, rather concave below, the last carinated near the aperture; suture not deep. Aperture transverse, squarish, the outer lip sinuated, the basal slightly arched, and the columella almost straight and vertical, but little expanded above. Mouth with two lamellæ; one slender, long lamella on the middle of the outer lip, and a similar one in the angle where the outer and basal lip meet. Umbilicus previous, very narrow, but open. Base almost flat.

Diameter, $1\frac{3}{4}$mm.; height, 2mm.

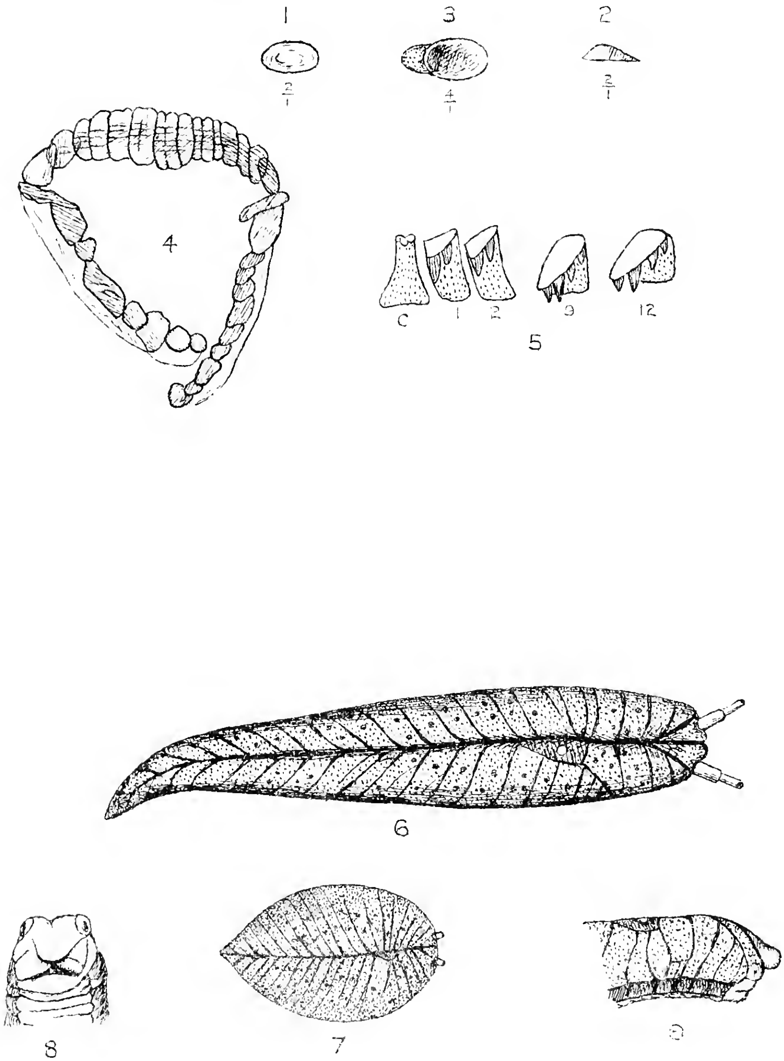
Hab. North Island: Near Wanganui, where it was discovered by our most enthusiastic conchologist, Mr. R. Murdoch.

Note.—This highly-interesting little shell is totally different from most of the other species of *Laoma s. str.*; in the peculiarities of the epidermis it is allied to *Phrixgnathus regularis*, *Æschrodomus*, and *Therasia celinde* and *tamora*.

Dentition very much the same as in *Laoma leimonias*. Formula of teeth 15—1—15.

9. Phrixgnathus murdochi, n. sp. Plate XXI., figs. 39–39*b*.

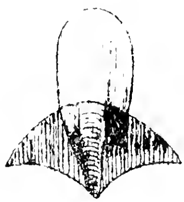
Shell depressed conoidal, broadly umbilicated, pale-horny, waxen, thin, diaphanous; finely and closely radiately striated, striæ crossed by microscopical spiral lines; spire somewhat dome-shaped, rather acute at the apex; embryonic whorl smooth; periphery carinated. Whorls 6, slowly and regularly increasing, flatly concave, strongly margined, margin projecting, tessellated with white and chestnut, the last not descending in front; suture superficial. Aperture squarish, diagonal; peristome straight, acute, outer lip sinuated, basal lip nearly straight, columella straight, slightly oblique, a little reflexed above. Umbilicus broad, 45 per cent. of the diameter,



Land Mollusca.

H.S. del.

F.H.T. lith.



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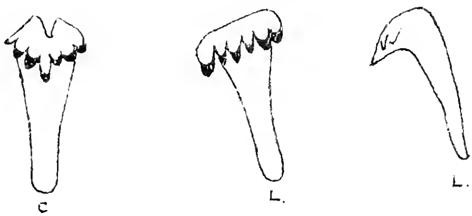

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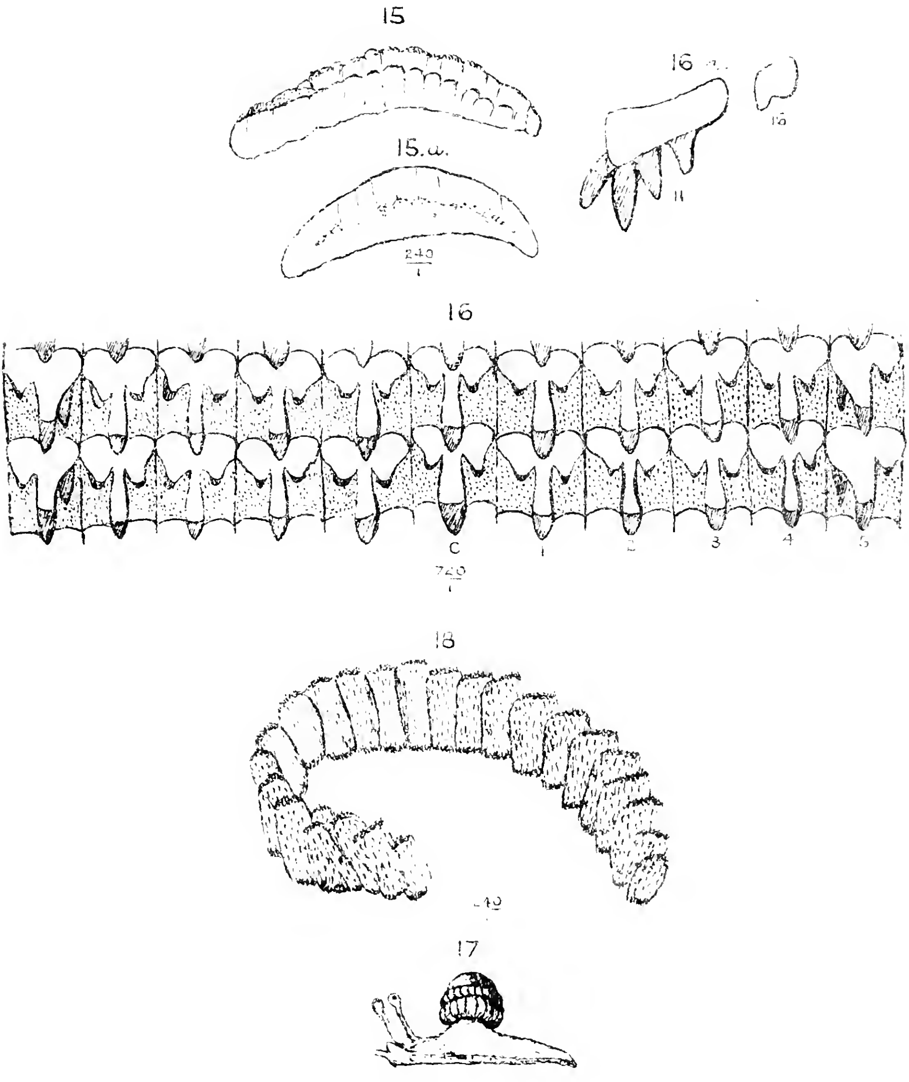
Land Mollusca.

H.S. del. F.H.T. lith.



Land Mollusca.

H.S. del.

F.H.T. lith.

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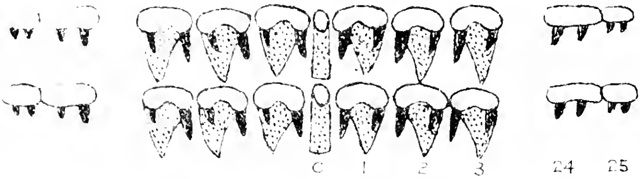

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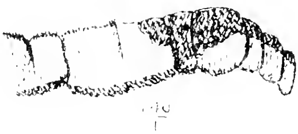

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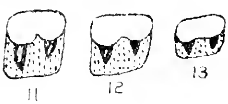

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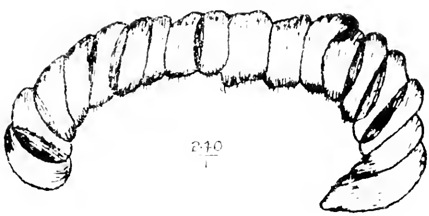

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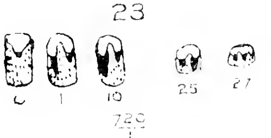

Land Mollusca.

F.H.T. lith.

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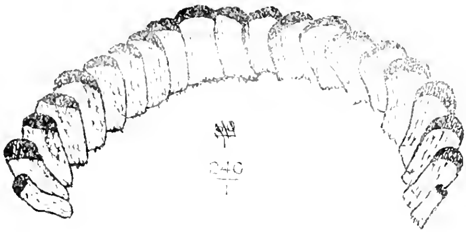

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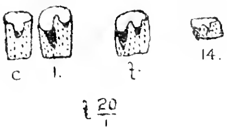

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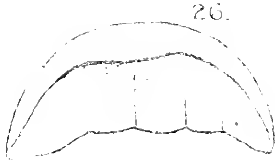

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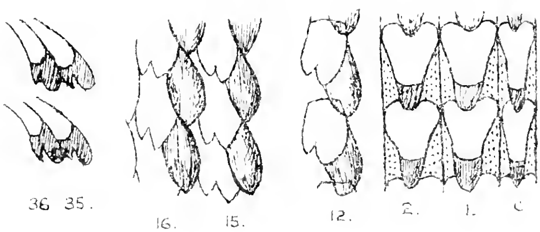

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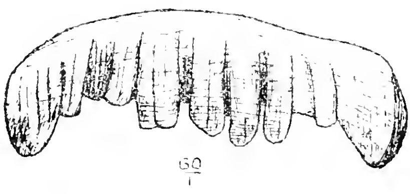
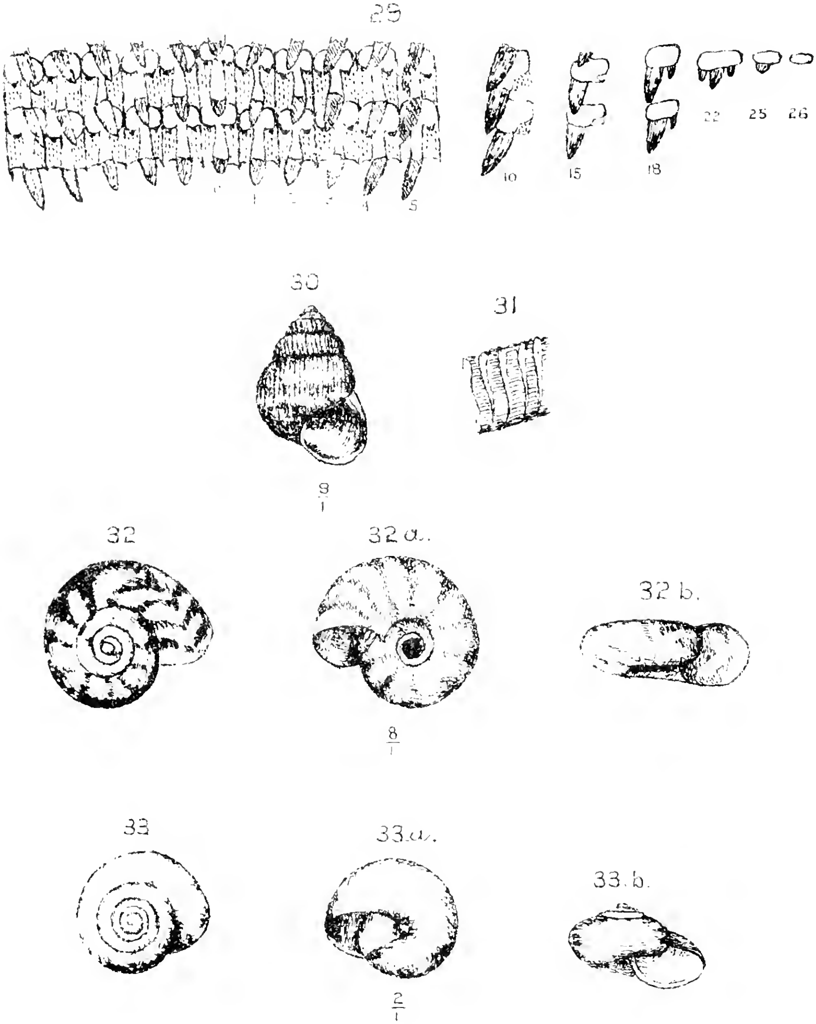


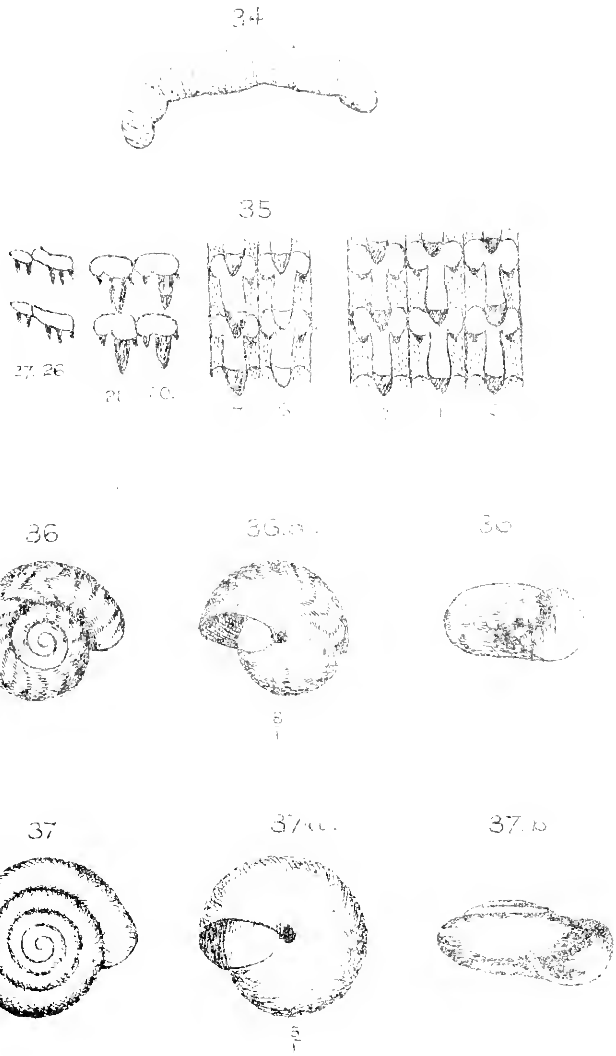
Land Mollusca.

H.S. del. F.H.T. lith.



Land Mollusca.

H.S del. F.H.T. lith.



Land Mollusca.

H.S. del.

F.H.T. lith.

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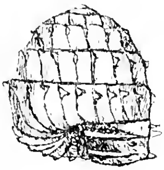

38. a.

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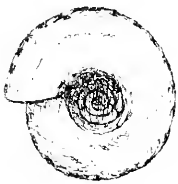
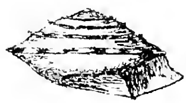
39. a.



39. b.



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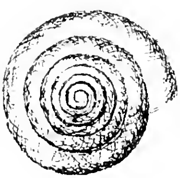
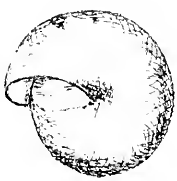


40. a.



40. b.

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Land Mollusca.

H.S. delt. *F.H.T. lith.*

perspective, limited by a carina which forms a sinus at the base of the columella. Base flattened.

Diameter, greatest $5\frac{1}{2}$mm., least $5\frac{1}{4}$mm.; height, $2\frac{1}{2}$mm.

Hab. North Island: Rawene, near Hokianga.

Mr. R. Murdoch, of Wanganui, has been the discoverer of this most beautiful shell, and I have much pleasure in uniting his name with the species.

Note.—Only one empty shell was found, and the animal therefore remains unknown for the present. Its nearest ally is *Ph. sciadium*, Pfeiffer.

10. Phrixgnathus cheesemani, n. sp. Plate XXI., figs. 40–40*b*.

Shell conoidly semi-globose, subperforated, pale-horny, sometimes variegated with light-brown zigzag bands, which are close together, and tessellating the base; rather shining, thin, diaphanous, with irregular close-set growth lines, which are very indistinctly reticulated above by spiral lines. Spire conoidal, apex rather blunt. Embryonic whorl minutely spirally striated. Periphery angled. Whorls 6, slowly and regularly increasing, slightly rounded; suture not much impressed. Aperture oblique, broadly lunar; peristome simple, straight, acute, outer lip somewhat arched, forming an angle with the basal lip, which forms one broad arch with the columella, the latter being somewhat reflexed. Umbilicus almost completely closed up by the columella reflection. Base spirally striated, flatly rounded.

Diameter, greatest $4\frac{1}{2}$mm., least $4\frac{1}{10}$mm.; height, 3mm.

Hab. North Island: Waitakerei, near Auckland.

Named in honour of Mr. T. F. Cheeseman, curator of the Auckland Museum, to whom I am indebted for the specimens.

Dentition.—That characteristic of *Phrixgnathus*. Formula of radula 40—1—40. Remarkable for the large number of teeth on a transverse row of the radula.

EXPLANATION OF PLATES XIV.–XXI.

PLATE XIV.

Figs. 1, 2. *Gundlachia*, sp., shell $\frac{2}{1}$, River Avon.
Fig. 3. „ „ shell with septum, River Avon.
Fig. 4. „ „ jaw, magnified.
Fig. 5. „ „ teeth of radula, magnified.
Fig. 6. *Athoracophorus papillatus*, animal extended, natural size.
Fig. 7. „ „ in repose, „
Fig. 8. „ head from below. (Spirit specimen.)
Fig. 9. „ anterior part, showing genital orifice. (Spirit specimen.)

PLATE XV.

Fig. 10. *Athoracophorus papillatus*, jaw.
Fig. 11. " teeth of radula. C = central, L = lateral, LS. = side view of lateral.
Fig. 12. *Endodonta varicosa*, Pf., mouth.
Fig. 13. " *timandra*, Hutt., mouth.
Fig. 14. " *jessica*, Hutt., mouth.

PLATE XVI.

Figs. 15, 15*a*. *Charopa caput-spinulæ*, Reeve, 2 jaws, $\frac{240}{1}$.
Figs. 16, 16*a*. " " teeth of radula, $\frac{720}{1}$.
Fig. 17. *Tesseraria novoseelandica*, Pf., animal magnified.
Fig. 18. *Laoma leimonias*, jaw, $\frac{240}{1}$.

PLATE XVII.

Fig. 19. *Laoma leimonias*, teeth of radula, $\frac{720}{1}$.
Fig. 20. *Phrixgnathus pumilus*, Hutt., part of jaw, $\frac{240}{1}$.
Fig. 21. " " " marginal teeth, $\frac{720}{1}$.
Fig. 22. " *microreticulatus*, jaw, $\frac{240}{1}$.
Fig. 23. " " teeth of radula, $\frac{720}{1}$.

PLATE XVIII.

Fig. 24. *Phrixgnathus allochroid.*, v. *latcumbil.*, jaw, $\frac{240}{1}$.
Fig. 25. " " " teeth of radula, $\frac{720}{1}$.
Fig. 26. *Ariophanta novaræ*, Pf., jaw, magnified.
Fig. 27. " " teeth of radula, magnified.
Fig. 28. *Otoconcha dimidiata*, Pf., jaw, $\frac{60}{1}$.

PLATE XIX.

Fig. 29. *Otoconcha dimidiata*, Pf., teeth of radula, $\frac{480}{1}$.
Fig. 30. *Lagochilus fasciatum*, n. sp., shell $\frac{8}{1}$.
Fig. 31. " " part of shell greatly magnified.
Fig. 32. *a*, *b*. *Flammulina pilsbryi*, n. sp., shell $\frac{5}{1}$.
Fig. 33. *a*, *b*. *Pyrrha subincarnata*, n. sp., shell $\frac{2}{1}$.

PLATE XX.

Fig. 34. *a*, *b*, *Pyrrha subincarnata*, n. sp., jaw, magnified.
Fig. 35. " " teeth of radula, magnified.
Fig. 36. *a*, *b*. *Allodiscus smithi*, n. sp., shell $\frac{8}{1}$.
Fig. 37. *a*, *b*. " *rusticus*, n. sp., shell $\frac{10}{1}$.

PLATE XXI.

Fig. 38. *Laoma ciliata*, n. sp., shell $\frac{10}{1}$.
Fig. 38*a*. " " part of shell greatly magnified.
Fig. 39. *a*, *b*. *Phrixgnathus murdochi*, n. sp., shell $\frac{4}{1}$.
Fig. 40. *a*, *b*. " *cheesemani*, n. sp., shell $\frac{5}{1}$.

Art. IX.—*Check-list of the New Zealand Land and Fresh-water Mollusca.*

By Henry Suter.

[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Very important changes in the classification of our Mollusca and valuation of species have taken place lately, and I think a check-list will be acceptable to New Zealand scientists. I give short references to descriptions and figures contained in works which are supposed to be easily accessible in New Zealand, and, to abbreviate as much as possible, the ciphers only are used for the following works:—

(I.) "Transactions of the New Zealand Institute."
(II.) Hutton: "Manual of New Zealand Mollusca," 1880.
(III.) "Proceedings of the Linnean Society of New South Wales."
(IV.) Tryon: "Manual of Conchology;" continued by H. A. Pilsbry. Second series.
(V.) "Voyage 'Erebus' and 'Terror,'" vol. ii.: Mollusca.

Class GASTEROPODA. Sub-class ANISOPLEURA.

Branch STREPTONEURA. Ord. AZYGOBRANCHIA.

Sub-ord. HOLOCHLAMYDA.

Fam. **Melaniidæ.**

Genus I. Melanopsis, Férussac pat., 1807.

1. *M. trifasciata*, Gray, 1843 (*zelandica*, Gould, 1848; *strangei*, Reeve, 1860; *ovata*, Dunker, 1862).
(II.), p. 78. (V.), pl. 1, fig. 18, 22. North and South Islands.

Fam. **Hydrobiidæ.**

Genus II. Potamopyrgus, Stimpson, 1865.

2. *P. cumingiana*, Fischer, sp. 1860 (*salleana*, Fischer, 1860; *crossei*, Frauenfeld, 1864).
(I.), vol. xiv., p. 144, pl. 1, figs. A, 1. (II.), p. 83. North and South Islands.

3. *P. corolla*, Gould, sp. 1848 (*badia*, Gould, 1851; *fischeri*, Dunker, 1862; *reevei*, Frauenfeld, 1862).
(I.), vol. xiv., p. 145, pl. 1, figs. B, 1, 2. (II.), pp. 82, 83. North and South Islands.

4. *P. antipodarum*, Gray, sp. 1843, em. (*antipodum*) (*zelandiæ*, Gray, 1843; *egena*, Gould, 1851; *gracilis*, Gould, 1852; *spelæa*, Frauenfeld, 1862).
   (I.), vol. xiv., p. 145, pl. 1, figs. C, 1. (II.), pp. 81, 82. North and South Islands.

5. *P. pupoides*, Hutton, 1882.
   (I.), vol. xiv., p. 146, pl. 1, fig. D. North and South Islands.

Sub-ord. PNEUMONOCHLAMYDA.

Fam. **Cyclophoridæ.**

Genus III. DIPLOMMATINA, Benson, 1849.

6. *D. chordata*, Pfeiffer, 1855.
   (II.), p. 38. North Island.

Sub-genus PAXILLUS, H. and A. Adams, 1851.

7. *D. peregrina*, Gould, sp. 1848.
   (II.), p. 38. North Island.

Genus IV. LAGOCHILUS, Blanford, 1864, em. (*Lagocheilus*).

8. *L. cytora*, Gray, sp., 1850.
   (II.), p. 37. North Island.

9. *L. lignarium*, Pfeiffer, sp. 1857.
   (II.), p. 37. North and South Islands.

10. *L. pannosum*, Hutton, sp. 1883.
   (I.), vol. xv., p. 140. South Island.

11. *L. calvum*, Hutton, sp. 1883.
   (I.), vol. xv., p. 140. South Island.

12. *L. pallidum*, Hutton, sp. 1883.
   (I.), vol. xvi., pp. 184, 210. North Island.

13. *L. hedleyi*, Suter, n. sp.
   (III.), vol. viii. (2). North Island.

14. *L. torquillum*, Suter, n. sp.
   (III.), vol. viii. (2). North Island.

15. *L. fasciatum*, Suter, n. sp.
   (I.), vol. xxvi., p. 132, pl. 19, figs. 30, 31. North Island.

Fam. **Cyclostomatidæ.**

Genus V. OMPHALOTROPIS, Pfeiffer, 1854.

16. *O. vestita*, Pfeiffer, 1854.
   (II.), p. 40. North Island.

Genus VI. REALIA, Gray, 1850.

17. *R. egea*, Gray, 1850.
   (II.), p. 39. North Island.
   Var. *albina*, Suter, 1892. North Island.

18. *R. turriculata*, Pfeiffer, 1855.
(II.), p. 39. North Island.

19. *R. carinella*, Pfeiffer, 1862.
(II.), p. 39. North Island.

20. *R. hochstetteri*, Pfeiffer, 1862.
(II.), p. 39. North Island.

Fam. **Hydrocenidæ.**

Genus VII. HYDROCENA, Parreyss, 1847.

21. *H. purchasi*, Pfeiffer, 1861.
(II.), p. 40. North and South Islands.

22. *H. antipodum*, Filhol, sp. 1885.
Campbell Island.

Branch EUTHYNEURA. Ord. PULMONATA.

Sub-ord. BASOMMATOPHORA.

Fam. **Latiidæ.**

Genus VIII. LATIA, Gray, 1850.

23. *L. neritoides*, Gray, 1850.
(II.), p. 29. North Island.
(*a.*) Var. *lateralis*, Gould, 1852.
(II.), p. 29. North Island.
(*b.*) Var. *petitiana*, Fischer, 1856. North Island.
(*c.*) Var. *gassiesiana*, Fischer, 1856. North Island.

Fam. **Limnæidæ.**

Genus IX. GUNDLACHIA, Pfeiffer, 1849.

24. *G.* sp. [*Ancylus woodsi*, Johnston (juv.).] Introduced (?) South Island.

Genus X. LIMNÆA, Lamarck, 1792.

25. *L. tomentosa*, Pfeiffer, sp. 1855.
(II.), p. 13. North Island.

26. *L. leptosoma*, Hutton, 1885.
(I.), vol. xvii., p. 55, pl. 12, fig. 3. North Island.

27. *L. tenella*, Hutton, 1885.
(I.), vol. xvii., p. 55, pl. 12, fig. 4. South Island.

28. *L. pusilla*, Hutton, 1885, em. (*pucilla*).
(I.), vol. xvii., p. 56, pl. 12, fig. 5. North Island.

29. *L tenisoni*, Clessin, sp. 1886, em. (*tennissoni*).
Var. *alfredi*, Suter, 1890.
(I.), vol. xxii., p. 229, pl. 15, figs. 17, 17*a*. South Island.

Genus XI. Amphipeplea, Nilsson, 1822.

30. *A. ampulla*, Hutton, 1885.
(I.), vol. xvii., p. 55, pl. 12, fig. 2. North and South Islands.
Var. *globosa*, Suter, 1891.
(I.), vol. xxiii., p. 93, pl. 18, figs. 12–12*c*. North and South Islands.

31. *A. arguta*, Hutton, 1885.
(I.), vol. xvii., p. 54, pl. 12, fig. 1. North and South Islands.

Genus XII. Planorbis, Guettard, 1756.

32. *P. corinna*, Gray, 1850.
(I.), vol. xvii., pl. 12, fig. 6. (II.), p. 32. North and South Islands.

Genus XIII. Bullinus, Adanson, 1757, em. (*Bulinus*).

33. *B. variabilis*, Gray, sp., 1843 (*guyonensis*, Tenison-Woods, 1879; *novæzelandiæ*, Sowerby, 1873; *novæseelandiæ*, Clessin, 1886; *gibbosus*, Hutton, 1882, not Gould.)
(I.), vol. xiv., pl. 4, fig. v.; vol. xvii., p. 56, pl. 12, fig. 7. North and South Islands.

34. *B. tabulatus*, Gould, sp. 1848 (*mœsta*, H. Adams, 1861; *coromandelicus*, Dunker, 1862; *hochstetteri*, Dunker, 1862; *lirata*, Tenison-Woods, 1879).
(I.), vol. xiv., p. 156; vol. xvii., p. 57. (III.), vol. iii., pl. 13, fig. 6. North and South Islands.

35. *B. antipodeus*, Sowerby, sp. 1873.
(I.), vol. xvii., p. 56. North and South Islands.

Sub-ord. STYLOMMATOPHORA.

A. MESOMMATOPHORA.

Fam. **Athoracophoridæ.**

Genus XIV. Athoracophorus, Gould, 1852.

36. *A. bitentaculatus*, Quoy and Gaimard, sp. 1832 (*antipodarum*, Gray, 1853; *dubius*, Cockerell, 1891).
(II.), p. 27. North and South Islands.

Sub-genus Konophora, Hutton, 1879.

37. *A. marmoreus*, Hutton, sp. 1879 (*marmoratus*, Von Martens, 1889).
(I.), vol. xi., p. 332; vol. xiv., p. 158, pl. 5, fig. 1. South Island.

Sub-genus Pseudaneitea, Cockerell, 1891.

38. *A. papillatus*, Hutton, sp. 1879 (*verrucosus*, Von Martens, 1889).

(I.), vol. xi., p. 332. (II.), p. 27.
(*a.*) Var. *nigricans*, Von Martens, 1889.
(*b.*) Var. *fasciatus*, Von Martens, 1889, em. (*fuscatus*).
North and South Islands, Chatham and Auckland Islands.

B. PLEUROMMATOPHORA.

Fam. **Helicteridæ.**

Genus XV. TORNATELLINA, Beck, 1837.

39. *T. novoseelandica*, Pfeiffer, sp. 1854.
(II.), p. 14. North Island.

Fam. **Bulimulidæ.**

Genus XVI. PLACOSTYLUS, Beck, 1837.

40. *P. bovinus*, Bruguière, sp. 1792 (*shongii*, Lesson, 1830).
(II.), p. 14.
(*a.*) Var. *novoseelandicus*, Pfeiffer, 1862.
(II.), p. 14.
(*b.*) Var. *candidus*, Crosse, 1864.
(I.), vol. xvi., p. 190.
North Island.

Fam. **Helicidæ.**

Group HAPLOGONA.

Genus XVII. FLAMMULINA (Von Martens, 1873), Suter.

Sec. I. Flammulina, *Von Martens, 1873, s. str.* (= Amphidoxa, *Hutton*, not *Albers*).

41. *F. zebra*, Le Guillou, sp. 1842 (*phlogophora*, Pfeiffer, 1850; *flammigera*, Pfeiffer, 1854; *multilimbata*, Hombron and Jacquinot, 1854).
(II.), pp. 12, 22. (IV.), vol. i. (2), p. 128, pl. 26, fig. 10. North and South Islands, Auckland Islands.

42. *F. chiron*, Gray, sp. 1850.
(II.), p. 23. (IV)., vol. i. (2), p. 129, pl. 26, fig. 19. North Island.

43. *F. compressivoluta*, Reeve, sp. 1852 (*omega*, Pfeiffer, 1854).
(II.), p. 10. (IV.), vol. i. (2), p. 128, pl. 26, fig. 28. North Island.

44. *F. crebriflammis*, Pfeiffer, sp. 1854.
(II.), p. 24. (IV.), vol. i. (2), p. 130, pl. 26, fig. 9. North and South Islands.

45. *F. corneo-fulva*, Pfeiffer, sp. 1862.
(II.), p. 12. (I.), vol. xxiv., pl. 20, figs. 5–5*b*. North and South Islands.

46. *F. cornea*, Hutton, sp. 1883.
(I.), vol. xv., p. 136. (IV.), vol. viii. (2), p. 75, pl. 22, figs. 64–66. North Island.

47. *F. jacquenetta*, Hutton, sp. 1883.
(I.), vol. xvi., p. 179. (IV.), vol. viii. (2), p. 76, pl. 22, figs. 70–72. South Island.

48. *F. perdita*, Hutton, sp. 1883.
(I.), vol. xvi., p. 179. (IV.), vol. viii. (2), p. 76, pl. 22, figs. 73–75. North and South Islands.

Subsec. Calymna, *Hutton, 1884.*

49. *F. costulata*, Hutton, sp. 1883.
(I.), vol. xv., p. 136. (IV.), vol. viii. (2), p. 73, pl. 3, figs. 20–22. North Island.

50. *F. lavinia*, Hutton, sp. 1883.
(I.), vol. xvi., p. 180. (IV.), vol. viii. (2), p. 74. North Island.

51. *F. feredayi*, Suter, sp. 1891.
(I.), vol. xxiii., p. 91, pl. 18, figs. 10–10*b*. North Island.
Var. *glacialis*, Suter, 1891.
(I.), vol. xxiii., p. 92. South Island.

52. *F. olivacea*, Suter, sp. 1892.
(I.), vol. xxiv., p. 290, pl. 21, figs. 13–13*b*. North Island.

53. *F. pilsbryi*, Suter, n. sp.
(I.), vol. xxvi., p. 133, pl. 19, figs. 32–32*b*. North and South Islands.

Sec. II. Gerontia, *Hutton, 1883.*

54. *F. pantherina*, Hutton, sp. 1883.
(I.), vol. xv., p. 135. (IV.), vol. ix. (2), pl. 3, figs. 1–3. South Island.

55. *F. cordelia*, Hutton, sp. 1883.
(I.), vol. xvi., p. 178. (IV.), vol. viii. (2), p. 66, pl. 22, figs. 34–36. North Island.

Sec. III. Phacussa, *Hutton, 1883.*

56. *F. hypopolia*, Pfeiffer, sp. 1854.
(II.), p. 6. (IV.), vol. ii. (2), pl. 54, fig. 15. North and South Islands.

57. *F. helmsi*, Hutton, sp. 1883.
(I.), vol. xv., p. 137. South Island.
Var. *maculata*, Hutton, 1884.
(I.), vol. xvi., p. 205. South Island.

58 *F. fulminata*, Hutton, sp. 1883.
(I.), vol. xv., p. 138. Stewart Island.

Sec. IV. Therasia, *Hutton, 1883.*

59. *F. celinde*, Gray, sp. 1850.
(II.), p. 6. (IV.), vol. ii. (2), pl. 62, fig. 41. North Island.

60. *F. ophelia*, Pfeiffer, sp. 1855.
(II.), p. 18. (IV.), vol. ii. (2), pl. 62, fig. 42. North and South Islands.

61. *F. decidua*, Pfeiffer, sp. 1857.
(II.), p. 6. (IV.), vol. viii. (2), pl. 22, figs. 52–54. North and South Islands.

62. *F. valeria*, Hutton, sp. 1883.
(I.), vol. xiv., p. 151. (IV.), vol. viii. (2), pl. 22, figs. 46–48. South Island.

63. *F. tamora*, Hutton, sp. 1883.
(I.), vol. xvi., p. 182. (IV.), vol. viii. (2), pl. 22, figs. 49–51. North Island.

64. *F. thaisa*, Hutton, sp. 1883.
(I.), vol. xvi., p. 182. (IV.), vol. ix. (2), pl. 3, figs. 14–16. North and South Islands.

65. *F. traversi*, E. A. Smith, sp. 1884.
(IV.), vol. ii. (2), p. 214, pl. 63, figs. 68–70; vol. viii. (2), p. 71. North and South Islands.

Sec. V. Carthæa, *Hutton, 1884.*

66. *F. kivi*, Gray, sp. 1843 (*irradiata*, Gould, 1848; *radiaria*, Pfeiffer, 1855).
(II.), p. 20. (IV.), vol. iii. (2), p. 37, pl. 21, figs. 8–10. North Island.

Sec. VI. Pyrrha, *Hutton, 1884.*

67. *F. cressida*, Hutton, sp. 1883.
(I.), vol. xvi., p. 178. (IV.), vol. ix. (2), pl. 3, figs. 17–19. North and South Islands.

68. *F. subincarnata*, Suter, n. sp.
(I.), vol. xxvi., p. 133, pl. 19, fig. 33; pl. 20, figs. 34, 35. North Island.

Sec. VII. Phenacohelix, *Suter, 1892* (Fruticicola, *Hutton, 1884, not Held.*).

69. *F. pilula*, Reeve, sp. 1852 (*iota*, Pfeiffer, 1854).
(II.), p. 6. (IV.), vol. ii. (2), pl. 62, fig. 43. North and South Islands.
Var. *unicolor*, Suter, n. var.
(I.), vol. xxvi., p. 134. North Island.

70. *F. granum*, Pfeiffer, sp. 1857.
(II.), p. 20. North Island.

71. *F. chordata*, Pfeiffer, sp. 1862.
(II.), p. 5. North Island.

Sec. VIII. Allodiscus, *Pilsbry, 1892* (Psyra, *Hutton, 1884, not Stal, 1876*).

72. *F. dimorpha*, Pfeiffer, sp. 1854.
(II.), p. 6. (IV.), vol. ii. (2), pl. 62, fig. 39. North Island.

73. *F. tullia*, Gray, sp. 1850.
(II.), p. 5. (IV.), vol. ii. (2), pl. 62, fig. 40. North and South Islands.

74. *F. venulata*, Pfeiffer, sp. 1857.
(II.), p. 10. South Island.

75. F. *cassandra*, Hutton, sp. 1883.
(I.), vol. xvi., p. 181. (IV.), vol. viii. (2), pl. 22, figs. 37–39. North Island.

76. *F. planulata*, Hutton, sp. 1883.
(I.), vol. xvi., p. 181. (IV.), vol. ix. (2), pl. 3, figs. 4–6. North and South Islands.

77. *F. adriana*, Hutton, sp. 1883.
(I.), vol. xvi., p. 175. North and South Islands.

78. *F. miranda*, Hutton, sp. 1883.
(I.), vol. xvi., p. 180. (IV.), vol. viii. (2), pl. 22, figs. 40–42. North and South Islands.

79. *F. godeti*, Suter, sp. 1891.
(I.), vol. xxiii., p. 90, pl. 17, figs. 8–8*b*. South Island.

80. *F. wairoaensis*, Suter, n. sp.
(III.), vol. viii. (2). South Island.

81. *F. urquharti*, Suter, n. sp.
(III.), vol viii. (2). North Island.

82. *F. smithi*, Suter, n. sp.
(I.), vol. xxvi., p. 134, pl. 20, figs. 36–36*b*. South Island.

83. *F. rusticus*, Suter, n. sp.
(I.), vol. xxvi., p. 135, pl. 20, figs. 37–37*b*. North Island.

Sec. IX. Suteria, *Pilsbry, 1892* (Charopa, *Hutton, not Albers;* Patulopsis, *Suter, not Strebel*).

84. *F. ide*, Gray, sp. 1850.
(II.), p. 9. (IV.), vol. ii. (2), pl. 62, figs. 32, 34. North and South Islands.

Sec. X. Thalassohelix, *Pilsbry, 1892* (Thalassia, *Hutton (? and of Albers); not* Thalassia, *Chevrolat, 1834, Coleopt.*).

85. *F. zelandiæ*, Gray, sp. 1843.
(II.), p. 19. (IV.), vol. ii. (2), p. 214, pl. 63, figs. 63, 64. North Island.

Var. *antipoda*, Hombron and Jacquinot, 1854.
(II.), p. 19. (IV.), vol. ii. (2), p. 214, pl. 63, figs. 65–67. South Island, Chatham and Auckland Islands.

86. *F. aucklandica*, Le Guillou, sp., 1842, em. (*auklandica*).
(II.), p. 19. Auckland Islands.

87. *F. ziczac*, Gould, sp. 1848 (*portia*, Gray, 1850; *kappa*, Pfeiffer, 1854; *collyrula*, Reeve, 1852).
(II.), pp. 7, 10. (IV.), vol. ii. (2), pl. 62, figs. 35–37; pl. 63, figs. 60–62. North Island.

88. *F. igniflua*, Reeve, sp. 1852 (*lambda*, Pfeiffer, 1854; *obnubila*, Reeve, 1852; *sigma*, Pfeiffer, MS.).
(II.), pp. 9, 11. (IV.), vol. i. (2), pl. 26, fig. 25. North and South Islands.

89. *F. propinqua*, Hutton, sp. 1883.
(I.), vol. xv., p. 137. (IV.), vol. viii. (2), pl. 22, figs. 55–57. North and South Islands.

Genus XVIII. ENDODONTA (Albers, 1850), Suter.

Sec. I. Endodonta, *Albers, 1850, s. str.* (+ Pitys, *Pease, not Beck*).

(*a.*) *Subsec.* Thaumatodon, *Pilsbry, 1893.*

90. *E. varicosa*, Pfeiffer, sp. 1854.
(I.), vol. xxvi., p. 128, pl. 15, fig. 12. (II.), p. 7. (IV.), vol. iii. (2), pl. 3, fig. 10. South Island.

91. *E. timandra*, Hutton, sp. 1883 (*varicosa*, Suter, not Pfeiffer).
(I.), vol. xvi., p. 175; and vol. xxvi., p. 128, pl. 15, fig. 13. (IV.), vol. viii. (2), pl. 24, figs. 21–23. North Island.

92. *E. jessica*, Hutton, sp. 1883.
(I.), vol. xvi., p. 174; and vol. xxvi., p. 128, pl. 15, fig. 14. (IV.), vol. viii. (2), pl. 24, figs. 24–27. South Island.

93. *E. cryptobidens*, Suter, 1891.
(I.), vol. xxiii., p. 89; pl. 17, figs. 7–7*c*. South Island.

(*b.*) *Subsec.* Ptychodon, *Ancey, 1888* (Strobila, *Hutton, 1883, not Morse;* Huttonella, *Suter, 1890, not Pfeiffer;* Maoriana, *Suter, 1891*).

94. *E. leioda*, Hutton, sp. 1883.
(I.), vol. xv., p. 135. (IV.), vol. viii. (2), pl. 24, figs. 32–35. South Island.

95. *E. pseudoleioda*, Suter, sp. 1890.
(I.), vol. xxii., p. 221, pl. 14, figs. 1–1*c*. North Island.

96. *E. wairarapa*, Suter, sp. 1890.
(I.), vol. xxii., p. 222, pl. 14, figs. 2–2*c*. North Island.

97. *E. hectori*, Suter, sp. 1890 (*magdalenæ*, Ancey, 1891).
(I.), vol. xxii., p. 222, pl. 14, figs. 3–3*c*. North Island.

98. *E. microundulata*, Suter, sp. 1890.
(I.), vol. xxii., p. 223, pl. 14, figs. 4–4*c*. North and South Islands.

99. *E. aorangi*, Suter, sp. 1890.
(I.), vol. xxii., p. 223, pl. 14, figs. 5–5*c*. South Island.

100. *E. hunuaensis*, Suter, n. sp.
(III.), vol. viii. (2). North Island.

Sec. II. Charopa, *Albers, 1860* (Patula, *auct., not Held.;* Simplicaria, *Mouss., MS.*).

101. *E. coma*, Gray, sp. 1843.
(II.), p. 8. (IV.), vol. ix. (2), pl. 4, figs. 1–3. North and South Islands.
Var. *globosa*, Suter, 1892 (*beta*, Pfeiffer, 1853).
(I.), vol. xxiv., p. 273; and vol. XXVI., p. 128. North Island.

102. *E. egesta*, Gray, sp. 1850.
(II.), p. 8. (IV.), vol. iii. (2), pl. 3, fig. 15. North Island.

103. *E. buccinella*, Reeve, sp. 1852 (*gamma*, Pfeiffer, 1854; *sylvia*, Hutton, 1883; *tau*, Suter, not Pfeiffer, 1862).
(II.), p. 8. (I.), vol. xvi., p. 175. (IV.), vol. iii. (2), pl. 3, fig. 11. North and South Islands.
Var. *serpentinula*, Suter, 1891.
(I.), vol. xxiii., p. 87, pl. 16, figs. 5–5*b*. South Island.

104. *E. anguiculus*, Reeve, sp. 1852 (*theta*, Pfeiffer, MS.).
(II.), p. 9. (I.), vol. xvi., p. 163. (IV.), vol. iii. (2), pl. 3. fig. 13. North and South Islands.
(*a*.) Var. *montivaga*, Suter, nov. var. (*buccinella*, Hutton, Suter, not Reeve).
(III.), vol. viii. (2). North and South Islands.
(*b*.) Var. *fuscosa*, Suter, n. var.
(I.), vol. xxvi., p. 135. North Island.

105. *E. corniculum*, Reeve, sp. 1852 (*eta*, Pfeiffer, 1854).
(II.), p. 9. (IV.), vol. iii. (2), pl. 3, fig. 12. North and South Islands.
Var. *maculata*, Suter, 1891.
(I.), vol. xxiii., p. 89. North and South Islands.

106. *E. infecta*, Reeve, sp. 1852 (*zeta*, Pfeiffer, 1854).
(II.), p. 9. (IV.), vol. iii. (2), pl. 3, fig. 14. North and South Islands.

(*a.*) Var. *irregularis*, Suter, 1890.
(I.), vol. xxii., p. 224, pl. 14, figs. 6–6*b*. North Island.
(*b.*) Var. *alpestris*, Suter, 1891.
(I.), vol. xxiii., p. 88. South Island.

107. *E. biconcava*, Pfeiffer, sp. 1854.
(II.), p. 11. (IV.), vol. i. (2), pl. 24, fig. 75. North Island.

108. *E. caput-spinulæ*, Reeve, sp. 1852 (*epsilon*, Pfeiffer, 1854).
(II.), p. 23. (IV.), vol. iii. (2), pl. 20, fig. 53. North and South Islands.

109. *E. tau*, Pfeiffer, sp. 1862 (*sylvia*, Suter, not Hutton; *mutabilis*, Suter, 1891).
(II.), p. 8. (I.), vol. xxiii., p. 84, pl. 16, figs. 2–2*b*. South Island.

110. *E. modicella*, Férussac, var. *vicinalis*, Mousson, 1873.
(IV.), vol. iii. (2), p. 39. Kermadec Islands.

111. *E. bianca*, Hutton, sp. 1883.
(I.), vol. xvi., p. 175. (IV.), vol. viii. (2), pl. 37, figs. 41, 42. North and South Islands.
Var. *montana*, Suter, 1890.
(I.), vol. xxiii., p. 88. South Island.

112. *E. tapirina*, Hutton, sp. 1883 (*coma*, Hutton, not Gray).
(I.), vol. xv., p. 134. (IV.), vol. ix. (2), pl. 6, figs. 63–65. North and South Islands.

113. *E. lucetta*, Hutton, sp. 1884 (*stokesi*, Smith, 1884).
(I.), vol. xvi., p. 162. (IV.), vol. iii. (2), pl. 3, figs. 7–9; pl. 22, figs. 48–50. North and South Islands.

114. *E. variecostata*, Suter, sp. 1890.
(I.), vol. xxii., p. 225, pl. 14, figs. 8–8*c*. North Island.

115. *E. colensoi*, Suter, sp. 1890.
(I.), vol. xxii., p. 225, pl. 14, figs. 7–7*b*. North Island.

116. *E. subantialba*, Suter, sp. 1890.
(I.), vol. xxii., p. 226, pl. 15, figs. 10–10*b*. North Island.

117. *E. moussoni*, Suter, sp. 1890.
(I.), vol. xxii., p. 227, pl. 15, figs. 12–12*b*. North Island.

118. *E. huttoni*, Suter, sp. 1890.
(I.), vol. xxii., p. 226, pl. 15, figs. 11–11*b*. North Island.

119. *E. sterkiana*, Suter, sp. 1891.
(I.), vol. xxiii., p. 85, pl. 16, figs. 3–3*b*. South Island.
Var. *major*, Suter, 1892.
(I.), vol. xxiv., p. 295. South Island.
Var. *reeftonensis*, Suter, 1892.
(I.), vol. xxiv., p. 294. South Island.

120. *E. brouni*, Suter, sp. 1891.
(I.), vol. xxiii., p. 86, pl. 16, figs. 4–4*b*. South Island.

121. *E. eremita*, Suter, sp. 1891.
(I.), vol. xxiii., p. 87, pl. 17, figs. 6–6*b*. South Island.

122. *E. pseudocoma*, Suter, n. sp.
(III.), vol. viii. (2). South Island.

123. *E. segregata*, Suter, n. sp.
(III.), vol. viii. (2). North Island.

Subsec. I. Phenacharopa, *Pilsbry, 1893* (Pupa, *auct., not Draparnaud;* Tesseraria, *Böttger, 1881, not Haeckel, 1879 or 1880*).

124. *E. novoseelandica*, Pfeiffer, sp. 1854.
(II.), p. 15. (IV.), vol. ix. (2), pl. 6, fig. 60. North Island.

Subsec. II. Æschrodomus, *Pilsbry, 1892* (Thera, *Hutton, 1884; not Stephens, 1831*).

125. *E. stipulata*, Reeve, sp. 1852 (*alpha*, Pfeiffer, 1854).
(II.), p. 18. (IV.), vol. iii. (2), pl. 19, fig. 1.; vol. ix. (2), pl. 6, figs. 67, 68. North and South Islands.

126. *E. barbatula*, Reeve, sp. 1852 (*beta*, Pfeiffer, 1854).
(II.), p. 18. (IV.), vol. iii. (2), pl. 19, fig. 2. South Island.

Group Polyplacognatha.

Genus XIX. Laoma (Gray, 1850), Pilsbry, 1892.

Sec. I. Laoma (*Gray, 1850, s. str.* (Endodonta, *Hutton, not Albers*).

127. *L. leimonias*, Gray, 1850.
(II.), p. 21. (IV.), vol. iii. (2), pl. 13, fig. 55. North Island.

128. *L. pœcilosticta*, Pfeiffer, sp. 1854, em. (*pœcilocostata*).
(II.), p. 17. (IV.), vol. iii. (2), pl. 13, fig. 56. North Island.

129. *L. marina*, Hutton, sp. 1883 (*nerissa*, Hutton, 1883—juv.).
(I.), vol. xvi., p. 176; vol. xxiv., pp. 283, 284. (IV.), vol. viii. (2), pl. 23, figs. 17–20. North and South Islands.

130. *L. pirongiaensis*, Suter, n. sp.
(III.), vol. viii. (2). North Island.

131. *L. ciliata*, Suter, n. sp.
(I.), vol. xxvi., p. 136, pl. 21, figs. 38, 38*a*. North Island.

Sec. II. Phrixgnathus, *Hutton, 1883.*

132. *L. mariæ*, Gray, sp. 1843 (*umbraculum*, Pfeiffer, 1854).
(II.), p. 25. (IV.), vol. iii. (2), pl. 21, fig. 11. (V.), vol. ii., pl. 1, fig. 2. North Island.

133. *L. erigone*, Gray, sp. 1850 (*heldiana*, Pfeiffer, 1854).
(II.), pp. 17, 18. (IV.), vol. iii. (2), pl. 21, fig. 13. North Island.

134. *L. glabriuscula*, Pfeiffer, sp. 1853.
(II.), p. 23. (IV.), vol. iii. (2), pl. 21, fig. 14. North Island.

135.?*L. regularis*, Pfeiffer, sp. 1855.
(II.), p. 17. (IV.), vol. iii. (2), pl. 21, fig. 12. North and South Islands.

136. *L. sciadium*, Pfeiffer, sp. 1857.
(II.), p. 19. North Island.

137. *L. fatua*, Pfeiffer, sp. 1857.
(II.), p. 19. North Island.

138. *L. conella*, Pfeiffer, sp. 1862.
(II.), p. 17. (IV.), vol. viii. (2), pl. 23, fig. 16. North Island.

139. *L. campbellica*, Filhol, sp. 1880.
(I.), vol. xvi., p. 195. Campbell Island.

140. *L. ariel*, Hutton, sp. 1883.
(I.), vol. xvi., p. 177. North Island.

141. *L. marginata*, Hutton, sp. 1883.
(I.), vol. xv., p. 137. (IV.), vol. viii. (2), pl. 23, figs. 94–96. South Island.

142. *L. celia*, Hutton, sp. 1883.
(I.), vol. xvi., p. 176. (IV.), vol. ix. (2), pl. 1, fig. 10. North and South Islands.

143. *L. pumila*, Hutton, sp. 1883.
(I.), vol. xv., p. 134. (IV.), vol. viii. (2), pl. 23, figs. 97–99. North and South Islands.

144. *L. phrynia*, Hutton, sp. 1883.
(I.), vol. xvi., p. 177. (IV.), vol. viii. (2), pl. 23, figs. 88–90. North Island.

145. *L. titania*, Hutton, sp. 1883.
(I.), vol. xvi., p. 177. (IV.), vol. viii. (2), pl. 23, figs. 82–84. South Island.

146. *L. haasti*, Hutton, sp. 1883.
(I.), vol. xvi., p. 177. (IV.), vol. viii. (2), pl. 23, figs. 91–93. South Island.

147. *L. microreticulata*, Suter, sp. 1890.
(I.), vol. xxii., p. 227, pl. 15, figs. 13–13*b*. North and South Islands.

148. *L. raricostata*, Suter, sp. 1890.
(I.), vol. xxii., p. 226, pl. 14, figs. 9–9*b*. North and South Islands.

149. *L. allochroida*, Suter, sp. 1890.
(I.), vol. xxii., p. 228, pl. 15, figs. 14–14*b*. North and South Islands.
(*a.*) Var. *sericata*, Suter, 1890.
(I.), vol. xxii., p. 228, pl. 15, figs. 15–15*b*. North Island.
(*b.*) Var. *lateumbilicata*, Suter, 1890.
(I.), vol. xxii., p. 228, pl. 15, figs. 16–16*b*. North Island.

150. *L. acanthinulopsis*, Suter, sp. 1891.
(I.), vol. xxiii., p. 92, pl. 18, figs. 11–11*b*. South Island.

151. *L. transitans*, Suter, sp. 1892.
(I.), vol. xxiv., p. 297, pl. 22, figs. 40–40*b*. North Island.

152. *L. murdochi*, Suter, n. sp.
(I.), vol. xxvi., p. 136, pl. 21, figs. 39–39*b*. North Island.

153. *L. cheesemani*, Suter, n. sp.
(I.), vol. xxvi., p. 137, pl. 21, figs. 40–40*b*. North Island.

Fam. **Zonitidæ.**

Genus XX. Helicarion, Férussac fil., 1822.

154. *H. ultimus*, Mousson, sp. 1873 (*kermadecensis*, Smith, 1873).
(I.), vol. xvi., p. 204. (IV.), vol. i. (2), p. 158, pl. 35, figs. 9, 10. North Island, Kermadec Islands.

Genus XXI. Otoconcha, Hutton, 1884.

155. *O. dimidiata*, Pfeiffer, sp. 1854.
(II.), p. 12. (IV.), vol. i. (2), pl. 42, fig. 22. North and South Islands.

Genus XXII. Ariophanta, Des Moulins, 1829 (Nanina, *Gray, 1834, not Risso, 1826*).

156. *A. novaræ*, Pfeiffer, sp. 1862.
(II.), p. 13. North Island.

Genus XXIII. Microcystis, Beck, 1837.

157. *M. kermadeci*, Pfeiffer, sp. 1857, em. (*kermandeci*). Kermadec Islands.

Genus XXIV. TROCHONANINA, Mousson, 1869.

158. *T. exposita*, Mousson, 1873.
(IV.), vol. ii. (2), p. 47, pl. 23, fig. 60. Kermadec Islands.

Fam. **Rhytididæ.**

(Proposed by Mr. H. A. Pilsbry to include the genera *Rhytida*, *Paryphanta*, *Schizoglossa*, *Rhenea*, *Diplomphalus* (s. str.), and *Natalina*.)

Genus XXV. RHYTIDA, Albers, 1860.

159. *R. greenwoodi*, Gray, sp. 1850 (*gunni*, Gray, MS.).
(II.), p. 16. (IV.), vol. i. (2), pl. 24, fig. 74. North Island.

160. *R. dunniæ*, Gray, sp. 1840.
(II.), p. 16. (IV.), vol. i. (2), pl. 24, fig. 73. (V.), pl. i., fig. 7. North Island.
Var. *beta*, Pfeiffer, 1853.
(IV.), vol. i. (2), p. 126. North Island.

161. *R. patula*, Hutton, 1883.
(I.), vol. xv., p. 138. South Island.

162. *R. citrina*, Hutton, 1883.
(I.), vol. xv., p. 139. South Island.

163. *R. australis*, Hutton, 1883.
(I.), vol. xv., p. 139. Stewart Island.

164. *R. meesoni*, Suter, 1891.
(I.), vol. xxiii., p. 84, pl. 16, figs. 1–1*b*. South Island.

Genus XXVI. PARYPHANTA, Albers, 1850.

165. *P. busbyi*, Gray, sp. 1840.
(II.), p. 21. (III.), vol. ii. (2), pl. 20, fig. 6. (V.), pl. 1, fig. 4. North Island.

166. *P. urnula*, Pfeiffer, sp. 1855.
(II.), p. 22. (IV.), vol. i. (2), pl. 26, fig. 14. North Island.

167. *P. hochstetteri*, Pfeiffer, sp. 1862.
(II.), p. 22. North and South Islands.

168. *P. gilliesi*, Smith, 1880.
(I.), vol. xvi., p. 207. (IV.), vol. i. (2), p. 127. South Island.

169. *P. lignaria*, Hutton, 1888.
(I.), vol. xx., p. 43. South Island.

Genus XXVII. SCHIZOGLOSSA, Hedley, 1893 (Daudebardia, *Pfeiffer, 1862, not Hartmann, 1821*).

170. *S. novoseelandica*, Pfeiffer, sp. 1862.
(II.) p. 12. (III.), vol. vii. (2), pp. 387–391, pl. 9, figs. 1–10. North Island.

Genus XXVIII. Rhenea, Hutton, 1893 (Elæa, *Hutton, 1884, not Ziegler, 1833*).

171. *R. coresia*, Gray, sp. 1850.
(II.), p. 24. (IV.), vol. i. (2), pl. 26, fig 15. North Island.

172. *R. jeffreysiana*, Pfeiffer, sp. 1854.
(II.), p. 24. (IV.), vol. i. (2), pl. 26, fig. 26. North Island.

Class PELECYPODA.

Fam. **Unionidæ.**

Genus XXIX. Unio, Philippson, 1788.

173. *U. menziesi*, Gray, 1843.
(II.), p. 160. North and South Islands.
(*a.*) Var. *aucklandicus*, Gray, 1843.
(II.), p. 161. North and South Islands.
(*b.*) Var. *waikarense*, Colenso, 1845.
(I.), vol. xiv., p. 169. North Island.
(*c.*) Var. *lutulentus*, Gould, 1851.
(II.), p. 161. North and South Islands.
(*d.*) Var. *hochstetteri*, Dunker, 1862.
(II.), p. 161. North and South Islands.
(*e.*) Var. *rugatus*, Hutton, 1883.
(I.), vol. xvi., p. 216. North and South Islands.

174. *U. mutabilis*, Lea, 1860 (? *depressus*, Lamarck, 1818; *depauperatus*, Hutton, 1883).
(I.), vol. xvi., p. 216. North Island.

175. *U. zelebori*, Dunker, 1866.
(II.), p. 161. South Island.

Fam. **Cyrenidæ.**

Genus XXX. Sphærium, Scopoli, 1777.

176. *S. novæzelandiæ*, Deshayes, 1853 (*lenticula*, Dunker, 1861).
(II.), p. 154. North and South Islands.

Genus XXXI. Pisidium, C. Pfeiffer, 1821.

177. *P. novæzelandiæ*, Prime, 1862.
(II.), p. 155. North and South Islands.

Art. X.—*Further Notes on New Zealand Earthworms.*

By W. W. Smith.

Communicated by A. Hamilton.

[*Read before the Otago Institute, 9th October, 1893.*]

In the present paper I offer abstracts of two valuable papers on new species of New Zealand earthworms by Mr. F. E. Beddard, F.R.S., and Dr. W. B. Benham, F.L.S.* The species described by Beddard were sent to him from New Zealand by Professor Parker, F.R.S., and myself. I do not know where Professor Parker obtained the specimens, but I have prefaced Beddard's anatomical descriptions with some notes indicating the locality where I obtained them, and their habits so far as I have been able to ascertain. It is now interesting to note that the New Zealand *Acanthodrilidæ* are represented by both pygmy and giant forms, while they constitute a remarkable gradational series in the evolution of species.

Before proceeding to give abstracts of these recent papers by Beddard and Benham, I desire to offer to this Institute some observations on the habits, anomalies in structure, and on the work of both native and exotic earthworms. In view of the phenomenal increase and dispersion of alien species, it is important to record their progress at the present time in order to ascertain their effects in future years on the extinction of endemic worms. It is a remarkable fact that the large native worms rapidly disappear from gardens and fields wherever the more diminutive aliens enter the soil. Apart from their greater liability to injury by the plough or spade, there are other causes operating against them which I hope to be able to work out fully at some future time. The smaller indigenous species also vanish from cultivated land in few years from the operation of some "inscrutable law of nature" unknown at present.

Abnormalities and Variability of Earthworms.—In several species, both endemic and introduced, I have occasionally met with several abnormal forms. The abnormality consists in their being *minus* a greater or lesser number of post-clitellian segments. The same occurrence has been observed by the Rev. H. Friend, F.L.S., in *Lumbricus rubellus*,† Hoffmeister,

* I have unavoidably omitted abstracting Benham's papers at the present time.

† "Journal of the Linnean Society," vol. xxiv., p. 313.

and has recently received from him the varietal name "*curticaudatus.*" In fully mature specimens of *Acanthodrilus rosæ* the average number of post-clitellian segments is about 226. I have, however, met with two individuals, one having only 37, the other 49. In such individuals the posterior extremity of the body is not attenuated as in normal specimens; it is of the natural size of the body where it abruptly terminates, and is almost flat. Similar specimens of *Acanthodrilus novæ-zealandiæ* and *Octochætus thomasi* also occur. The segments composing the flat posterior extremity narrow within each other in a series of rings towards the anus. These deformities are also common in *Lumbricus purpureus*, Eisen, another introduced species. I possess specimens of the latter species and *L. rubellus*, with the clitellum, as the Rev. Mr. Friend observes, "right in the middle of the body." At the present time it is important to call the attention of zoologists to these matters, seeing that they occur in widely-separated and widely-distributed genera. The careful study of such abnormal forms would, unquestionably, yield interesting and valuable results, morphologically.

Excepting some remarks by the Rev. Mr. Friend on abnormalities in two species of British earthworms, little attention has hitherto been given by naturalists to their great variability. Eisen has also shown that the clitellum in some species of European *Lumbricus* is occasionally moved one or more segments back or forward on the body of the worm. Both these peculiarities in structure occur occasionally in both introduced and native worms. Referring to *Lumbricus rubellus*, var. *curticaudatus*,* the Rev. Mr. Friend says, "I have failed so far to determine whether the effect is due to soil, height above sea-level, want of proper food, or otherwise." I cannot clearly conceive how any of these causes could produce a structurally imperfect worm. I think it is more probably due to some defect in the embryonic development of the worm, and not to the effect of any cause after its emergence from the cocoon. Animals belonging to both lower and higher groups than earthworms are occasionally born without certain limbs, or other parts of their bodies, the result of causes of which little is known at present. The var. *curticaudatus*, Friend, occurs among many thousands of the species living together in the rubbish-heaps on the banks of the Ashburton River. The heaps consist of rotten straw, old bags, paper, tins, &c., thrown out from the shops. When rotten the worms collect into and breed in them in vast numbers. The largest and finest developed specimens of several exotic species are generally obtainable in similar heaps wherever they accumulate.

* *Loc. cit.*

Earthworms vary greatly according to the soil and situation they inhabit. At the Rangitata Gorge *Octochætus multiporus* and *Acanthodrilus novæ-zealandiæ* attain their maximum size. The site they inhabit is composed of a deep, rich, blackish loam, about 10in. in depth, resting on a substratum of yellow clay. The worms, when taken out of the soil, are of a reddish colour; whereas at Ashburton and other districts where I have obtained them on the plains they are bluish-white, and occasionally of a yellowish tinge. At Ashburton they are smaller than individuals inhabiting moist land nearer the ranges. At one place where we dug out cocoons of *O. multiporus* we have occasionally obtained short, stout forms of that species with a largely-developed clitellum. *Acanthodrilus novæ-zealandiæ,* and the smaller species *annectens,* are very variable in size and colour in several districts where I have collected them. The known species of endemic *Acanthodrili* comprise a gradational series not known to exist in other genera in any single zoological region, while their prototype, *Deinodrilus benhami,* is also endemic. *A. rosæ* is the most constant form in colour and size I have met with in the endemic *Acanthodrili.*

Exotic earthworms, acclimatised in New Zealand, are extremely variable. Fully-matured individuals of *Lumbricus terrestris* are plentiful, ranging from 1in. to 6in. in length; the former occur in poor soil, the latter in decayed or decaying vegetable matter. I, however, need not particularise any species, for, although exotic earthworms are rapidly invading cultivated districts in hordes, they all attain their maximum size in heavily-manured gardens, and especially in accumulations of decayed vegetable matter*. In the case of *Microscolex modestus,* Rosa, I think it probable that the extreme disproportion in size and variation in colour of individuals of the species may be the only cause for supposing them to belong to two distinct species. The variability of earthworms has been almost overlooked by authors when describing new species, more especially in the genus *Lumbricus* and the allied genera. The Rev. Mr. Friend's "Revised Synonymy of British Worms"† should be specially acceptable to naturalists in unravelling much of the confused synonymy of British worms.

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* When referring to the rapid accumulation of mould ejected by worms living in the forest-clearings in the Grey Valley; Westland, I should have stated that it is the work of introduced worms. The rich humus covering the bottom of the moist forest, when newly cleared, is extremely nutritious to worms. The subsequent compression of the loose forest mould by cattle compels them to eject their castings on the surface. The nutritious food and moisture in the forest-clearings are the chief causes of the enormous increase of exotic worms in these places.

† *Loc. cit.*, p. 313.

The great disparity in size of individuals of the same species may be due to several causes. Worms living in rubbish-heaps and accumulations of decayed matter not reduced to soil are better nourished and less liable to checks—such as dry, cold, or hot weather—than worms living in ordinary garden-soil. The same remark applies to native worms living in districts where the soil they inhabit is deeper, and where the rainfall is annually greater. The decayed vegetable matter on which introduced worms thrive well is much more nutritious and more easily assimilated during digestion than garden-soil. The finely-developed worms living in and subsisting on the decayed humus are generally paler than others inhabiting any garden-soil. I hope in the near future to ascertain the exact period of growth of several species of worms from the time of emergence from the cocoon to maturity.

When describing the mode of escape of the young of *Octochætus multiporus* from the cocoon* I stated that the cocoons generally burst longitudinally. There are, however, some from which the worm escapes leaving a round hole at the end of the cocoon without rupturing the side. The cocoon-tissue is drawn out a little at the thicker end, which opens around the young worm's body while escaping. The head is protruded first, and the young worm slowly emerges. When the young worm is of large size the cocoon ruptures along the side and allows it to escape more easily. In a few instances we have observed them emerge in a doubled position. In the months of July and August we collected cocoons of *Lumbricus purpureus*, *L. terrestris*, *L. rubellus*, and *Microscolex modestus*. In the first-mentioned species the young emerged from the cocoon in three and four hours. The young of some of the three last named required from six to twenty-four hours. The cocoons of *O. multiporus* and *A. rosæ* are about equal in size. The recently-emerged worms are, however, distinguished by the latter becoming pale-brown in a few days.

Extinction of Endemic Earthworms.—When tussock land is first broken up great numbers of the larger species of worms (*Acanthodrili*) are torn to pieces or otherwise injured by the plough, and die from the effects. If the land is afterwards ploughed for a few years in succession very few full-grown worms escape destruction—in fact, wherever the land is well cultivated, whether in fields or gardens, the native earthworms disappear in a few years. So long as the native land remains in its naturally solid and rich condition alien worms avoid it, and are very rarely found in it. When once ploughed the natural freshness and loosening of the soil promotes a vigorous growth of introduced plants, which soon impover-

* Trans. N.Z. Inst., vol. xxv., p. 115.

ishes and changes its chemical nature. The native worms are unable to survive the cultivation of the land, and rapidly disappear from soils where natural or artificial manures are used. It is, however, very different with the introduced species—the more manure and culture the land receives the more rapidly they increase and spread. As alien earthworms take possession of newly-broken-up land they rapidly change its chemical nature from the original condition. The change is disastrous to the indigenous worms, as they are unable to survive the changed or chemically-altered nature of the soil. Like several other introduced animals, the enormous increase and dispersion of alien earthworms is phenomenal. The last mild, wet winter was very favourable to their increase. After every heavy rain-storm vast numbers were to be seen crawling about on the footpaths and streets, and in gardens and fields. From the 12th August to the night of the 5th September the weather continued very dry. In the evening of the latter date a heavy rain commenced to fall, and lasted until next morning. The storm caused prodigious numbers of worms to rise to the surface. Many of them were swept into the side-channels of the streets in Ashburton, and borne by them to the main sewer flowing along the east belt of the town. Owing to the gratings of several of the side-channels becoming choked, or through being unable to discharge the great rush of storm-water, the worms borne by the channels were left crawling about the grating in barrow-loads. This, nevertheless, represents a small number of the worms that are occasionally carried away by street-channels and other streams during and after heavy rains. They were nearly all *Lumbricus terrestris*, L. I observed a few only of *Allolobophora subrubicunda*, *A. turgidus*, *A. rubellus*, and *A. fœtidus* amongst them.

The numerous watercourses now traversing the Canterbury Plains from the hills to the sea are in many places favourable for the preservation of native earthworms. I have obtained very large specimens of *Octochætus multiporus* dug out of the sides of a water-race flowing through a paddock that had been cultivated for ten years. In many paddocks several yards wide of unbroken native land are left on both sides of the water-races. In these strips of land the native worms are favoured with moisture, and attain to a large size. While staying for three weeks at Mostyn House, near Springston, during July and August last, I was able to note the actions of earthworms in the neighbourhood of Lake Ellesmere. The soil, although of a light, free nature, is very fertile, and yields excellent crops of grain, grass, and other products of the farm. The eminence on which Mostyn House is built rises about 30ft. above the general level of the district, and forms an interesting relic of the sand-drift age in the neighbourhood of

Banks Peninsula. The dominant species of native worms inhabiting the district—at least, the slopes around the house—are *Acanthodrilus rosæ*, *A. novæ-zealandiæ*, and an undescribed species of the same genus. The three species were obtained in a solid piece of land which probably had been formerly ploughed, but not for eight or nine years. In the lawns and gardens introduced worms are extremely rare. The fact is noteworthy, as the district is longer settled than others where they now occur in millions. The three species named above are, as I have formerly explained, able to lubricate their bodies externally with mucus. In the friable, sandy soil of the Springston district these worms would enrich and make the soil more coherent than other species ejecting less-adhesive mucus.* Both *A. rosæ* and *A. novæ-zealandiæ* are very common in the limestone districts of Oamaru and Albury, where much of the land is extremely adhesive and very rich. In a large paddock in front of Mostyn House, now the residence of G. Jameson, Esq., a small slow-flowing creek winds irregularly through it. In the small bends of the creek where the plough had not touched I found some introduced worms. The creek is subject to small floods, which soon subside. On the night of the 30th July a heavy rainstorm commenced, lasting all night. Next morning the creek was in high flood, and spread out several feet from its bed on the gently-sloping grassy sides. As the water subsided during the day the worms ejected large castings composed of black soil. They were ejected on the surface of the slopes as far up as the flood-water had reached. They were the largest and most perfect castings ejected by a species of introduced *Lumbricus* that I have met with. The castings were ejected by *Lumbricus terrestris*, L., some of the specimens being exceptionally large and robust. I observed a few fresh castings in several parts of the open paddocks, but they were of small size. On the day after the storm I examined about a mile of the Springston–Leeston Road for traces of worms. I collected fourteen specimens of *Allolobophora subrubicunda*, Eisen, and observed over a hundred individuals of *L. terrestris*. A considerable number of fresh tracks were visible on the road where the worms had crawled over during the night. In an old plantation of *Eucalyptus globosus* I found two specimens of *Lumbricus purpureus*, Eisen, beneath an old cake of cow-manure. I also found three specimens of *Allolobophora*

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* These mucous secretions differ materially in several species. In *A. novæ-zealandiæ* and *A. rosæ* they are transparent, thick, and extremely adhesive. In *O. multiporus*, *O. antarcticus*, and *A. annectens* they are of a milk-like, thinnish, less-adhesive nature. I hope shortly to obtain an analysis of each, together with several soils from several parts of the plains still in their primitive state.

turgidus, Eisen, under a rotten wet sack. Doubtless a careful search in the district would reveal other species. The occasional flooding of small grassy gullies like the one at Springston is favourable to earthworms. The saturation of the grassy slopes, and the deposition of fine silt on the surface during every freshet, renders the soil moist and viscous, consequently compelling the worms to eject all their castings on the surface. In the hot summer months these small grassy gullies on the plains become dry, excepting, in some of them, an occasional stagnant pool. As the summer advances the worms gradually retreat into the bottoms of the gullies, and live under the fine silt and beds of dead leaves deposited by the water in winter.

If we study the remarkable work of New Zealand earthworms in former ages their rapid extinction at the present time in many districts is truly regrettable. The covering of the Canterbury Plains, and the sand-flats and dunes south-west of Banks Peninsula, with rich mould is worthy the attention of all interested in the work of earthworms. No less remarkable is their work on the West Coast plains, on the shingle-slopes and terraces and on the morainic accumulations in the valleys and upper parts of the plains on both sides of the Southern Alps. On the slopes of some of the higher alps, and in swampy flats often formed in depressions of the latter, where the alpine flora generally flourishes in luxuriance, the accumulation or layer of vegetable mould is frequently of considerable depth. The greater rainfall in these higher regions, especially during the summer and autumn months, would be favourable to the work of earthworms at a period of the year when the surface of the mountains and upland swamps are free from snow. To what altitude worms exist in the New Zealand Alps I cannot at present say. I have found them under partially-embedded stones on the slopes of the mountains overlooking the Clyde branch glacier of the Rangitata, and at an altitude of about 4,000ft. on Mount Peel. They lie beneath the partially-embedded blocks of stone on the mountain-slopes and -spurs. The undersides of these large angular blocks are moist, and afford good shelter for worms at rest. The surface of the soil beneath the stones is frequently marked with a network of worms' tracks. The latter are moistened with their slimy secretions, and smoothened by the worms crawling along them. The soil on the higher slopes is coarse, and generally mixed with sharp stones. It is, however, more often moistened with rain and drizzling mists during summer and autumn than the land on the lowlands. The only worms I have found in these high elevations were some large greenish specimens of *Acanthodrilus novæ-zealandiæ*. The larger form, *Octochætus* *multiporus*, occurs in great numbers in a portion of an old river-bed near Ashburton covered with only a few inches of soil. Their actions in such situations are a perfect illustration of their mode of covering the shingle-flats with mould as they have done the plains in former ages, now elevated higher above the rivers. Although some eight or more species of native worms, ranging from 1in. to 16in. in length, inhabit the plains, the work of all was necessary to reduce the once great expanse of shingle, sand, and glacier-mud to the present mould-covered, fertile state. The periodical flooding of the rivers now traversing the Canterbury Plains is conducive to the formation of soil on the shingle-flats over which the flood-water spreads. The deposition of beds of unequal depths of fine silt explains the cause of the uneven depth of soil covering some parts of the plains. An examination of sections exposed on both sides of the rivers shows the same process or action of the rivers to have proceeded continuously since they commenced to cut their channels lower in the plains. During the retreat of the glaciers the volume of water in the rivers was immensely greater than now, while it flowed at a higher level, and spread out extensively over the plains. Occasionally smaller streams branched off, leaving small plateaux of shingle between them and the main stream. As the latter wore their channels deeper the beds of the smaller streams were silted up during high floods, often forming extensive swamps. I have observed the Ashburton River deposit 2ft. and 3ft. of muddy silt during a single flood in these older side-channels now elevated above the main stream. In a few years a sparse vegetation grows in these silty or fine sandy places, while the earthworms gradually advance, and work them and the intervening shingly parts into areas of fertile land.

A broad shingly area is a formidable task for earthworms to cover with soil; yet such was accomplished by native earthworms on the now fertile Canterbury Plains. The late Sir Julius von Haast, the illustrious geologist and explorer of New Zealand, described the origin of the plains as follows: "With the exception of some morainic accumulations in the upper parts, and the drift-sands round Banks Peninsula, and the partial lacustrine deposits filling the former extension of Lake Ellesmere, the whole of the plains were formed by the deposits of huge rivers issuing from the frontal end of gigantic glaciers." In the same article also occurs the following: "We must conclude that the Canterbury Plains were formed by the outlets of enormous glaciers, large torrents bringing down with them the morainic matter thrown in their course at the terminal face, raising their beds and shifting their channels at the same time so as to form fan-shaped fluviatile accumulations consisting of shingle, sand, gravel, and glacier-mud."* Since the close of the glacier epoch in New Zealand the native worms have worked unremittingly "reclaiming the wilderness." They have worked vast areas or plains composed of fluviatile deposits, as described by Haast, into fertile land on both sides of the Alps. In Canterbury the land is of the finest quality, while in Westland it supports magnificent forests only equalled in beauty and value in a few other parts of the world.

In addition to the aid they received in working some parts of the plains by the deposits of fine silt, they would, occasionally, be assisted in others by high winds filling the interstices of the shingle with fine sand. The work was unmistakably performed by the larger species of worms. They are able to swallow the larger particles of sand or small stones, which become gradually reduced by attrition in their gizzards and intestines, while the abundance of slimy secretion with which they lubricate their body externally would render the soil-forming particles more cohesive. In one place near the river-bed where we frequently visit to observe their habits and collect cocoons the surface-soil is about 3in. in depth. Beneath the latter the subsoil is simply a conglomerate of small stones and worms' castings voided in the interstices. The voided earth is deposited in the tracks of the worms, and varies in diameter from $\frac{1}{4}$in. to $\frac{1}{2}$in. It contains numerous small stones, also of varying size, according to the size of the worms depositing them. Their cocoons occur promiscuously in the mixed shingle and castings, no attempt being made to construct burrows. By the same process some of the sloping shingly terraces are slowly, but gradually, covered with mould by the actions of the large worms. Slowly, but gradually, they have climbed the mountain-sides to considerable heights, covering them with mould in their upward advance. A glacial moraine is not an inviting field for the actions of worms, yet in New Zealand many have been, and are now being, successfully covered with soil by the constant work of these lowly-organized animals. How the mucous secretions of the large worms may act chemically in reducing the coarse soil in the earlier stages of formation cannot be approximately ascertained until an analysis of each is known.

In the introduction to Beddard's paper, from which the following abstracts are taken, some interesting remarks occur on the comparative structure of certain New Zealand species:—

"The species of *Acanthodrilidæ*," he adds, "found in New Zealand have been hitherto referred to three genera. Six years ago I described, under the name of *Neodrilus mono-*

* "Geology of Canterbury and Westland," pp. 396–398.

cystis,* an Acanthodrilid differing from the typical forms (included within the genus *Acanthodrilus*) by the presence of but a single pair of atria and spermatothecæ. This worm has been lately reinvestigated by Dr. Benham,† who has confirmed and extended my original account. I may add that I have within the last few months received some more examples of the same worm. There is, accordingly, no longer any doubt as to the characters of this species. It is not, as I at first thought it might be, a mere abnormality of such a species as *Acanthodrilus dissimilis*. Whether this earthworm should be really referred to a distinct genus is another matter. I prefer, however, to leave the question alone for the present. In any case, there can be no doubt whatever about the generic distinctness of *Deinodrilus* and the recently-described *Plagiochæta*.‡ This latter may conceivably be identical with Hutton's *Megascolex sylvestris*;§ at any rate, that species is stated and figured by Hutton to possess numerous setæ, arranged in couples, which is the principal external character of Benham's *Plagiochæta*.

"The remaining *Acanthodrilidæ* have been all referred by me‖ to the genus *Acanthodrilus*. This genus comprises altogether some forty species, of which nine are inhabitants of New Zealand.¶ Forty species are not, perhaps, an unwieldy number for a single genus; it has, nevertheless, been divided into two genera—*Acanthodrilus* and *Benhamia*—by Michaelsen. *Benhamia*, it should be remarked, includes Benham's *Trigaster*. In distinguishing the two genera, Michaelsen has not considered the characters of the New Zealand *Acanthodrilidæ*. *Benhamia* is the name applied to those *Acanthodrilidæ* with a 'diffuse' nephridial system—that is, in which the nephridia are not paired, but open on to the exterior by numerous pores. Added to this character, Michaelsen originally called attention to the fact that the species with a diffuse nephridial system possess a pair of gizzards, or, as in *Trigaster*, three gizzards. Later he was led, by a consideration of the species *Acanthodrilus schlegelii*, to consider the definition of the genus, and to use, as part of the generic diagnosis, the

* "Observations on the Structural Characters of certain New or Little-known Earthworms," Pro. Roy. Soc. Edin., 1887, p. 157.

† "Notes on Two Acanthodrilid Earthworms from New Zealand." Q.J.M.S., vol. xxxiii., p. 289.

‡ Benham, *loc. cit.*, p. 294.

§ "On the New Zealand Earthworms in the Otago Museum," Trans. N.Z. Inst., vol. ix., p. 352, pl. xv., fig. E.

‖ "On the Specific Characters, &c., of New Zealand Earthworms." P.Z.S., 1885, p. 810. "On the Oligochætous Fauna of New Zealand," P.Z.S., 1889, p. 377. "On the Structure of Three New Species of Earthworms, &c.," Q.J.M.S., vol. xxix., p. 102.

¶ I have recently sent several specimens to Mr. Beddard, some of which will, I think, prove to be new species of *Acanthodrilus*.

phrase, '*as a rule* more than one gizzard.' According to this definition, my *Acanthodrilus multiporus* should be referred to the genus *Benhamia;* and yet it differs from the African species (Africa is at present the head-quarters of the genus) in a number of characters. There are no penial setæ; the calciferous glands are limited to a single pair; the dorsal vessel is double; the setæ are not strictly paired, but separated by a little distance. There are two other species described in the present paper which agree with *Acanthodrilus multiporus* in these points. A fourth species—*Acanthodrilus antarcticus*—agrees with *A. multiporus* in most of these characters, but not in all.

"It has penial setæ; the two pairs of calciferous glands are in segments xv., xvi., and there is a smaller gland in xiv.; only the single gizzard and the distant setæ distinguish this species from the majority of those assigned by Michaelsen and others to the genus *Benhamia.* In spite, however, of the near resemblance of this particular Acanthodrilid to *Benhamia,* I am not inclined to refer it to that genus. In the first place, it is possible that *Benhamia schlegelii,* which is stated to have but one gizzard, has really two; the two gizzards in this genus are often so close together that it is not a little difficult to make out that they are really two; the interval of soft-walled œsophagus between them is reduced to the lowest terms in many cases. In the second place, *Acanthodrilus antarcticus* is so like *A. multiporus* in other particulars that it would be doing violence to their obvious relationship to separate them.* Taking into account also the distribution of these species, it seems reasonable, now that the old genus *Acanthodrilus* is being broken up, to associate the New Zealand species here referred to into a genus distinct from *Benhamia,* which may be termed *Octochætus.* It will be thus defined:—

"OCTOCHÆTUS, nov. gen.

"Prostomium not continued by grooves on to buccal segment; clitellum, xiii.–xix. (xx.); male pores on prominent papillæ; setæ distant; ventral setæ present on segment xviii.; a single gizzard in vi., or v. and vi., or v.; calciferous glands one or two pairs, in xvii., xviii., or xv. and xvii.; typhlosole well developed; nephridia diffuse, a mucous gland present; dorsal vessel present from seventh segment onwards; diverticula of spermatothecæ very minute. Distribution: New Zealand.

* It may turn out that the position of the gizzard distinguishes my genus *Octochætus* from *Benhamia.* I am aware that Rosa speaks of the gizzards of *B. scioana* as occupying segments xv. and xvi.; this is at present the only exception to the rule that in *Benhamia* the gizzards are a segment or two further back.—F.E.B.

"There is another character to which comparatively little attention has been paid which may prove to distinguish the genera *Benhamia* and *Acanthodrilus*. In the two species of *Benhamia* described in the present paper, as well as in *B. stuhlmanni*, there are no setæ upon the eighteenth segment where the ventral pair should be; these setæ are also absent from the seventeenth and from the nineteenth segments, or, rather, they are there replaced by the penial setæ. In all the species of *Acanthodrilus*, on the other hand, which I have been able to examine, the ventral setæ are not missing from the eighteenth segment, though they are not present on the seventeenth and nineteenth segments, being there replaced by the penial setæ. This is also the case with the genus *Octochætus*; in two of the species of that genus, at any rate—viz., *O. multiporus* and *O. antarcticus*—the ventral pair of setæ of segment xviii. are present and quite normal; on segments xvii. and xix. the ventralmost seta is present and unmodified. *Octochætus antarcticus* is, furthermore, remarkable for the fact that the setæ of the seventeenth and nineteenth segments appear at first sight to be present and normal; as a matter of fact, the outer seta of the ventral pair is replaced by the penial setæ, which occur exceptionally in this species. These setæ are very much smaller than in *Acanthodrilus dissimilis*, for example, and can hardly be seen until they are examined microscopically, but they are undoubtedly there. The ventralmost seta of the ventral pair is not absent from these segments as it usually is, but is quite recognisable. This species is, therefore, in a less modified condition than is any other of the species of *Octochætus*, or *Acanthodrilus*, or *Benhamia*. In *A. annectens* and *A. paludosus*, described in the present paper, there is, as in *Octochætus*, a single seta ventrad of the atrial pores.

"In all the species of *Benhamia* which I have dissected, the calciferous glands are different from those of *Acanthodrilus* or *Octochætus*. These glands are, in *Benhamia*, reniform pouches attached to the sides of the œsophagus; in *Acanthodrilus* and *Octochætus* these glands present the appearance of swellings upon the course of the œsophagus. Moreover, in *Benhamia* there always appear to be three pairs of calciferous glands, which may, perhaps, prove to be always in segments xv., xvi., and xvii.; they have been for the most part described as in these segments, and it is possible that in those cases (*e.g.*, *B. buttikoferi*, Horst) where they are stated to occupy the fourteenth, fifteenth, and sixteenth segments a mistake of one segment may have been made; anyhow, the three pairs seem to be characteristic, and nearly, if not quite, universal.

"The species *Acanthodrilus novæ-zealandiæ*, *A. assimilis*, *A. rosæ*, and *A. smithi* (to be described in the present paper), I refer to genus *Acanthodrilus sensu stricto.* I am doubtful about *Acanthodrilus annectens,* a species which I described some years since.* In possessing paired nephridia it agrees with *Acanthodrilus* (s.s.), but it has the 'mucous gland' of *Octochætus,* and the gonads are placed in contact with the funnels of their ducts, as is the case with three of the species which I refer to this genus *Octochætus.* It has the further peculiarity that the sperm-ducts run in the thickness of the body-wall, a peculiarity which it apparently shares with the genus *Octochætus,* but which, among other *Oligochæta,* is rare, and only found, so far as I am aware, in *Diplocardia communis* and in the not-nearly-allied form *Siphonogaster.* The absence of calciferous glands is occasionally met with in *Acanthodrilus.*

"I shall now describe two apparently new species which I refer to my genus *Octochætus.*"

Genus Octochætus, Beddard.

Octochætus thomasi,† Beddard. Pro. Zool. Soc., Lond., 1892, p. 671.

The present species is not uncommon on some parts of the Canterbury Plains. Except *Acanthodrilus paludosus* (to be described in the present paper), it lingers longer in well-cultivated gardens and fields than any other native species I have observed. The size and number of segments in mature individuals vary considerably. The colour is pale, almost transparent, brown, with dull-yellowish clitellum. In habits it is the most active form of the four indigenous species of *Octochætus,* and succeeds well when kept in large flower-pots in fresh soil. Appended is Mr. Beddard's anatomical description of the species :—

"I have received on various occasions during the last few years examples of a small-sized Acanthodrilid from New Zealand, which I have hitherto confounded with *O. multiporus.* I regarded these individuals merely as small specimens of that species. A full-sized specimen of *O. multiporus* is a very large worm, measuring even in a contracted condition some 14in. in length by ½in. or so in breadth. On the other hand, the worms which I now consider to represent a new species of this genus are of a much more slender build.

"The external characters of the species recall *O. multiporus.* The *prostomium* is not continued by grooves on to the buccal segment; that segment and the two following are not annulate; segments iv., v., vi. are triannulate, the middle annulus being much the narrowest; segments vii., viii., ix. are

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* "On the Structure of Three New Species of Earthworms, &c.," Q.J.M.S., vol. xxix., p. 102.

† Named after Professor A. P. Thomas, of Auckland, New Zealand.

very much wider (astero-posteriorly), but still triannulate; so, too, are the segments which immediately follow, though much narrower. After the clitellum the segments continue to be triannulate.

"The clitellum extends from segments xiii.–xix.; it is at first complete, extending right round the body; but on segments xvi.–xix. there is a ventral median area without any glandular modification.

"The atrial pores are upon very conspicuous papillæ; the two of each side of the body are connected by a longitudinal groove, which is not straight, but has a semicircular outline, the convexity being dorsal. The oviducal pores are just in front of the ventralmost seta. The setæ are rather distant from each other; a somewhat greater distance separates the two lateral setæ.

"I have not seen any dorsal pores.

"The pharynx occupies the first four segments of the body; the gizzard is very elongated, with parallel margins; it measures 65mm. in length; the gizzard occupies two complete segments, the fifth and the sixth. The œsophagus bears in segment xvii. the single pair of calciferous glands, which present the appearance of an oval swelling of the œsophagus itself. The intestine commences in the nineteenth segment.

"The septa of some of the anterior segments are, as is so constantly the case with earthworms, strengthened and bound together with thin muscular strips, which occasionally pass through one septum to reach another lying behind it. The first septum, which is thin and transparent, divides segments iv./v.; it is traversed by a large number of muscular threads which bind the pharynx to the pariatis. The next septum is also thin and delicate in texture; it is attached at the end of the first third of the gizzard; a good number of the threads which bind the pharynx to the pariatis pass through it. The following seven septa are thickened; the last of them, therefore, bounds the thirteenth segment anteriorly.

"The dorsal vessel is completely double; the two tubes of which it is composed retain their individuality when they pass through the intersegmental septa. The dorsal vessel is, however, at first a single tube; it is not until the seventh segment that it becomes double. In this segment commences the supra-intestinal vessel, which is large and very conspicuous. In segments x., xi., xii., xiii. are the four pairs of dilated hearts; in a few segments, anterior to the tenth, are more delicate peri-œsophageal vessels.

"There are, as in *Octochætus multiporus*, a pair of large nephridia lying close against (in front of) the first septum; from each of these a slender duct was traced forwards which opens, it may be inferred, into the buccal cavity; I did not, however, succeed in seeing the actual orifice. In the rest of the body the nephridia are also constructed upon the plan which is characteristic of *O. multiporus;* the tufts appear to be massed chiefly around the setæ.

"Both testes and ovaries occupy the usual segments, but the gonads are attached to the posterior wall of their respective segments, as they are in *Acanthodrilus annectens* and in *Octochætus multiporus*.

"The racemose sperm-sacs are in xi., xii.

"The spermatothecæ are elongated pouches in viii. and ix.; they appear to have numerous minute diverticula crowded round the duct near to its external opening.

"The atria do not extend beyond their proper segments. A number of strong muscular bands, such as occur in *Octochætus multiporus*, pass from the lateral to the ventral walls of segments, and serve, no doubt, to extrude the papillæ already spoken of, on to which the atrial pores open. There are no penial setæ.

"This species is clearly most intimately related to *O. multiporus;* indeed, it is not a little difficult to separate the two; the difficulty, too, is increased by the variability of the larger species. This difference of size is the most obvious difference; and it is, I think, a difference that must be allowed. The variability of *O. multiporus* unfortunately concerns those very organs upon which I had at first attempted to lay stress as distinguishing the two. In some individuals of *Octochætus multiporus* the gizzard is limited to the sixth segment, the second septum lying just in front of it, attached, therefore, to the œsophagus; but in other specimens this septum is inserted on the gizzard itself, which thus occupies two segments, as in *Octochætus thomasi*. In two individuals the single pair of calciferous glands are in segment xviii.; but in others, as is the case with *Octochætus thomasi*, in the seventeenth. Another possible distinction between the small and the large species concerns the dorsal vessel; in *O. thomasi*, as already mentioned, this vessel is single until the seventh segment. In a specimen of *Octochætus multiporus* the dorsal vessel was single until the commencement of the sixth segment only; in this segment it became double; in another the single dorsal vessel became double at the septum separating v./vi., but immediately after the two halves became fused, to again divide about the middle of the segment. The shape of the gizzard and its relative strength in the two species does appear to differ; in the smaller species it is proportionately longer and narrower than in the large species.

"The next new species cannot by any possibility be confounded with the foregoing. I name it after Captain Hutton, who has done so much in describing the fauna of New Zealand."

Octochætus huttoni, Beddard. Pro. Zool. Soc. Lond., 1892, p. 674.

The first specimens sent to Beddard were discovered in the rich moist soil on the banks of Albury Creek, in South Canterbury. It is a larger species than *O. thomasi,* and very sluggish in habits. When taken out of the soil it becomes extremely limp and soft, and does not appear to thrive in flower-pots. All the specimens I brought home with me died in a few weeks, although they were placed in fresh soil, and kept moist in a cool place. Following is Beddard's diagnosis of the species :—

"The examples sent to me were all of approximately the same size; an individual selected for accurate measurement was 130mm. in length by 7mm. in breadth at the clitellum. It consisted of 233 segments.

"The colour during life was pink, the clitellum being white; this colour is due to the fact that the species, like *O. multiporus,* had no pigment in the skin.

"The anterior segments are much annulated. After the clitellum there is also, though to a less extent, an annulation of the segments.

"The clitellum occupies segments xiii.–xix. (xx.).

"The atrial pores are borne upon a very prominent fold overhanging on each side the ventral surface, which in this region appears, in consequence, as if hollowed out. The two pores of each side are connected by a longitudinal furrow.

"The prostomium is short and wide, and is not continued by grooves on to the buccal segment, which is marked by numerous furrows.

"The setæ are in pairs not closely approximated.

"The dorsal pores commence between xi. and xii.

"The gizzard measures 8mm. in length, and appears at first sight to occupy four or five segments; it really corresponds to segment v., which is increased in size at the expense of neighbouring segments for its reception. The calciferous glands are in xv. and xvi.; they have the appearance of being merely dilatations upon the course of the œsophagus, which is the case with the other species of this genus.

"The intestine begins in xviii., but the typhlosole (which is very prominent) does not begin before segment xx.; it ends at about 60 segments before the end of the body.

"The first septum is in front of the gizzard. After the gizzard are six stout septa, and, following these, are two which are rather more developed than the rest, but not so strong as those which precede them. The nephridia are diffuse, and there is a particularly dense mass of tubes in the anterior segments, which seem to represent the mucous gland of *Octochætus multiporus*.*

"The dorsal vessel is double, and there are three pairs of hearts in x.–xii.

"All the gonads are attached to the front wall of their segments.

"The spermatothecæ (in viii., ix.) have a minute clump of diverticula, presenting the appearance of a solid body, about the size of a pin's head.

"There are no penial setæ.

"This species is evidently perfectly distinct from the last; it is, however, clearly referable to the same genus, if this genus be admitted. The diffuse nephridia, double dorsal vessel, separate setæ, absence of penial setæ, and anterior position of gizzard cause it to resemble the three other species which I refer to the genus *Octochætus*. It differs from *O. multiporus* and from *O. thomasi* in the following points:—

"(1.) The prominence of the atrial pores as seen from the outside.

"(2.) The position of the gizzard in segment v., and its limitation to this segment.

"(3.) The presence of two pairs of calciferous glands in xv., xvi.; in this the present species resembles *O. antarcticus*.

"(4.) The existence of only three pairs of hearts instead of four.

"(5.) Six thickened septa instead of seven.

"(6.) The attachment of the gonads to the front wall of their segments; in this character *O. huttoni* resembles *O. antarcticus*.

"The next species which I describe is referable to the genus *Acanthodrilus* (s.s.)."

Acanthodrilus smithi, Beddard. Pro. Zool. Soc. Lond., 1892, p. 675.

I discovered the first specimens of this species underneath large stones lying among the tussocks on the flat beneath the main limestone rock at Albury. It is the most active form of all the indigenous species of *Acanthodrilus* yet discovered. Like *A. rosæ*, its colour is rich brown, which changes only slightly in alcohol. In the living worm the segments are very clearly defined, and impart a neat effect to the animal when crawling over the ground. Its rapid motions are similar to those of *Lumbricus rubellus*, Hoffmeister, and *Perichæta intermedia*, Beddard. While in the act of crawling the an-

* I did not ascertain whether these opened into the buccal cavity, as in *O. multiporus*.—F.E.B.

terior half of the body is frequently off the ground, and placed down until the posterior half is drawn forward. These alternate movements, or modes of progression, are repeated in rapid succession. It is a very sensitive species, and if touched a little roughly will twist itself violently about, often leaping several inches along or off the ground. These remarks may enable collectors to identify the species when met with. Herewith I give an abstract of Beddard's description of the species :—

"The general appearance of the worm is very different from that of the other New Zealand *Acanthodrilidæ* which I have so far had the opportunity of studying—so different that it was unnecessary to dissect the species in order to ascertain its distinctness. All the New Zealand *Acanthodrilidæ* with the exception of the present species are either devoid of pigment in the skin, or, if pigment is present, the worms are of a brownish colour. *Acanthodrilus smithi* is (after preservation in alcohol) of a violet colour, the clitellum being whitish-yellow; the ventral surface of the body is the same colour as the clitellum.

"The worms are slender, measuring up to 75mm. in length, with a diameter of 3mm. at the widest part of the body. An individual of this size consisted of 114 segments.

"The prostomium completely divides the buccal segment, as it does in the New Zealand species, *Acanthodrilus novæ-zealandiæ*, &c.

"The setæ are paired, and the pairs are equidistant, the body being thus divided into four equal areas. There is no difference in size between the setæ of different segments.

"The clitellum occupies segments xiii.–xix.; it is saddle-shaped, and is not developed ventrally beyond the outermost of the two ventral setæ.

"I could find no dorsal pores.

"The nephridiopores are very evident; they alternate in position from segment to segment, as is the case also with other species of *Acanthodrilus* from New Zealand. They sometimes lie in front of the dorsal, sometimes in front of the ventral setæ. When they open in front of the ventral they appear to be particularly related to the outer of the two setæ. When, on the other hand, they appear in front of the dorsal setæ the orifice is in front of the innermost of the two setæ which constitute the pair.

"The spermatothecal pores lie on the border-line, between segments vii./viii. and viii./ix. They lie in front of and to the outside of the ventral pair of setæ.

"The atrial pores are upon segments xvii. and xix.; their position corresponds exactly with that of the ventral pair of setæ, which are absent from these segments. The ventral are, on the other hand, present upon the seventeenth segment; and the sperm-duct pores lie a little to the outside of and in front of these setæ; their position, therefore, corresponds more accurately to that of the spermatothecal pores than do those of the atria.

"The internal structure does not present any special points of interest, being, on the whole, very similar to that of the other New Zealand *Acanthodrili*.

"The nephridia are alternate in position, as in *A. dissimilis;* this peculiarity is confined, as regards the genus *Acanthodrilus*, to the New Zealand species.

"The dorsal blood-vessel is single; there are four pairs of dilated hearts, the last of which is in segment xiii.

"The alimentary canal is furnished with a rudimentary gizzard, which needs a microscopical examination for its demonstration; such as it is, it lies in segment v. There are no conspicuous calciferous glands, but in segments xiv. and xv. the œsophagus becomes wider, and its lining membrane much folded and very vascular. This region evidently corresponds to the calciferous glands of other earthworms; all doubt upon the matter appears to be removed by the discovery of crystals exactly similar to those which occur in the calciferous glands of other *Oligochæta*. The vascularity of the œsophagus is not limited to these two segments; from the tenth segment onwards its walls are vascular, though not so folded as in the two segments xiv. and xv. The intestine commences on the eighteenth segment.

"The gonads occupy the usual position; the sperm-sacs are in segments ix., x., xi., xii. The atria are like those of other *Acanthodrilidæ*, and each is provided with a bundle of penial setæ. These setæ are recurved at the extreme end; the extremity has two delicate wing-like processes, which, when the seta is viewed from above, give to the end an oval contour; the tip of the seta in this aspect is seen to be bifid. The absence of any ornamentation upon the setæ appears to distinguish the New Zealand *Acanthodrilidæ*, with the exception of *Octochætus antarcticus*, where it is only very slight.

"The spermatothecæ are, as is nearly universally the case with the *Acanthodrilidæ* (*Acanthodrilus* (*Diplocardia*) *communis* is, so far as I am aware, the only exception), two pairs situated in segments viii. and ix. Each pouch has three small diverticula, one of which is constantly in front of the septum."

Acanthodrilus paludosus, Beddard. Pro. Zool. Soc. Lond., 1892, p. 677.

Although the first specimens of this species—the smallest of the known native *Acanthodrilidæ*—were found in a marsh, I have found them in the fine, damp, sandy soil near the river-bed, and under half-dried cakes of cow-manure. In habits it is extremely inactive, and when touched or handled curls up and remains motionless for a considerable time. In the living worm the natural colour in some specimens is pale-pink, while others are almost transparent, and show the dorsal blood-vessel through the clear body-wall. It is a very distinct and handsome little worm, and forms pretty spirit specimens. The following is an abstract of Beddard's paper describing the species :—

"This is a small and slender worm, but I have not preserved any accurate notes of its dimensions; it was about 1in. in length, and something like 1mm. in diameter. This species is a near ally of *Acanthodrilus annectens*, which I have already referred to as possibly worthy of generic separation from the *Acanthodrilidæ* with paired nephridia.

"The present species has the same arrangement of the setæ, which are not modified upon any of the segments of the body. I did not describe, in my account of *Acanthodrilus annectens*,* the fact that only one of the two ventral setæ is missing on the segments which bear the atrial pores—*i.e.*, xvii. and xix.; the apertures take the place of the missing outer seta of the ventral couple; on the eighteenth segment both setæ of the ventral pair are present; the pore itself lies to the outside of the pair. *Acanthodrilus paludosus* shows exactly the same arrangement, and both species therefore differ from *Acanthodrilus smithi* and from the other New Zealand species of *Acanthodrilus* in this matter: in them the ventral setæ are entirely absent from the seventeenth and nineteenth segments.

"The clitellum was not developed, though in other respects the worm appeared to be fully matured.

"The gizzard lies in segments v. and vi., but only one-fourth of the organ lies in the anterior segment. Calciferous glands are, as in *Acanthodrilus annectens*, totally absent; the intestine begins in the twentieth segment; some of the septa are thickened.

"There is a mucous gland, and the nephridia are paired.

"The gonads are normal in position; they are situated on the posterior face of their segments, as is the case with *A. annectens*. Opposite to them are the funnels of the ducts, which are like those of other species, and occupy the same segments. The sperm-ducts, however, agree with those of *A. annectens* to differ from those of most other earthworms, in running within the thickness of the body-wall; they retain their individuality until just before the external aperture.

"The atria have no peculiarities of structure; there are no

* Trans. N.Z. Inst., vol. xxv., pp. 122–124.

penial setæ; strong muscular bands run from the lateral to the ventral pariates in the neighbourhood of the atria, a character which unites this species and *Acanthodrilus annectens* to the genus *Octochætus;* the presence of these muscular strands is perhaps to make up for the absence of penial setæ; the atrial papillæ can possibly be considerably protruded by their means; and, as they (the extruded papillæ) are tapered at the extremity, they can, it is likely, be actually inserted in the spermatothecal orifice, and convey the sperm direct.

"The oviducal pores are placed just in front of the ventral-most setæ.

"The oviducts have no egg-sacs attached to them.

"The sperm-sacs are in segments ix., xi., xii. I could not find any sac in the intervening segment.

"The spermatothecæ are, as in all the *Acanthodrilidæ* (excepting only *A. communis*), two pairs, and lie in the usual segments—*i.e.*, viii., ix.; each pouch has, as in *Acanthodrilus annectens*, more than one diverticulum; in the present species there are two, one of which is rather the larger.

"Closely allied to *Acanthodrilus annectens* as this species undoubtedly is, there will be no difficulty in distinguishing it. The chief points of difference are—(1) position of gizzard, (2) normal position of gonads, (3) form of spermatothecæ."

Corrigenda.—In my last paper (Trans. N.Z. Inst., vol. xxv., p. 117), for *Allolobophora rubicunda* (*subrubicunda*, Eisen), read *Allolobophora rubellus*, Savigny (*Lumbricus campestris*, Hutton).

Art. XI.—*Contribution to a Knowledge of the New Zealand Sponges.*

By H. B. Kirk, M.A.

[*Read before the Wellington Philosophical Society, 11th October, 1893.*]

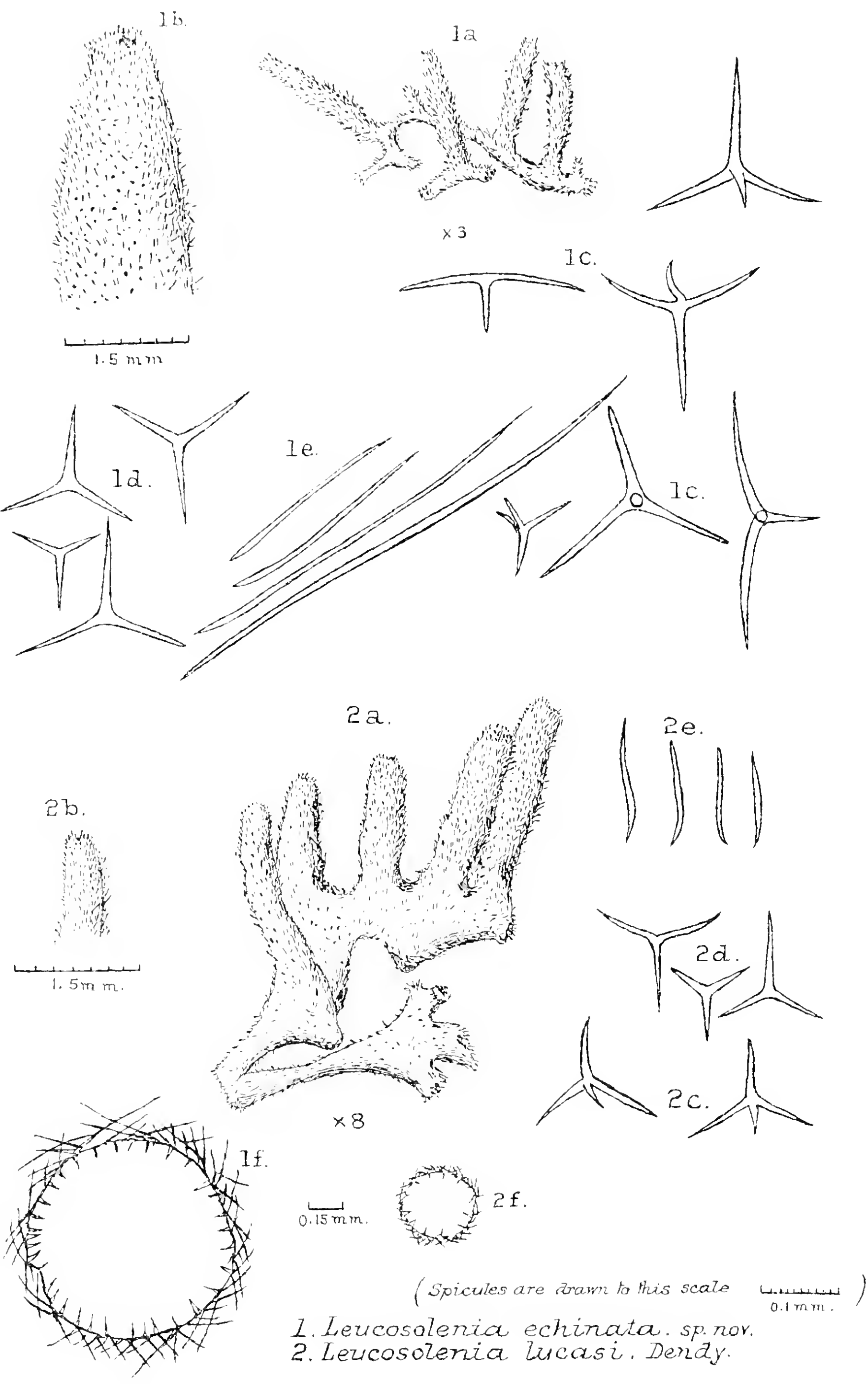
Plate XXII.

In presenting what is intended to be the first of a series of papers on the New Zealand sponges, I feel that a few words of explanation, perhaps of apology, are necessary. The field of spongiology is such a wide one, it is so difficult to traverse—it has been trodden by so many men of eminence, who, while doing the most valuable work, have not always succeeded in walking in amity there, and whose footsteps, crossing and re-crossing, often make a network difficult to unravel—that it might be thought that most biological workers would do well to avoid it. The field is, however, a splendid training-ground for the earnest student, and there is much work of great value to be done that can well be done by an observer who is content to describe, in words and by drawings, what he sees and no more, and who, when resorting to diagrams, makes it clear that they are diagrams, and not drawings. Some of this work in relation to the New Zealand sponges, it is hoped, may be done and may be described in the series of papers contemplated, and in the criticisms that will be evoked. Only the publication by each worker of what is known to him, or of what he thinks is known to him, and the correcting of his errors by other workers, can prepare the way for the production of a monograph of the group in New Zealand.

The worker that deals with a group of which there is a widely-recognised classification is enabled to reduce his material to order with some confidence and ease; but in this group every writer of note, and many a one besides, has proposed a scheme that is largely his own, and often he has been the only worker that has adopted his scheme. There has, however, been advance; and the classification of the sponges, which might have been regarded as a very murky and troubled fluid a few years ago, has become clearer and colloid, and may be expected to solidify, in time, in a satisfactory form. The advance that has been made is very largely owing to the magnificent work done by the men to whom the material of the "Challenger" expedition was intrusted, and the classification proposed by them will be generally followed in these papers.

I wish to acknowledge the great help and encouragement that I have received from Dr. Dendy, one of the foremost workers of the day. This help was not confined to good advice, but took also the concrete form of a number of European and Australian types of calcareous sponges, including a large number of the blocks from which Dr. Dendy had cut his own sections. The confidence so generously bestowed on an unknown worker has formed one of the strongest reasons I have had for persevering in this work.

As it must be long before the material collected is sufficient for the production of a monograph, and as much preparatory work has to be done, and some of it probably undone and done again, it is proposed, in the interests of students generally, to describe the New Zealand sponges in something like their natural order, beginning with the Calcarea. As, moreover, the literature of the subject is very scattered, and much of it is difficult to obtain, it is deemed advisable to copy the descriptions of New Zealand forms that may be identified as already described, amplifying and illustrating the description where it seems necessary to do so.



1. *Leucosolenia echinata*. sp. nov.
2. *Leucosolenia lucasi*. Dendy.

H. B. K. del.

The scheme of classification followed in dealing with the Calcarea will be generally that adopted by Dr. Dendy in his "Monograph of the Victorian Sponges," part i., and his "Synopsis of the Australian Calcarea Heterocœla."

The present paper contains the descriptions of two simple ascons, one of which I believe to be new.

Phylum—*Porifera, Parazoa*, or *Spongiæ*.
Class—*Calcarea* (Grant).—Sponges in which the skeleton is composed of calcareous spicules.
Order—*Homocœla* (Poléjaeff).—Calcarea in which the endoderm consists throughout of collared cells.
Section I.—*Homocœla simplicia* (Dendy).—"*Homocœla* in which the ascon persons either remain solitary and do not form colonies, or in which they form simple colonies in which the component ascon persons may branch but never form complex anastomoses nor give off radial tubes, so that the individuality of the different members of the colony is easily recognisable."
Genus—*Leucosolenia* (Bowerbank).—Of the characters of the order.

1. Leucosolenia echinata, sp. nov.

The sponge forms colonies of ascon persons springing from a hollow, creeping, and anastomosing sponghoriza. The ascon persons are cylindrical, and are generally wider than the sponghoriza. They are usually about 6·5mm. in height and may be as much as 1·5mm. in diameter. Each tube has a terminal osculum. The colour of the sponge is brownish-white.

The skeleton consists of triradiate, quadriradiate, and oxeote spicules. The radiates are arranged in a single layer in the mesoderm, the apical rays of the quadriradiates projecting into the gastral cavity. The thicker end of the oxeotes is embedded in the mesoderm, and the thin portion projects outwards and generally upwards through the ectoderm.

Spicules.

Triradiates (Pl. XXII., fig. 1*d*): These are generally regular, but are frequently slightly sagittal, in which case the oral angle is the largest and the basal ray the longest. The ordinary length of the rays is 0·1mm., but the basal ray may be 0·13mm. long. The thickness of the rays at the base is generally 0·01mm., and they taper to a point.

Quadriradiates (Pl. XXII., fig. 1*c*): These are more numerous than the triradiates, and larger. They are sagittal, the oral angle being the largest and the basal ray the longest; the oral angle may be as great as 180°. The points of the oral rays may be curved towards each other in their own plane or towards the point of the apical ray. Ordinary length of basal ray, 0·15mm.; of oral rays, 0·13mm.; and of apical rays, 0·07mm. Thickness of rays at base, 0·015mm. They taper evenly to a point. The apical ray is slightly curved away from the basal ray, and the point is directed towards the osculum of the sponge.

Oxeotes (Pl. XXII., fig. 1*c*) : These are slender and at times almost filiform. They generally taper irregularly to sharp points at both ends. The thickest part of the spicule is generally near the basal end, and near this end is often a sharp bend in the spicule. Sometimes the spicules are slightly truncated or quill-shaped at the base. Length, 0·24mm. to 0·73mm.; greatest breadth, 0·01mm., but sometimes the greatest breadth is not more than 0·005mm.

The projecting oxeotes give this sponge a hispid appearance, observable with the naked eye. The fact that although generally directed towards the oscule they often project at right angles to the axis of the tube, and are often directed towards the sponghoriza, gives the tubes the echinated appearance that suggests the specific name of the sponge. This appearance, and the comparatively large size of the sponge, are the external characters that distinguish it from *L. lucasi*, Dendy, to which it is allied. The microscopic characters that distinguish it at once from *L. lucasi* are the immense size and more tapering shape of its oxeotes, and the fact that its quadriradiates are for the most part noticeably larger and less regular than the triradiates. The triradiates are larger than those of *L. lucasi.*

Localities.—Cook Strait, Poverty Bay, Kawakawa (near East Cape).

In a sponge that appears to be a form of this, and that occurs on Stewart Island, there is a tendency in the ascon tubes to branch. The 4-radiates in this sponge are not larger than the 3-radiates, and are much less numerous. The oxeotes, moreover, are smaller, and do not tend so decidedly to be filiform. This form makes a near approach to *L. lucasi.*

2. Leucosolenia lucasi, Dendy.

The following account of the sponge is slightly compressed from Dr. Dendy's description :—

Sponge forming loose colonies, the ascon persons being connected at their base by a hollow creeping sponghoriza. Ascon persons small, cylindrical, thin-walled tubes, 2mm. or 3mm. in height, and 0·7mm. in diameter. When the sponge is full-grown each tube has a wide osculum at the summit. Outer surface of tubes minutely hispid. Colour in spirits, white.

Skeleton of 4-radiates, 3-radiates, and oxeotes. The radiates are arranged in a single layer in the thickness of the mesoderm, the apical rays of the 4-radiates projecting into the gastral cavity. Broader ends of oxeotes embedded in the mesoderm; narrower ends projecting outwards and upwards.

Spicules.

Triradiates: Sagittal, but the three angles about equal; basal ray long and gradually sharp-pointed; 0·1mm. × 0·005; oral rays slightly curved away from one another, gradually sharp-pointed, 0·07mm. long.

Quadriradiates: About same size as 3-radiates, apical ray shorter than the others, gradually sharp-pointed, curving slightly upwards.

Oxeotes: Irregularly fusiform, sharply pointed at both ends, broader at one end than at the other, usually bent suddenly at a slight angle near the broader end, often slightly and irregularly curved, tapering gradually to a fine point at the narrow end, but with a very slight annular swelling at a short distance below the apex. They measure up to 0·16mm. in length by 0·005mm. in diameter at the broadest part.

See "Monograph of the Victorian Sponges," page 45, and plates.

A single colony, part of which is figured at Pl. XXII., fig. 2*a*, from Cook Strait, is in my opinion identical with Dr. Dendy's sponge. It shows, however, some slight differences. The bent form of the oxeotes is more frequent and pronounced than in a specimen of *L. lucasi* that Dr. Dendy has kindly sent me from St. Vincent's Gully, and the oral rays of the 3-radiates are often turned slightly towards instead of away from each other. The annular swelling near the apex of the oxeotes is not always present.

EXPLANATION OF PLATE XXII.

Fig. 1*a*. *Leucosolenia echinata* × 3.
Fig. 1*b*. " a portion of an ascon person magnified to scale.
Fig. 1*c*. " 4-radiate spicules.
Fig. 1*d*. " 3-radiate spicules.
Fig. 1*e*. " oxeote spicules.
Fig. 1*f*. " cross-section showing arrangement of spicules. Many of the oxeotes are cut across, and appear shortened.
Fig. 2*a*. *Leucosolenia lucasi* × 8.
Fig. 2*b*. " a portion magnified to same scale as 1*b*.
Fig. 2*c*. " 4-radiate spicules.
Fig. 2*d*. " 3-radiate spicules.
Fig. 2*e*. " oxeote spicules.
Fig. 2*f*. " cross-section showing arrangement of spicules. Drawn to same scale as 1*f*.

ART. XII.—*On a New Rail from the Auckland Islands.*

By the Hon. WALTER ROTHSCHILD.

Communicated by Captain F. W. Hutton, F.R.S.

(Extract from "Bulletin of the British Ornithologists' Club," No. VIII., 19th April, 1893.)

[*Read before the Philosophical Institute of Canterbury, 2nd August, 1893.*]

Rallus muelleri, sp. n.

UPPER surface of head, occiput, and neck brownish-red, faintly and irregularly striated with black; back and rump bright chestnut, with the centres of the feathers black; wings brownish-black, faintly edged with rufous-grey; cheeks reddish-grey; centre of the throat reddish-white; lower part of the throat and breast rufous-grey; flanks, abdomen, and under tail-coverts black, each feather tipped with pale-rufous, and with two white bands; tail rufous, with indistinct grey bands. Wing, 3·3in.; culmen, 1·1in.; tarsus, 1·1in.; central toe with claw, 1·3in.; tail, 1·3in.

Hab. Auckland Islands, south of New Zealand.

Remarks.- This little Rail in general appearance resembles *Rallus lewini*, from Australia, but, on comparison, presents so many important differences that it might also be separated generically. The chief distinguishing feature of the new species is the enormous development of the feathers on the back and rump, which have become a huge bunch like that of the Puff-birds (*Bucco*) of South America.

The single specimen was sent for description by Count Von Berlepsch, who considered it to belong to a new species. It is the property of the Stuttgart Museum.

Art. XIII.—*Brief Ornithological Notes.*

By T. W. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 26th July, 1893.*]

Carpophaga novæ-zealandiæ (Wood-pigeon).

Quite a number of instances of abnormal colouring in this handsome species have been recorded, but so far only two pure albinos. The first was exhibited by myself before a meeting of this society in 1879, and a description appears in the Transactions of that year. The specimen is now in the mounted collection in the Colonial Museum, and is the one referred to in the second edition of the "History of the Birds of New Zealand."

The second was noted last year by the author of the work just mentioned, Sir W. Buller, and is preserved in Mr. Drew's museum at Wanganui.

I have now to exhibit a mounted specimen obtained three weeks ago in the Wairarapa. It will be seen that, though somewhat damaged and badly stained with blood, the whole plumage, even to the shafts of the feathers, is pure white.

Prosthemadera novæ-zealandiæ (Tui—Parson Bird).

There is in the Museum a specimen of this bird showing a most remarkable variation from the type. The general plumage is pure white, with a black band on the lores, forehead, and on each side of the neck. The wings are pure white, except the outer secondaries and the primary coverts, which are black.

I recently had an opportunity of examining a skin, found on the hills at Wai-nui-o-mata, which was in general appearance even more remarkable. The head, neck, and body were quite white; the tail, except the middle feathers, black, with a broad terminal band of white, as in the Huia (*Heteralocha acutirostris*), the middle tail-feathers white. The wings were smoky-black above, with a few cream-coloured feathers on the underside. Unfortunately the specimen was in such a condition when found that preservation was quite out of the question.

Nycticorax caledonicus (Nankeen—Night Heron).

Some time ago I mentioned having seen an example of this species on the east coast of the Wellington Province, near the Pahau River. Last Christmas I again saw this bird, but a few miles further north, and was informed that it had several times been observed, but always alone.

Art. XIV.—*On the Birds observed during a Voyage from New Zealand to England.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 13th December, 1893.*]

In the bright sunshine, at 3 p.m. on Thursday, the 2nd March, we steamed out of Lyttelton Harbour on board the good ship "Coptic" (Captain Kempson, R.N.R.), bound for London. Flocks of Seagulls (*Larus dominicanus* and *Larus scopulinus*) hovered near us as we left our moorings and bore down the harbour. A few Crested Shags (*Phalacrocorax punctatus*) crossed our weather-bow as we reached the Heads, but as we got away from the coast these birds disappeared, and there was not a sign of animation on the dark waters as we stood out to sea. On the following morning, there being a stiff breeze blowing, we had a number of large Albatroses in our wake, and these kept in close attendance all the next day. Most of them were *Diomedea exulans*, about an equal number of old and young birds, the former in dappled-white plumage and black wings, and the latter in dark plumage with white face and belly. There were also a few of my *Diomedea regia*, all showing the white patch on the humeral flexure very conspicuously. On the 4th March a Skua (*Lestris antarcticus*) made two cruises round the ship and then disappeared, his plump, rounded body and heavy flight rendering him very readily distinguishable on the wing. He came near enough to the ship to make the white spot at the base of the primaries distinctly visible. I saw a pair of what appeared to be *Œstrelata lessoni*. They did not come very near to us, and were not, so far as I could see, very alert on the wing. When about 1,060 miles from port (lat. 50° 31′ S., long. 163° 14′ W.) a Shy Albatros (*Diomedea cauta*) put in an appearance, and after performing one or two wide circuits, often rising high in the air with a very angular disposition of the wings, vanished in the mists of the ocean and was seen no more.

On the morning of the 5th March a very beautiful Albatros (*Diomedea regia*) appeared on the scene. It was of enormous size, and wholly white, except the pinions beyond the second flexure of the wing, looking in the distance like a huge Gannet held against the sky, and so conspicuous in its albinism that it could be readily distinguished among a hundred ordinary birds. So near an approach to perfect albinism I have not before met with among the Albatroses, although, as recorded from time to time, I have obtained several more or less pure albinoes of *Ossifraga gigantea*, one of these having not a vestige of colour on any part of the body. A fellow-passenger, however, Mr. William Temple, who came out to New Zealand by the R.M.S. "Arawa," informs me that last Christmas, when about half-way between the Cape of Good Hope and Hobart, an exceedingly large Albatros, of snowy whiteness, without a single dark feather of any sort, came up astern, and followed the steamer for some time. The chief engineer was induced to stop the engines for half an hour, and lines were thrown out in the hope of taking this beautiful bird. It came very near being caught; but, after one of the ordinary kind had been hoisted on board, the engines were put in motion again and the albino was left behind. These birds are known to live to a great age, and for years to come, in all probability, this majestic Albatros will sweep with its snow-white pinions the dark waters of the South Pacific. Let us hope that at the breeding-season it will repair to one of the great Albatros nurseries periodically visited by the Government steamer "Hinemoa," and that Captain Fairchild, who is ever on the lookout for novelties, may have an opportunity of annexing it for science. These "nurseries" are doubtless a long way off from where the bird was seen, but, as will presently appear, distance is as nothing to an Albatros.

To return, however, to my bird now in attendance on the ship. But for the black-tipped wings this magnificent Albatros might have been the one that so narrowly escaped being hooked by the "Arawa" passengers. He cruises about amongst the other Albatroses, but always at a distance from the ship. The individuality of this bird is so pronounced that it can be distinguished from the rest at almost any distance, and it will be interesting to note how long it will follow the steamer.

It seems to me that we have not yet solved the problem involved in the flight of the Albatros—a rapid, well-sustained motion, ever against the wind, with scarcely any visible movement of the wings. There are some very sensible observations on the subject in Dr. Bennett's "Gatherings of a Naturalist in Australasia"; Professor Hutton has grappled with the mechanical principles it rests upon; and the Duke of Argyll has treated the question in a masterly way in his "Reign of Law." But, after all, can it be said that the problem has been satisfactorily solved? I think not. Sir James Hector believed, with myself, that it might be explained by some peculiar mechanism in the wing of this bird; and at a meeting of our society some years ago he elaborated a very ingenious theory on the subject, exhibiting at the same time an Albatros-wing specially prepared to illustrate his argument. In 1889 he took the trouble to send to England a fine adult

Albatros in spirits of wine for critical examination by an expert. I forwarded it to the well-known comparative anatomist, Dr. Hans Gadow, F.R.S., at Cambridge, but he reported that he could not discover any departure from the normal character in the structure of the wing; and so the matter rests at present. The most remarkable point is that the bird, without any apparent effort—without any visible movement of the limbs themselves—by merely shifting its position so as to alter the angle of incidence, performs an elegant sweep, cutting a great figure 8 in the air, and, as Froude puts it, with the adroitness of an accomplished skater on an untouched field of ice. The one thing that surprises one most, next to this marvellous power of sustained flight, is that the Albatros will soar for hours together without once descending to the surface of the water to feed. And yet, if an Albatros should happen to be caught, it immediately vomits an abundance of pure oil, indicating anything but an empty crop. The squid is said to be its principal food; but where does it collect this diet? and, if it is so plentiful on the surface of the ocean, why do these birds so persistently follow ships in search of food?

6th March.—My White Albatros appeared again about 11 a.m. to-day, so that it must have been on the wing during part of the night. There was an easterly gale blowing, and few birds to be seen. I observed some Dove Petrels (*Prion turtur*), and some other White-bellied Petrels, but too far off from the ship to permit of my identifying them with any certainty. They flew very low, turning often so as to expose the underside, and were rapid on the wing.

7th March.—We had a very tempestuous night, and this morning not a single Albatros was to be seen. But we were now followed by a flock of about forty large Grey Petrels (*Adamastor cinereus*). The flight of this bird is very light and buoyant, with scarcely any movement of the wings, the back being slightly arched, the head drawn in close to the body, and the tail partially spread. The motion is very graceful, and, as the birds unceasingly cross and recross each other's course in ever-varying circles, they furnish the listless passenger on deck with very pleasant diversion. It would seem that different areas or tracts of the ocean's surface are inhabited by distinct species of Petrel, their presence or absence being doubtless regulated by the abundance or otherwise of their special food-supply; and also that this species of Petrel, like many others, hunts in communities. For, as we proceeded on our course, there were fresh recruits, till, at the close of the day, we had fully a hundred of these aerial followers close in our wake. On garbage being thrown overboard they would quickly congregate and settle down upon the waters to dispute over its possession, manifesting their eagerness by a twittering or squeaking cry. About noon (lat. 51° 54′ S., long. 150° 34′ W.) a single Albatros appeared among these Petrels, and later on another, and then a third. A large Black Petrel with a white bill (apparently *Majaqueus parkinsoni*) joined the company for a short time, its dark plumage making it a conspicuous object among the lighter-coloured birds. About 2 p.m. my White Albatros came up to us again, and coursed about in wide circles as before, but disappeared long before nightfall.

8th March.—There was a heavy south-easterly gale during the night, lasting four hours. It had abated somewhat in the morning, but I did not expect to see the White Albatros again. However, he overtook us once more about 2 p.m., and, after a circuit fully a mile in extent, he vanished in the wide expanse, returning later on, and remaining with us till the close of the day. The only other Albatros seen to-day was a Mollyhawk (apparently *Diomedea culminata*), which kept company with the ship for an hour or two, never coming very near but coursing about among the Grey Petrels, which were less numerous than yesterday.

9th March.—The wind being fair, we made a good run during the night, averaging twelve knots an hour. In the morning there were very few Grey Petrels and no Albatroses. It would seem that the latter rest on the surface of the water during the night, and overtake the steamer next day by following her up in a direct line; but, seeing the start the ship has got during the night, this performance presupposes a marvellous power of wing, and not of wing only, but of instinctive knowledge of the course to be followed. I can hardly accept Professor Hutton's theory that this is the result of sight, one set of birds mounting high in the air and following the movements of another set of birds nearer the ship: for example, to-day the atmosphere is hazy, and no power of vision would be of any avail. I watched with much interest for the reappearance of my White Albatros, and, to my delight, true to time—a little after 2 p.m.—he came sweeping up in grand style. Since we first made his acquaintance, on the 5th instant, he has performed a voyage, measured in a straight line, of 970 miles; but when the never-ending circles of flight and gyrations in the air are taken into account, probably three times that distance, or, say, 3,000 miles—perhaps even more! This is one of those incidents in the romance of natural history that set the mind thinking; and one is quite prepared to accept Mr. Gould's conclusions as to an Albatros being able to encircle the globe in its unwearied flight.

10th March.—When the morning broke the wind had fallen, and there was a haze over the ocean which had not cleared away as the day advanced. I looked out anxiously for my White Albatros at the usual hour, but he did not reappear from behind those misty veils, and we saw him no more. Later on a few *Adamastor cinereus* followed the ship, and towards evening a pair of *Diomedea exulans*, but the latter did not stay long.

11th March.—Calm weather, with intense cold and no birds. A solitary Grey Petrel passed and repassed astern of us several times, and then made off across the waste of waters, leaving us to pursue our course easterly without a sign of animation around or above us. Towards evening a Giant Petrel (*Ossifraga gigantea*), the first we have seen, made a long sweep ahead of us, flying low, and keeping at a distance from the ship. This species is common enough in higher latitudes.

12th March.—No appearance to-day of the Grey Petrel, although the weather seemed favourable enough.

13th March.—Grey Petrel again numerous; also *Diomedea culminata*, the young birds (with dark-coloured head and neck) predominating, and an occasional *Diomedea exulans*.

14th March.—At noon on this day we had got as far south as lat. 56° 52′ without, however, having seen any icebergs. The Grey Petrel (*Adamastor cinereus*) is, I should say, far and away the commonest species of bird in these seas. It is evident that the same flock does not keep in constant attendance like the Albatros, because I have noticed that, whereas one day the birds are shy and keep well astern of the ship, the next day they will fly over and around her after-part with every appearance of confidence. We have not, so far, seen any *Diomedea melanophrys*, a form very common in the South Pacific, but inhabiting a somewhat lower latitude. There is said to be a large breeding-place of this species on some outlying rocks near the Chatham Islands, which are visited periodically by the Maoris for the sake of the young birds.

15th March.—To-day was the last of the appearance of *Adamastor cinereus*, which followed us, but in diminished numbers, till nightfall, when we were in lat. 56° 52′ S., long. 82° 10′ W. It is clearly a strictly oceanic species, for we are still 150 miles from land. According to my observations on this voyage, the meridian of 152° represents the limit of its range to the westward; and it is significant that during the whole of my experience in New Zealand I have never known of its occurrence more than once in our adjacent seas. Last year Captain Fairchild (as already recorded*), on his return voyage from the Chatham Islands in the "Hinemoa," came upon a flock of them in calm weather. He stopped the engines,

* Trans. N.Z. Inst., vol. xxiv., p. 69.

lowered a boat, and shot a pair of them, which he sent to me in the flesh.

16th March.—Sighted land at 10 a.m.—the island of Diego Ramirez. A flock of penguins reported on our starboard side, disporting themselves in the water, but I did not see them. I observed a pair of *Ossifraga gigantea*, a single *Diomedea melanophrys*, and a very fine *Diomedea regia*, the white marking on the wings being very conspicuous. Off Cape Horn I noticed several large Black Petrels with very rapid flight, which I was unable in the distance to identify; also a pair of *Oceanites oceanicus*, fluttering over the water like butterflies, although the sea was smooth.

17th and 18th March.—As we passed up into the waters of the South Atlantic, the weather being thick, bird-life for a time disappeared; but on nearing the Falkland Islands a Black Shag, after hovering round us on wearied wing for half an hour, took refuge on the ship.

19th March.—Dense fog in the morning, and no birds. It cleared off in the afternoon, and after passing the Falklands I saw a small Grey-and-White Petrel in the distance, and a solitary *Ossifraga gigantea.*

20th March.—Wet and foggy in the forenoon; not a wing to be seen. At noon we were in lat. 47° 30′ S., and in long. 53° 41′ W. I saw an Albatros in the distance (apparently *D. melanophrys*), a pair of black-and-white Petrels of large size; also a flock of what appeared to be *Prion turtur*, or an allied species; and, at intervals, scattered flocks of *Oceanites oceanicus*, their white croup showing very conspicuously as they skimmed the surface of the water in their erratic flight.

21st March.—A flock of Storm-petrels, and a few other birds too remote from the ship for identification, completed the day's list.

22nd and 23rd March.—One is much impressed by the general absence of bird-life in the South Atlantic. The waters are intensely blue to-day, with a light breeze blowing, causing crested wavelets as far as the eye can reach, but there is no sign of anything except a solitary Storm-petrel now and then, or a pair of some larger species. Captain Kempson, who has made this journey by steamer two-and-twenty times, informs me that, as a rule, no Albatroses are to be seen after passing the Falkland Islands, but that in the winter months, and especially in August, he has known them to follow the ship some hundreds of miles further north. In the Indian Ocean, on the other hand, he has met with Albatroses two days north of the Cape of Good Hope, or quite near to the equator.

24th March.—To-day, when about a hundred and forty miles from Rio, in lat. 29° 25′ S., and long. 45° 53′ W., a

Noddy (*Anous stolidus*) came up to us, and, after hovering about for some time with a beautiful hawk-like flight, alighted on the ship. From the absence of white on the crown, it was evidently a young bird, and it was so tame and fearless that I actually touched it with my hand before it took flight again.

26th March.—We found ourselves early this morning in the spacious and picturesque harbour of Rio. A string of black shags passed us as we were approaching our anchorage, and one or two large gulls were hovering in the harbour, whilst high overhead birds called "Kites" by the residents, but in reality the small Frigate-bird (*Tachypetes aquila*), were soaring about. On landing, I was astonished to see seven or eight of these "vultures of the sea" disporting themselves in the air inside the quay, and within easy stone's-throw of the people who were crowding the thoroughfare. They were apparently intent on floating garbage, and it was most interesting to watch their rapid evolutions on strong pinion, sometimes hovering with slow flappings of the wings, the head being turned first to one side then to the other, often wheeling suddenly down, with their forked tails quickly opened, to within a few yards of the bystanders, their crimson and yellow pouches being plainly visible as they came near to us.

27th March.—As we were leaving our anchorage a Booby passed us on the wing, and I could hear the call of a Tern, although the bird was not visible.

28th March to 1st April.—During the last five days, although the light south-east trades were blowing, and the tropics comparatively cool, there was not a bird to be seen. Twice only I saw in the distance a small flock of Petrels flying low. The only sign of animation was furnished by the shoals of tiny flying-fish, quitting for a moment their natural element, and performing a direct, rapid flight, as if endeavouring to elude the pursuit of some enemy under the surface.

2nd to 4th April.—Gentle north-east trades blowing. No birds seen when we were crossing the Line except an occasional Storm-petrel performing its erratic flight over the surface of the water after the manner of a bat hawking for flies.

8th April.—To-day, when abreast of Bonavista, one of the Cape de Verde Islands, a pair of Boobies hovered round the ship, as if to reconnoitre, and then disappeared (lat. 16° 10′ N., long. 22° 17′ W.).

9th to 10th April.—Not a bird of any kind.

11th April.—About 2 p.m. a Turtle-dove from the shore came on board, and rested in the rigging.

12th April.—Off Teneriffe. The common Seagull of this part of the world, *Larus cachinnans*, hovered about in large numbers as we lay at our anchorage for several hours, quarantined on account of yellow-fever at Rio.

13th to 15th April.—No birds of any kind.

16th April.—Whilst in the Bay of Biscay a Stone-chat from the mainland came on board, and remained an hour or two in the rigging. Whales were disporting themselves about the ship, the sea being very calm, but there was a remarkable absence of bird-life. Indeed, we saw nothing more till we reached the English coast.

Notes made on the Return Voyage from Plymouth to Auckland, by way of the Cape of Good Hope.

(Supplementary to Article read on 13th December, 1893.)

WE left Plymouth in the R.M.S. "Doric" at 2 p.m. on Saturday, the 27th January, 1894, with a stiff breeze blowing from the S.W. We were fortunate enough to be again under the command of Captain Kempson, transferred from the "Coptic." This head-wind afterwards changed to W.N.W., and increased in force till it had become a gale in the Bay of Biscay. We had a bad night on the 28th, but the morning of the 29th broke fine, with a light breeze from N.W. to W., and a comparatively calm sea. The Sea-gulls (*Larus marinus*) which had followed us out from Plymouth, and had stood by us all through the storm in the Bay of Biscay, now suddenly disappeared, and when we were about eighty miles from the Spanish coast there was not a wing to be seen of any kind, the only sign of animation being the occasional appearance of a school of small porpoises, plunging madly through the sea. Till our arrival at Teneriffe, at noon on the 1st February, we saw nothing more; but on reaching our anchorage at Santa Cruz, with the Peak, more than 15,000ft. in height, full in view, we were again visited by *Larus marinus*; and till about noon on the following day we were attended on our voyage by the Grey-backed Gull (*Larus cachinnans*). For the rest of the day there was not a sign of life on the dreary waste of waters. This may be in a measure due to the season of the year. The last time I traversed this part of the ocean it was summer, and thousands of "Portuguese men-of-war" (*Physalia*) were floating on the surface of the water or dancing on the waves. On taking one of these curious little animals on board with a bucket, it caused much amusement among the passengers by its power of giving off, on being touched, a peculiar electrical shock. The body secretes an acrid fluid, and the long blue threads or filaments cling firmly to the hand on the slightest touch, and sting like nettles.

3rd February.—About 10 o'clock this morning I saw a large Petrel, dark-grey on the upper and white on the under surface, which followed in our wake for an hour or more with a very hawk-like flight. After this, not a wing of any sort nor other sign of animal life till night, when the sea was ablaze with phosphoric displays—sparks and flashes of light—given out, no doubt, by Medusæ and other small invertebrate inhabitants of the deep; but, in addition to this, the whole of the disturbed water seemed luminous, the effect being probably due to the decomposition of animal matter on the surface of the ocean. There had been a breeze from the E.N.E. all day, it was misty in the afternoon, and there was nothing in the way of a sunset. The night was dark, and these phosphorescent effects were very beautiful. Jupiter was resplendent in the heavens, and Sirius shone with his accustomed pale effulgence; but the sparkling lights on the surface of the water as our steamer ploughed her way through it seemed more brilliant even than those of the firmament above: everywhere points of light that flashed like sparks from a giant dynamo and expired in a tiny illumination, and occasional balls of lambent flame which dashed past the ship and then dissolved in an instant in the seething foam, reminding one of Coleridge's graphic, although perhaps rather overdrawn, description: "A beautiful white cloud of foam at momently intervals coursed by the side of the vessel with a roar, and little stars of flame danced and sparkled and went out in it; and every now and then light detachments of this white cloud-like foam darted off from the vessel's side, each with its own small constellation, over the sea, and scoured out of sight like a Tartar troop over a wilderness." Darwin writes in "The Voyage of the 'Beagle'" (ed. 1893, p. 154), "While sailing a little south of the Plata on one very dark night, the sea presented a wonderful and very beautiful spectacle. There was a fresh breeze, and every part of the surface, which during the day is seen as foam, now glowed with a pale light. The vessel drove before her bows two billows of liquid phosphorus, and in her wake she was followed by a milky train. As far as the eye reached the crest of every wave was bright, and the sky above the horizon, from the reflected glare of these lurid flames, was not so utterly obscure as over the vault of the heavens." Later on, in discussing this phenomenon, he says, "I am inclined to consider that the phosphorescence is the result of the decomposition of the organic particles, by which process (one is tempted almost to call it a kind of respiration) the ocean becomes purified." Although now about a hundred miles from the African coast, a quantity of impalpable red dust was deposited to-day on the ship, all the rigging being more or less tinted with it. It is no doubt composed of minute Infusoria, instances of the kind being not uncommon. I collected a small packet of this red dust on the captain's bridge, and have handed it over to Sir James Hector for microscopical examination.*

4th February.—A beautiful cool day, with just sufficient breeze to fan the air. No sea-birds, but when about sixty miles off Cape Verd a small bird of the size and general appearance of a Hedge-sparrow came on board and remained about an hour in the rigging: greyish-brown, with black cap, and rufous spot on forehead. About 11 o'clock at night a Storm Petrel *(Oceanites oceanicus)*, attracted by the glare of the electric light, dashed itself on board, and was captured by one of the passengers. It proved on dissection to be a ♀, and the stomach contained pasty organic matter of a greyish-brown colour. Length, 8·5in.; extent of wings, 17·5in.

5th to 7th February.—No bird-life of any sort; but plenty of Flying-fish, and a solitary whale disporting itself in the distance. We crossed the Line at 7 p.m. The night was dark, and there was not a spark of phosphorus on the waters, nor was there on the 6th, although the night before the whole ocean seemed illuminated. It is difficult to account for this uncertainty in its appearance.

8th February.—No birds; but about noon I observed two large porpoises in the distance, moving very languidly, as if it was too much exertion even for them to plunge about in this tropical heat. To-day is beautifully fine, but there is no animated object to break the monotony of this great wilderness of waters. Since seeing the large Petrel on the 3rd instant we have traversed over two thousand miles of ocean without seeing so much as the wing of a bird, with the exception of the Storm Petrel that came on board on the 5th, and the little visitant from the shore on the preceding Sunday. In this respect this is a veritable Dead Sea: so different indeed from the great southern ocean, with its plenitude of bird-life at all seasons of the year! We look for a change in this respect now that we have crossed the Equator. At noon I observed a large dark Petrel with white croup, but too distant for identification, and later in the day four Storm Petrels *(O. oceanicus)* hunting in company.

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* Report on specimen submitted:—

RED DUST from the rigging of s.s. "Doric," 100 miles off the African coast, in lat. 19° 53′ N., and long. 18° 30′ W.

Consists of about 90 per cent. of sea salt, in rough grains = $\frac{1}{50}$in. —which readily develope characteristic crystals. The colouring matter (reddish-brown) is organic; and about 1 per cent. of the organic matter has distinctive form as follows:—(1.) Frustules of a marine diatom (*Synedra fulgens*). (2.) Spiculæ of sponges. (3.) Elongated and jointed cells, probably fucoidal. (4.) Calcareous spines with a deep groove, probably echinodermid. I think the deposit must be tropical sea-scum that has been picked up by a tornado and distributed in an upper air-current. It is certainly not material swept from a land-surface.—JAMES HECTOR.

9th February.—I watched for a considerable time from the bows of the ship, which afforded an excellent post of observation, the movements of the Flying-fish. There are two kinds in this part of the ocean, a larger and a smaller, both belonging to the genus *Exocœtus*. One of each species came on board, at different times, so I had an opportunity of examining them. The larger one measures, in extreme length, 19in.; spread of pectoral fins, 23in.; length of pectoral fins, 10·75in. The smaller one measures 9in., with a spread of 10·75in., the length of the pectoral fins being 4·75in. There are important structural differences in the two forms, and their colouring also distinguishes them. The smaller species, which is by far the more abundant of the two, has the upper surface dark indigo-blue, the sides of the body bright cobalt, the under surface white, and the eyes lustrous black, with orbits of iridescent blue; the fins are bluish-grey with transparent colourless webs, and the tail is greyish-white. The larger species is naturally more vigorous on the wing and capable of a more sustained flight than the smaller kind. The latter performs a flight of twenty to thirty yards, and then drops abruptly into the sea. As a rule the flight is direct, even against the wind; but occasionally I observed a vigorous flyer make a half-circuit, and I observed one turn back slightly on its course. Immediately after rising out of the water the fish often dips to the surface, apparently for the purpose of gaining fresh impetus by means of the produced lower vane of the tail, which is the only part that touches the water. The wings do not vibrate, but are perfectly rigid. The tail is used as a means of propulsion not only at starting, when it ploughs a little course in the water, but at intervals during the flight, when the fish dips to the surface, and, touching the water with this member, seems to be impelled forward again. About 11 o'clock this morning, when about six hundred miles from Ascension Island, and eight hundred miles from the coast of Africa, a pair of large Grey Petrels passed our weather-bow, flying low and rapidly, but we saw nothing more of them.

10th and 11th February.—No birds, but calm and hot days, with Flying-fish in large shoals. The nights are clear and beautiful, the unusual brilliance of the starlight being no doubt due to the great rarity of the atmosphere. Orion's Belt, to my mind the most beautiful of the constellations, was specially brilliant; and on the evening of the 10th we had our first view of the Southern Cross.

12th February.—The wind strengthened during the night, and now we are experiencing the steady N.E. trades, which will probably go through to the Cape with us. The entire absence of birds is very remarkable, for we have had all kinds of weather: first of all the warm Guinea current, of mysterious origin, running with us; later on the Equatorial current running against us, and then the still waters of the Tropics; at first light S.W. winds in our favour, and now these trade-winds right in our teeth, with a broken sea; and yet no birds of any kind whatever! We have now travelled three thousand miles over this vast solitude without seeing any birds, and Captain Kempson tells me it is always so. Well may the Arabs term it the "desert of water." In the afternoon a Grey Petrel (of the size and appearance of *Puffinus griseus*) appeared in sight, but did not remain very long. At night the water was phosphorescent again; but we seemed now to have some different kind of animal producing this effect, for they kept as near as possible to the sides of the ship, and the sparks of light emitted presented a green tinge.

13th February.—Weather unchanged. The Grey Petrel appeared again at intervals; no other object.

14th February.—The wind has freshened, and there is now a rough sea. The Grey Petrel (if the same) has been joined by a mate, and they have remained with us all day. About noon we bore down upon a flock of about fifty Cape Gannets (*Sula capensis*) floating on the water. This species is distinguished by its nearly black tail. During the whole of the afternoon we were attended, at a long distance astern, by a small Albatros which I take to be the true *Diomedea culminata*, but not the species hitherto referred to by that name in New Zealand, which has lately been distinguished by Messrs. Rothschild and Salvin as a distinct form, and named *Diomedea bulleri*.

15th February.—The wind freshened during the night, and to-day we have had a heavy swell setting in from the westward, along the wide expanse of ocean stretching away to Cape Horn. We have been steaming most part of the day only about fifty miles from land, and have seen more birds. In the afternoon we came upon a flock of *Diomedea culminata* (?), about twenty in number, disporting themselves in the water on our weather-bow. They took no notice whatever of the steamer, although we passed quite near to them. In the evening a pair of Boobies (*Sula fusca*) passed us on the wing. We also came upon a flock of fifty or sixty Shearwaters (? *Puffinus major*), and saw in the distance what appeared to be a pair of *Lestris catarractes*.

16th February.—As we approach the Cape bird-life is getting plentiful. The small Albatros already mentioned is ever present, but, as a rule, keeps at a distance from the ship. Large Seagulls hover over us, and the little Penguin (*Sphenisceus demersus*) plays about in the water, singly or in pairs, diving frequently and remaining long under the surface. Shags, and Petrels, and Boobies are plentiful, and an astonishing number of Gannets. Of the latter I counted one hundred in less than twenty minutes, all proceeding northward, going with the wind and flying high. I observed about half a dozen going in an opposite direction and against the wind, and these kept very near to the surface, where, owing to the waves, the resistance would be less felt. As we reached Table Bay, about 9 p.m., a perfect storm came over the mountain, and we had to cast anchor in the offing and wait for it to abate. Was it the instinctive knowledge of the approaching gale that made all the Gannets hurry northward for shelter in the afternoon? On Wednesday night the whole sea was aflame with phosphoric light; last night and to-night it was black as ink. This may be due to sudden changes of temperature in the water.

17th February.—At 9 o'clock last night we anchored outside the breakwater. It was blowing a hurricane, and, although we were fully two miles from the shore, while on deck our eyes were punished with the fine wind-borne dust. The gale subsided during the night, and at 6 a.m. we moved in to the usual anchorage. The bay was alive with the common Seagull and a species of Shag (*Phalacrocorax capensis*). I was interested in watching the fishing operations of the latter. When it dives it springs bodily out of the water and goes down head foremost. I timed the dive with my watch. It generally lasted from a minute to a minute and a half, but in one instance the bird remained under water a second beyond two minutes! During the forenoon one of these Shags settled in a boat hanging in our davits, and suffered one of the sailors to capture it without offering any resistance. I handled it afterwards and found it quite docile, but it was in very poor condition, and probably out of health.

18th February.—On leaving the Cape of Good Hope yesterday, before a strong head wind, and again to-day, we have been attended by two or three Mollyhawks (*Diomedea melanophrys*) and a large greyish-brown Petrel which is unfamiliar to me. In the afternoon we saw a pair of Storm Petrels, greyish-brown with white underparts—probably *Pelagodroma marina*.

19th February.—The same birds reappeared in the morning; and in the afternoon a small whale came up to within a mile of the ship, plunging and spouting. Then he took alarm and disappeared in the depths of the ocean, not even venturing up to spout.

20th February.—During the morning a large white Petrel, evidently *Œstrelata glacialoides*, appeared several times, but never very near to the ship. About 10 a.m. I saw the first Wandering Albatros (*Diomedea exulans*), a fine adult bird in full plumage.

21st February.—Lat. 43° 20′ S., long. 41° 14′ E. Several

Diomedea exulans, and one *Diomedea regia*—distinguishable at almost any distance by its perfectly white head and neck and the large amount of white on the wings—were in attendance to-day. There were also some Dove Petrels (*Prion turtur*), and fully a dozen Black-bellied Storm Petrels (*Fregetta melanogaster*). The last-named species is very active on the wing, flies high and in wide circles, a manner of flight very different from that of the other species of Storm Petrel already noticed. It seems to be decidedly gregarious in its habits, whereas *Oceanites oceanicus* is a solitary species, being generally seen singly or in pairs. During the day several of the Sooty Albatros (*Diomedea fuliginosa*) followed us, and I noticed that this species sometimes sails in couples, which *D. exulans* never does, nor indeed, so far as I am aware, any other species of Albatros.

22nd February.—Wind has veered round to S.S.W., and there is a heavy swell. Unusually cold for this latitude and this season of the year: water 45° Fahr., and the atmosphere, in the shade, 48°. On Saturday the temperature of the water was 70° Fahr.; to-day it is only 60° Fahr. The reading in the shade yesterday was 51°, and the day before 61°. But the inequality of temperature of the atmosphere in these latitudes is sometimes very remarkable. Captain Kempson tells me that on his last voyage Home, when in sight of Cape Horn, the temperature in the sun was 85° Fahr., whilst in the shade, on the other side of the ship, the thermometer stood at 50°. This is almost as curious as Captain Scoresby's report that at 80° north latitude he had the pitch melted on one side of his ship by the heat of the sun, while water was freezing on the other side owing to the coldness of the air. Now that we are getting beyond the influence of the warm current from the Mozambique, birds are getting more numerous: a few *Diomedea exulans*, a splendid pair of *D. regia*, and six of *D. fuliginosa* (the "Cape Hen" of sailors) remained with us nearly all day. When about sixty miles from the Crozets a fine Skua (*Lestris antarcticus*) appeared among them, and instantly gave battle to a Sooty Albatros. Before finally leaving us, he mounted high overhead and took a good survey of the ship. *Prion turtur* very abundant; also, in less numbers, a larger species, probably *Prion vittatus*.

23rd February.—We are attended to-day by a large number of sea-birds, including the three last-named species of Albatros,—*Diomedea fuliginosa*, however, preponderating. The flight of this species is very easy and buoyant, and it rises more gracefully out of the water than any of the other species of Albatros. When on the wing the somewhat long, wedge-shaped, tail is very conspicuous. It is a powerful flyer, and Captain Kempson says he has known a marked bird follow the ship for three thousand miles at a stretch. The number of these Sooty Albatroses continued to increase till in the afternoon I counted five-and-twenty in close attendance on the ship. There was a single grey-and-white Petrel which I referred to *Adamastor cinereus*, although we do not appear to have yet reached the ordinary range of that gregarious species. *Fregetta melanogaster* was particularly numerous, hunting as it were in a community, often rising high in the air and performing a rapid bat-like flight, very unlike that of the other Storm Petrels. The *Prions* that were so plentiful yesterday have entirely disappeared. This sudden absence, although the conditions of weather and sea remain the same, seems to prove the theory I have previously advanced that flocks of different species feed over certain tracts of the ocean, the particular areas being no doubt in great measure determined by the food-supply.

24th February.—The swell has subsided, and the wind is sufficiently favourable to enable us to have all our sails set. But there is a slight mist on the ocean, and not a bird of any kind to be seen. If the sea-birds are guided to the ship by their vision, the explanation is sufficiently obvious. A haze over the ocean renders the ship invisible at a little distance, although there may be, to all appearance, as seen from the deck, a clear space around it. The birds follow the ship on the same principle that Terns and Seagulls follow the plough on a newly-turned field. As the latter glean the grubs and worms, these feed on the small marine animals that are brought to the surface by the disturbance of the water in the ship's course, as well as on the garbage thrown overboard from time to time. We were now about 250 miles from Kerguelen's Land. In the afternoon the mist lifted, and we were at once visited by a few Albatroses and Storm Petrels, and by about half a dozen of the Grey-and-white Petrel (*Adamastor cinereus*), whose customary range we appear now to have reached.

25th February.—This morning we were about twenty miles to the eastward of Kerguelen's Land. For the first time on our voyage out the Giant Petrel (*Ossifraga gigantea*) put in an appearance, there being several of them coursing about the ship; also another species of Petrel, a large black bird with whitish bill (? *Majaqueus parkinsoni*), and a number of the true Mollyhawk (*Diomedea melanophrys*), their yellow bills glancing in the sunshine as they sailed around the ship. *Adamastor* and *Prion* rather numerous; a single example of my *Diomedea regia*, a few *Diomedea exulans* and *D. melanophrys*, one of the latter having a single white primary in the right wing. As the day advanced the Prions increased to hundreds; but in the afternoon, as we got farther away from the land, they diminished in number and finally disappeared altogether, whilst *Adamastor cinereus* became more numerous. At 8 p.m., there being no moon, but a fair amount of starlight, an *aurora australis* illumined the western heavens. The phenomenon commenced with the appearance of two comet-like expansions of light, and then changed to a series of huge luminous rays of irregular size, arranged somewhat in fan fashion, and resting on a bank of clouds. The rays were not persistent, but seemed to change their position and their intensity every few minutes, and there was an entire absence of tint or colour. At the end of half an hour the appearance gradually faded away, and soon afterwards the moon rose.

26th February.—Saw yesterday, for the first time during the voyage, the young of *Diomedea exulans*, in slaty plumage with white face. Surprise has often been expressed at the relative fewness of the dark-coloured Albatroses as compared with the white-plumaged ones. But the explanation is a very simple one. There are two closely-allied species of Wandering Albatros (*D. exulans* and *D. regia*), one of which is white at all ages. Supposing, therefore, that a pair of each has one young one, the proportion of white birds to dark in the two families will be as five to one—that is to say, two adult *D. exulans*, two adult and one young *D. regia* (all of these white), to the one young *D. exulans* in dark plumage. In addition to the four species of Albatros, we have to-day *Majaqueus parkinsoni*, but no *Prion turtur*. We have now the "brave west wind" right aft, with the sea mountains-high, and a very rough sea does not suit the Dove Petrel. The manner in which numbers are cast ashore on the strand after every heavy gale is sufficient proof of this. At noon to-day—three hundred miles from land—a Skua (*Lestris antarcticus*) passed twice round the ship, and returned later in the day to complete the inspection, flying high, and in a very hawk-like manner. *Adamastor cinereus* in great numbers to-day, Their flight is an easy one, alternately soaring and skimming, with very rapid evolutions, and they seem rarely to descend to the water to pick up food. In calm weather they look very pretty as they wheel about simultaneously in a large flock, their white underparts gleaming in the sunshine. Among the Sooty Albatroses following the ship one exhibited a broad white patch on the nape.

1st March.—Same birds as yesterday. The steamer having stopped for twenty minutes, I observed that in calm water *Adamastor cinereus* dived for its food, first settling down on the surface, and then diving for a moment quite out of sight. About 11 p.m. the *aurora australis* was again announced, and the passengers left their cabins and crowded on deck to observe this strange phenomenon. It was certainly very magnificent. At first a luminous arch with a broken or irregular outline, and resting as it were on a bank of cloud, appeared in the western sky, covering an extent of fully 50°. From this arch rays or flashes of white light ascended fitfully to the heavens; these long beams of light, shooting upwards almost to the zenith, travelled slowly along the arch, always moving from east to west; whilst every now and then a luminous expansion, like the tail of a giant comet, appeared in the sky for a few seconds, and quickly faded away. Then the arch widened, and presented a more regular circumference. This was succeeded by a pale rainbow-like effect of blending red and purple colours immediately above it, with coruscations of pure white light, forming a shifting halo, and, for a few seconds only, a less perfect and fainter bow below the arch. This grand effect lasted only a brief time, and with its disappearance the arch itself melted out of sight. At this conjuncture the moon, which had hitherto been obscured, made her appearance through a rift in the clouds, and, although in her fourth quarter, shone forth with unusual brilliance. At the same moment a shimmering beam of light appeared below the shining crescent, and continued to lengthen itself out till it seemed to touch the horizon, when it gradually melted away; but the whole of the western sky was still illumined with flashes of pale light and luminous clouds which quivered and pulsated as if produced (as no doubt they are) by electricity, and then insensibly passed away, the whole phenomenon from first to last occupying barely thirty minutes.

2nd March.—Lat. 48° 35′ S., long. 111° 26′ E. The white-marked Sooty Albatros is with us still. We first saw it on the 29th, and we have ever since been steaming at the rate of fourteen knots an hour. At 5 p.m. the rare *Œstrelata antarctica* paid us a visit, and made three circuits at a moderate distance from the ship. It is a beautiful object on the wing, and has a very graceful flight. Saw what appeared on the wing to be a pair of *Puffinus bulleri*.* They carry their long pointed wings in a bow shape, and make rapid sweeps in the air, crossing always in front of the ship.

3rd March.—Saw several of what I take to be *Œstrelata neglecta*. They are powerful on the wing and fly high, often in pairs, crossing in front of the ship, and never astern like *Adamastor*.

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* *Puffinus bulleri*, Salvin. The proper range of this species has not yet been ascertained or defined. The type, now in the Rothschild collection, was picked up by me on the Waikanae coast many years ago. Another specimen (the type of *Puffinus zealandicus*, Sandager) now in my possession was taken at Mokohinau Island, in the Hauraki Gulf, having dashed itself against the lighthouse at night; and the only other known specimen, now in the British Museum, was obtained from a dealer, labelled "from New Zealand seas." These may therefore be only stragglers out of the ordinary range.

4th March.—Besides *Œ. neglecta*, there were a few of *Adamastor cinereus* to-day, but this was its last appearance.

7th March.—Arrived at Hobart in the early morning. The harbour was alive with porpoises. There were the usual Seagulls and estuary birds, such as Gannets and Penguins, and a flock of Mutton-birds (*Puffinus griseus*) numbering many hundreds, and packed so closely together on the water that they looked like a sand-bank or reef till the approach of the steamer made them take wing.

7th to 12th March.—There was nothing deserving of special mention from Tasmania to New Zealand. For two days out the weather was rough and wet, and few birds were to be seen, but after that *Diomedea exulans* became very numerous, with a fair proportion of young birds, and now and then a solitary *D. regia*. Acting on a suggestion made by Professor Newton, I obtained a number of snap-shots at these birds with a Kodak camera for the purpose of illustrating their manner of flight. On the morning of the 12th we sighted land. When about twelve miles from the shore a pair of *Larus dominicanus* came off to us, and remained in attendance on the ship down the coast to Auckland. A Kingfisher also came off to welcome us, and made a circuit of the ship, then attempted to come up again, but was apparently too much exhausted, and finally sank to the surface and disappeared. In the Hauraki Gulf *Majaqueus gouldi* was occasionally seen, and small parties of the Diving Petrel (*Halodroma urinatrix*) were disporting themselves in the water. The shades of evening had closed in upon us when we cast anchor inside of Rangitoto, and the calling of the Morepork could be heard from the shore, bringing back many pleasant associations of New Zealand life.

Art. XV.—*On the Importance of New Zealand Biological Collections.*

By G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 9th August, 1893.*]

My attention was first directed to this subject by a most interesting address read by Dr. Sharp before the Entomological Society of London, in January, 1888. Since that time I have thought a good deal about the changes that are being produced by civilisation on the living animals and plants in New Zealand.

The fauna and flora of these Islands are, I believe, largely composed of endemic species of great scientific interest, but, at present, excepting the efforts of a few private individuals, very little appears to have been done to make any complete collections of our plants and animals. Probably many important species are already completely exterminated, and there is not the least doubt that a very large number are rapidly approaching extinction. The annihilation of obscure forms of life no doubt appears to a great many people a matter of small importance, and they would probably regard the careful collection and preservation of the smaller plants and animals as quite unnecessary. Ideas of this kind, however, simply arise from the present imperfect state of scientific knowledge. There are very few who have not some interest in such extinct animals as the moa and the mammoth, and who do not regret that they are unable to see these creatures as they actually appeared when alive. The Maoris, or other people who destroyed the last of the moas, had no ideas of this kind; they regarded their dinner as of far more practical importance. The Siberian peasants had even more advanced ideas on economic utility, as they used the flesh of the frozen, extinct mammoth to feed their dogs. I am afraid that our more cultured successors, whose scientific knowledge will have become a little more developed than ours, will regard us in very much the same light as we now regard these savages. They will say that "the people of the nineteenth century, in their haste to obtain wealth, altered the face of the earth, not even taking the trouble to preserve collections of its ancient inhabitants for our instruction." I think that, if we do not wish to incur future criticism of this kind, more efforts will have to be made in the direction of making and preserving collections than has yet been done.

Setting aside for a time the enormous value of such collections to future naturalists, I should like to direct attention to their importance, from an educational point of view, at the present time. It is, I believe, generally admitted that far more lasting and accurate knowledge is gained by direct observation than by instruction through the medium of books. There is no doubt, then, that well-arranged collections would enable students to arrive at a far more definite knowledge of the science of biology than is at present possible. The appearance of such collections would also act as a stimulus, first to collecting, and afterwards, as a natural result, to scientific study. It has been noticed in nearly every instance that the greatest biologists in different branches have risen from the vast body of ordinary collectors. I am sure that if complete and well-arranged collections of the New Zealand fauna and flora were to be seen in the Wellington Museum our naturalists would largely increase. As an example, I may mention that I know of several persons whose attention to entomology has been solely aroused by the cabinet of New Zealand insects which Mr. Palmer presented to the Museum some years ago. It is, as Professor Huxley has pointed out, an easy transition from "simple curiosity" to "natural science," and I feel confident that the inspection of collections is far more likely to arouse such curiosity than any amount of school-teaching. As to the present modes of education, I think their success must be regarded as somewhat questionable, as we observe that in the majority of instances there is not the slightest desire for any kind of intellectual advancement after the requisite examinations have been passed. This subject has, of course, been fully discussed, with great ability, by Herbert Spencer, but his system of education is, unfortunately, far from being followed out even now; hence, no doubt, the imperfect result.

Under the present museum arrangements it is certain that all the best collections of both fauna and flora are sent to England. They are not sufficiently appreciated or looked after here, and it is but natural that workers who have spent many years and much labour in getting together good collections should desire to see them safely deposited in an institution like the British Museum, where their careful preservation is insured. At the same time, there cannot be the least doubt that such collections would be far more valuable in the colony, as they would assist students in investigation by enabling them to identify and classify their specimens with ease and accuracy. At present, for the want of local collections, any worker in any branch of natural history is obliged to send specimens to Europe for identification. I have, by following this course, got together a named collection of Lepidoptera, comprising about 250 species (or less than half of the known New Zealand lepidopterous fauna), and, judging from the number of applications I receive for the identification of species, it would appear that there is nothing of the kind in any of the New Zealand museums. I presume the other branches of biology are in much the same condition. In fact, I know that if I wish to obtain the name of a plant, mollusc, crustacean, or, in fact, almost anything, I have to consult specialists who have their private collections to refer to. These should certainly be represented in the Museum. In fact, if museum collections were once established, they could be easily extended indefinitely by adopting the same course as that followed by many entomologists. It is a generally-understood thing that in naming insects for a correspondent a specimen is forfeited for every identification; consequently, if the Museum undertook the identification of all plants and animals submitted to it, its collections could be increased almost without expense, and would thus become more widely known, and the ratio of their increase would be cumulative. Exchanges could also be carried on, if desirable, with museums in other countries, and collections of great variety, magnitude, and value might thus be readily formed. In fact, the Museum would have such great advantages over private individuals that its collections would soon become the accepted standards for reference.

Few branches of natural science are now regarded as of greater importance than the geographical distribution of organisms. The occurrence of the same species and genera of animals and plants at remote localities on the earth's surface has been often regarded, by geologists and others, as affording the best evidence of the configuration of the land and water in long-past epochs of the world's history. Many other facts have been derived from a careful comparison of forms of life obtained at widely-distant localities. These are related in a most concise and masterly manner by Charles Darwin in that truly marvellous work "The Origin of Species." With your permission, I will briefly quote two examples as instances of what may be learned from geographical distribution. It has been noticed that a very close relationship exists between the marine productions on each side of the Isthmus of Panama, a fact apparently only to be explained by the existence of an opening between the two Americas at a period not sufficiently remote to have allowed any important modifications to have occurred in the organisms on each side of the present isthmus. There is also a very close relationship between the high alpine fauna and flora and the arctic fauna and flora all round the world in the Northern Hemisphere, apparently indicating that at one time the intervening lowlands were under an arctic climate, a gradual increase in heat driving the organisms northwards and to the mountain-tops, where they now remain as isolated survivals, the inhabitants of the most remote summits showing the closest possible resemblance to one another. These, and many other facts of equal interest and importance, have been derived from our scanty knowledge of geographical distribution, and it may be reasonably anticipated that other equally-important facts will be discovered as our knowledge in this direction increases.

It is almost unnecessary to state that no approach to a complete knowledge of the geographical distribution of living beings can be attained without the formation of exhaustive collections in each country. One effect of modern civilisation is to alter the ancient distribution of all organisms; and the importance of speedy attention to this branch of knowledge is manifest, unless, indeed, we are content to let everything go, and thus forbid any accurate knowledge of the prehistoric earth from ever being obtained. The importance of New

Zealand in connection with the subject of geographical distribution cannot be overestimated, and the alterations which have already taken place in both fauna and flora are enormous. It is really incredible that the first and best efforts of New Zealand scientists should have been directed to the fossils. Extensive collections have been made of these, which, above everything else, could best have been left alone. They are neither subject to extinction nor to modification like the living forms, and a sojourn of a few more hundred years in their original museum, the crust of the earth, would not in any way have detracted from their use or value to future scientists. Already it is often difficult to say whether many species of animals and plants are indigenous, or whether they have been accidentally introduced by man, and many questions of great importance must thus for ever remain unanswered. As I have already said, if immediate steps are not taken to make good collections, everything that could be learned from geographical distribution will be irrecoverably lost.

In conclusion, I should like to mention, for the satisfaction of those who always desire to know the use or incentive to the study of the various branches of natural science, that, as Dr. Burmeister well puts it, "The chief incentive to our study of natural bodies in general is the instinctive impulse of the human mind towards progressive information, and the extension of the circle of its knowledge; but in this pursuit a multiplicity of useful discoveries are made which are applicable to daily life, and which distinctly show the evident advantages of the science, although their elicitation can never be considered the primary object of scientific research."

In connection with this it may also be stated that all the modern inventions and discoveries—which, by the way, the unscientific have not been slow to avail themselves of—were only found by men who were investigating natural forces purely with the desire for information, as prior to the discoveries their labours had no apparent economic value. The experience of the past has taught us that scientific inquiry is incessantly aiding us in everyday life, and we may rest assured that, as knowledge increases, this will continue to be the case, but, if every branch of investigation is to be stopped unless it can be proved to be immediately remunerative, it is not likely that we shall succeed in discovering any really new useful facts.

Art. XVI.—*Descriptions of New Species of* Araneæ.

By A. T. Urquhart, Corr. Mem. Roy. Soc. of Tasmania.

[*Read before the Auckland Institute, 23rd October, 1893.*]

Fam. THERAPHOSIDÆ.

Gen. Nemesia, Latr.

Nemesia kirkii, sp. nov.

Fem.—Ceph.-th., long, 9·1; wide, 7; facial index, 5. Abd., long, 14; wide, 9·5. Total length, including falces, 22·3. Legs, 4, 1, 2, 3 = 22·8, 21, 20·4, 19·5 mm.

Cephalothorax orange-ochreous, median stripe brown, narrow, occurs on occiput; ocular eminence brown. With the exception of a few black hairs on lateral margins and medial line of caput, almost devoid of hairs. Length equal to the tibia, metatarsus + tarsus of fore-leg, breadth to patella + tibia; oval, slightly compressed at caput, truncated at each end; one-fifth broader in front than behind; pars cephalica convex; depth of *clypeus* about equal to space occupied by central pair of eyes—anterior row; pars thoracica depressed; fovea circular, deep; caput and radial striæ well defined; profile-contour ascends from petiolum to frontal margin with a double arch, at an angle of 30deg.

Eyes grouped on a tolerably well developed, elliptical eminence; viewed from above represent procurved and recurved lines. Posterior row moderately procurved; anterior slightly recurved; lateral pairs oval, largest of eight, posited obliquely—less than one-third of their greater diameter apart, on somewhat collar-like elevations; posterior centrals approximate to an oval form; about one-third smaller than side-eyes; placed a trifle in advance, and separated from them by an interval slightly shorter than that which divides the latter pairs from each other; anterior centrals circular, only dark eyes of the set; sensibly exceed hind-centrals in size; divided from each other by an interval equalling three-fourths their own diameter; separated from hind-median pair by an eye's radius, and from laterals of same row by a visibly-shorter interval.

Falces purple-black; moderately furnished with black hairs and bristles; project abruptly forwards; profile-contour represents a somewhat even curve; stout; length equals facial index.

Maxillæ acutely conical, enlarged at insertion of palpi, which are articulated near the extremity; latter point bent outwards; divergent; inferior slope of basal half studded with small papillæ.

Labium broad-oval, emarginate; barely one-fourth length of maxillæ; covered with small papillæ. Organs have a yellow-brown tone; moderately haired.

Sternum dark coffee-brown; tolerably well furnished with hair; obovate.

Legs brownish-tan colour, more or less suffused towards extremities with olive-brown; longitudinally striped with same shade. Tolerably stout, do not differ much in length or strength; fairly well armed with black hairs and fine bristles, both of which occur on the darker tints. Spine armature, 1st leg, patella 1 on inner side; tibia 1 on either side, 1, 1 at extremity; metatarsus 1 central spine beneath; 1, 1 at apex; 2nd, patella 1 inner aspect; tibia 1 beneath, 1, 1, 1 at extremity; 1, 1 on inner side; metatarsus 1 spine on inferior aspect; 1, 1, 1 at articulation with tarsus; 3rd, patella 1 inner side; tibia 1 centre, 1, 1 apical, inferior surface; metatarsus 8 spines, mostly on second half; 4th leg, patella 1 inner side; metatarsus 13. Claws strong; superior pair 1st leg well curved; 12 open teeth—1, 2, 3, 4, from base, smallest and closest; 5–8 nearly equal in length; 6, 7 longest and strongest; 4 terminal teeth of medium strength. Inferior claw well curved, stout, 4 close, fine teeth.

Palpi colour and armature of legs. Palpal claw strong, well curved, 7 stout, open, comb-teeth.

Abdomen elongate-obovate; integument somewhat coarse, studded with small papillæ, projecting fine bristles—mostly short, yellowish; light olive-brown, densely suffused with dark-brown; inferior surface resembles superior. Vulva consists of two transverse labiæ; upper semicircular, projects over the rima genitalis. Superior pair of spinners 6·5mm. in length.

This fine species of trap-door spider, which is, as far as I am aware, new to science, was captured near Wellington. I have much pleasure in naming it in honour of *Mr. T. Kirk, F.L.S.*, the discoverer, who, in a short note that accompanied the specimens, stated that they were found amongst stones, and that most of the nests were furnished with two doors. It is to be hoped that Mr. Kirk will find time to write a descriptive account of the nests and their surroundings.

Fam. THERIDIIDÆ.

Gen. Theridium, Walck.

Theridium gibbosa, sp. nov.

Mas.—Ceph.-th., long, 1·1. Abd., long, 1·3. Legs, 1, 2, 4, 3 = 7·5, 5·8, 4·5, 3 mm.

Cephalothorax yellow-brown; medial stripe fuscous, obscure on caput. Ovate; lateral compression of cephalic region moderate; roundly truncated; frontal index more than half lateral; fovea subcircular, fairly deep; radial and caput striæ well defined; *clypeus* projects moderately, height visibly exceeds depth of eye-area; profile-contour arched, posterior slope very abrupt compared with anterior incline.

Eyes large; posterior row procurved; middle pair on lake spots, separated by about an eye's radius, removed by scarcely their diameter from lateral pair; anterior row recurved, centrals dark, perceptibly smaller than hind pair—form a square with them; lateral eyes about one-fourth smaller than hind-centrals, posited contiguously on prominent, lake-coloured tubercles.

Falces and cephalothorax concolorous; linear, about twice as long as broad, inclined perceptibly forwards.

Maxillæ pale stone-colour, dusky clouds; linear, rounded, basal third turgid; slightly inclined towards each other.

Labium similar in tone to maxillæ, about one-third their length; oval.

Sternum normal stone-grey shade; cordate.

Legs pale slaty-grey; a slate-coloured, wide, vein-like streak runs through their entire length; almost glabrous; few black, bristle-like spines.

Palpi pale metallic stone-colour; humeral joint of somewhat even breadth, about one-fourth longer than two following articles together; armed with few spine-like bristles; cubital short, cup-shaped; radial joint large, crateriform, deeply cleft above; pars digitalis well developed; basal fourth inserted within the cup-shaped cavity of penultimate article; lamina sparingly haired, assumes a yellowish tone towards extremity; ovate curves round lower aspect of bulb; prolonged in a stout, trunk-like form, abscinded, apex concave; genital bulb metallic-grey; membranous, convex above, deeply cleft at fore-end; the cutaneous fold of the superior (upper) extremity is down-curved, somewhat revolute; inferior projection about same length as superior, wide, tapering, extremity rapidly acute; the brownish beading of fore-half, which is bent forwards, forms a continuous line with the bead bordering the deeply sinuous membranous folds of the lower part of bulbus. Within the bulb, just beneath the above-mentioned projections, are two dark, easily perceptible, subprocesses.

Abdomen ovate in outline, sides deep; a depressedly conical tubercle projects at the verge of the abrupt posterior slope. Ground-colour yellowish-stone, sides have a dull metallic lustre; folium exhibits no very determinate limits; spotted with fair-sized, white, lobate flecks; a V-shaped figure composed of confluent flecks extends from apex of tubercle to base of abdomen, enclosing an unspotted area, and bordering the fuscous, linear petiole; central third traversed by two lines composed of six fuscous, small conoid papillæ, three on each side of the V-shaped dorsal mark; a dusky, interrupted, pencilled line connects the tubercle with spinners. Ventral shield linear, brownish.

Single specimen, *Powell* collection.

Most of the species described in this short paper were contained in the collection of the late Dr. L. Powell, F.L.S., which has been sent to me for determination by Captain F. W. Hutton, Curator, Canterbury Museum.

Gen. Linyphia, Latr.

Linyphia mundenia, sp. nov.

Mas.—Ceph.-th., long, 2·1; broad, 1·6. Abd., long, 2·2; broad, 1·4. Legs, 1–4, 2, 3 = 5, 4·5, 4 mm.

Cephalothorax deep orange-colour, suffused, more especially over cephalic part, with lake; normal grooves well defined by streaks of same shade; almost glabrous. Pars cephalica slightly constricted, round-pointed, lateral index surpasses frontal by one-fourth; *clypeus* nearly vertical, height fully equal to half that of facial space; thoracic indentation deep, longitudinal; caput and radial striæ shallow. Profile-line rises from frontal margin rather steeply, descends with a slight incline from centre of occiput to limit of caput; from thence falls, at an angle of 25 degrees, to petiolum.

Eyes barely of medium size, on black spots; posterior row moderately procurved, centre pair separated from laterals by an eye's diameter, rather more than one-half that interval from each other; anterior row sensibly recurved — nearly straight; median pair much the smallest of eight; dark, removed from one another by an interval equalling their radius, and from side-eyes by nearly their space; laterals exceed hind-centrals in size by one-fourth, posited on moderately developed elevations, contiguous.

Falces have the tints of caput, conical, divergent, inwardly-inclined, quite as long as tarsus of first leg.

Maxillæ light amber-colour, sublinear, pointed, inclined towards each other.

Labium yellowish, stained with lake, oval.

Sternum deep-fulvous, lake tinge, broad-cordate.

Legs light ochreous-yellow, faint indications of olive-green annulations; hairs and spines yellowish, latter tolerably strong on posterior pairs.

Palpi, light ochreous-yellow; pars humeralis gradually dilated, about one-fourth longer than cubital and penultimate articles together; pars radialis campanulate, rather longer and much stouter than cubital joint; clava rather exceeds humeral joint in length; lamina ovate, pointed, base produced into a lake-coloured process of somewhat uniform breadth, curved upwards and backwards. Genital bulb represents principally a series of membranous folds and processes, which have yellowish and brownish-yellow tints; bulb viewed from outer sides exhibits a conoid outline, projects at nearly a right-angle to lamina, occupies about one-half its length; consists of four folds, the upper or basal fold is produced into a triangular enlargement in front, second projects only slightly beyond the first, third and fourth of nearly equal width, together perceptibly narrower than upper fold; the fore-extension of terminal fold differs from that of basal membrane inasmuch as the apex of it is drawn out and curved backwards. Two strong apophyses occur beneath lamina, springing from base of bulbus, both membranous, wide, tapering, inner shortest, dark, spiral; crossed outwardly by the larger and pale apophysis, whose apex reaches nearly to extremity of clava. A third apophysis, which has a yellowish colour, springs from near centre of inner side, base stout, tapers rapidly from first third into a thin flexible bristle, spiral (plane), curved backwards.

Abdomen elongate-oviform; in colour light-fuscous, flecked with spots of a paler tone; folium ovate, covers most of dorsum, approximates to olive-brown, lake-stains; edge wide, olive-green, undulating, partially encloses on fore-half an ovate space; exhibits on posterior half a series of tooth-like dilatations projecting inwards. Inferior half of lateral margins mottled with dark-brown.

Single example, *Powell* collection.

Linyphia decolora, sp. nov.

Fem.—Ceph.-th, long, 2; wide, 1·2. Abd., long, 3; wide, 2·5. First and fourth pairs of legs about equal, 5·5. Second pair, 4·4, slightly exceeds third.

Cephalothorax amber-colour, stained with lake and olive-green; almost glabrous. Cephalic part roundly truncated, facial index sensibly shorter than lateral; height of *clypeus* nearly equal to one-half the depth of facial space; thoracic indentation longitudinal, deep; radial and caput striæ well defined; profile-contour rises from the petiolum at an angle of 45 degrees; runs with a perceptible incline to centre of occiput, from thence dips more abruptly to frontal margin.

Eyes of fair size, seated on fuscous spots; posterior row procurved, intervals separating middle pair from each other and laterals are about equal to eye's radius and diameter respectively; anterior row recurved, median pair much the smallest of eight, one-fourth of an eye's breadth apart, removed from side-eyes by a space fully equalling their own diameter; laterals have the opalescence of hind-centrals, exceed them in size by one-fourth; posited on moderately low elevations, contiguous.

Falces yellowish-amber colour, figured with olive-green, display a conspicuous pale patch; inwardly inclined, of somewhat even breadth to fore-third, which is bent rather abruptly outwards.

Maxillæ pale-brown, basal half red-brown, clouded with a dusky shade; of somewhat even breadth, pointed, inclined over *lip*, which is tinted with deeper shades; subcircular, margins turgid.

Sternum deep yellow-brown, dappled with dark-brown; cordate.

Legs creamy-fulvous; femora suffused with a bright fulvous colour; broad, somewhat obscure, central and distal annuli of a similar shade, tinted with green, occur on the femoral, tibial, and metatarsal joints; sparingly armed with pale-yellow hairs and spines.

Palpi, coloration and armature of legs.

Abdomen oviform, projects well over base of cephalothorax; glossy, brownish-cream colour, suffused with rather large, subconfluent flecks of a paler tone; folium has the shade of ground-colour; pattern olive-brown, not very pronounced; fore-half represents a broad, sublinear band with a wide edge, much interrupted on basal slope; produced again, somewhat beneath, into a subcrescentic transverse figure; band exhibits two pairs of coarse, tooth-like dilatations; area enclosed by anterior pair has a somewhat hastate form, is sharply constricted at its junction with posterior part, which is subelliptical, projects a pair of lateral dilatations; contains within a dusky spot of similar form; folium on hind-slope cordate, olive-brown, without very determinate limits, deepens in tone towards the lighter parts, which represent free or coalescing chevrons of irregular form; lateral margins suffused with creamy-olive, marbled with a darker shade. Ventral region pale. *Corpus vulvæ* yellowish, stained with olive-green; subquadrate, elevated; superior area exhibits two ovate, lake-tinted foveæ, bordered by rather turgid costæ, which are prolonged beneath the scapus vulvæ; latter organ short, broad, apex disciform, margins moderately turgid.

Single specimen, *Powell* collection.

Linyphia fucatinia, sp. nov.

Mas.—Ceph.-th., long, 1·5; wide, 1. Abd., long, 1·6; wide, 1. Legs, 1, 4, 2, 3—do not differ much in length; 1st pair 3·7mm.

Cephalothorax rich mahogany-colour, approximating to lake; thoracic region tinged with olive-green. Clathrate; furnished with few short bristles. Pars cephalica prominently convex, lateral index slightly longer than facial; *clypeus* inwardly inclined, rather shorter than ocular area; thoracic groove longitudinal, moderately deep; radial striæ lake-coloured, sensibly indented. Contour of profile ascends from petiole to occiput at an angle of 25 degrees, representing a double curve, the greater being across occiput.

Eyes on dark spots; posterior row slightly procurved, of nearly equal size; middle pair separated by rather more than an eye's radius, visibly less than their diameter from laterals; anterior row recurved; centrals dark, much the smallest of eight, posited, their radius apart, on a large, black, cordate mark; plainly more than their diameter from side-eyes of same row; lateral pairs have the opalescence of hind-centrals; seated contiguously on dark, tubercular prominences.

Falces dark amber-colour, conical, divergent, directed visibly towards maxillæ, nearly as long as tarsus of second leg.

Maxillæ shade lighter than falx; base greenish-brown; of somewhat even breadth, pointed, inclined towards each other.

Labium fuscous, yellowish margins; semicircular.

Sternum fuscous-lake; clathrate; cordate, prolonged between coxæ of fourth legs.

Legs light-fulvous, faint indications of annuli. Hairs pale-yellow, sparse; sparingly armed with light-coloured spines.

Palpi yellowish-amber tone; humeral joint slightly dilated towards extremity, one-fourth longer than two following articles together; cubital joint somewhat campanulate, projects one slender bristle; radial cup-shaped, rather longer and much stouter than preceding article; pars digitalis about twice as long as penultimate joint; lamina acute-ovate, moderately haired, produced on outer side into a dark, sharply backward-curved process, of fair size; bulbus genitalis yellowish, stained with lake; viewed from outer side globose, somewhat elongated, extremity truncated, margin roundly emarginate; lower part produced into a short, round-tipped process; projecting forwards from within the vase-like bulb is a semi-transparent, stout, pointed process, revolute beneath, whose apex reaches nearly to extremity of clava.

Abdomen elongate-oviform; hairs light, short, fine, somewhat sparse; pale olive-yellow, spotted with flecks approximating to cream-colour; folium occupies dorsal area, has a rather deeper tone than ground-colour, specific markings olive-brown, somewhat obscure; basal third bordered and traversed by more or less faint and interrupted lines; central third marked with two transverse bands deepening in shade at extremities; two creamy spots occur between bands; posterior third bounded by dense shading, displays three clusters of confluent creamy flecks, intercepted by a continuous, narrow medial stripe; inferior half of lateral margins olive-brown.

Ventral area exhibits an olive-green, trapezoidal shield, laterally bordered with short, white hairs.

Single example, *Powell* collection.

TEKELLA, gen. nov.

Cephalothorax broad-ovate, nearly as wide as long; compression at caput slight, lateral index short; pars cephalica, viewed from front, conoid; clypeus projecting; height scarcely equals one-half depth of facial space; contour of profile strongly arched, dips at an angle of 40 degrees to petiolum and ocular region. Eyes rather large, fore-centrals dark; posterior row procurved, of about equal size, about twice as far from side-eyes as they are from each other—an interval equalling an eye's radius; anterior row recurved, middle pair more than half size of side-eyes, posited on a tolerably prominent elevation, their own radius apart; removed rather more than their diameter from the pair next to them; perceptibly more than the latter interval from hind-centrals; laterals contiguous, on prominent tubercles. Falces linear, vertical, one-third longer than wide. Maxillæ twice as long as broad at base, gradually contracted, especially second half; curve round lip; apices round-pointed, close. Labium subquadrate, rather wider than long, margin tumid. Sternum cordate, rugose. Legs, 1, 2, 4, 3, tolerably long and slender; hairs sparse; patellæ 1 bristle-like spine; tibiæ 1, 1. Claws slender, few open teeth. Palpal claw fine, few teeth. Abdomen oviform, globose.

Tekella absidata, sp. nov.

Fem.—Ceph.-th., long, 1. Abd., long, 1·4. Legs, 1, 2, 4, 3 = 6, 4, 3·2, 2·3 mm.

Cephalothorax chestnut-brown, studded with depressed papillæ; larger set arranged in radial lines, sparsely armed with spine-like bristles. Broad-ovate, lateral compression at caput very moderate; pars cephalica conoid in outline; *clypeus* projecting, height visibly less than one-half depth of facial space; striæ fairly well marked, fovea ill-defined; profile-contour strongly arched.

Eyes rather large, with exception of fore-centrals have a pearl-grey lustre; posterior row procurved, median pair about as large as laterals, removed from latter pair by rather more than an eye's interval, and from each other by a space fully equal to their own radius; anterior row recurved, centrals more than half as large as side-eyes; posited, their radius apart, on a tolerably prominent elevation; separated by an interval plainly exceeding their diameter from side-pair, and rather further from hind-centrals; laterals seated, contiguously, on a dark, prominent elevation.

Falces yellow-orange, basal three-fourths stained with brown-pink; linear, vertical, as long as the pars digitalis of palpus.

Maxillæ creamy-brown, dappled; width at base equal to about half length; gradually compressed, especially second half; curved round lip; apices round-pointed, close.

Labium approximates to maxillæ in colour; subquadrate, breadth somewhat surpasses length; margin tumid.

Sternum deep brown-pink; cordate; rugose; exhibits few well-developed papillæ projecting bristles.

Legs very pale-brown, subhyaline; femora of two first pairs light ochraceous; femoral joints have three olive-brown annulations; tibial + metatarsal two; more or less evanescent on two latter articles; hairs light, somewhat sparse; patellæ + tibiæ project respectively 1 + 1, 1 semi-pellucid bristle-like spines. Claws opaque, slender, armed with few open teeth.

Palpi subhyaline, stone-colour; basal rings on humeral radial + digital joints, latter very wide; cubital + radial joints armed with bristles. Palpal claw fine, few teeth.

Abdomen globose-oviform, projects well over base of cephalothorax; ground-colour olive-green, pattern creamy-stone; figure on dorsal region reaches from base to spinners; on basal fourth narrow and interrupted, enlarged and lanceolate on summit of dorsum; on first half of posterior slope the mark is further enlarged, represents a hastate figure, below the latter it runs into a wide band which extends in a continuous stripe round lateral margins of abdomen; contained in the dark ground enclosed by the latter stripe and dorsal marks are three large spots of irregular form. Ventral region occupied by a triangular-cordate shield, margins lobate, wide, creamy-stone; enclose a small, triangular, olive-green area. *Corpus vulvæ* fulvous, light fuscous clouds; represents a large, transverse, somewhat elliptical elevation, centrally drawn out into a semicircular scape, margins beaded, reaches nearly to the superior margin of corpus, which is developed into a palish, wide, membranous, introflexed, emarginate lip. Easily perceptible within cavity of corpus are two lake-brown, pyriform or comma-shaped foveæ.

Two specimens, *Powell* collection.

Fam. EPEIRIDÆ.

Gen. Epeira, Walck.

Epeira decorosa, sp. nov.

Fem.—Ceph.-th., long, 3; wide, 2·2. Abd., long, 5; wide, 4·5. Legs, 1, 2, 4, 3=8·6, 8, 7·9, 5 mm.

Cephalothorax yellowish, tinged with pea-green, suffused, more especially over thoracic part and sides of caput, with lake-brown. Hairs white, somewhat sparse. Length equal to the patella + tibia of a fore-leg, sides moderately rounded, lateral constriction rather sharp; outline of the pars cephalica, viewed from front, semicircular; lateral index nearly equals facial; ocular eminence prominent; *clypeus* in depth visibly exceeds diameter of a fore-central eye; thoracic indentation somewhat diamond-shaped, radial and caput striæ well defined. Profile-contour represents a low arch, with a somewhat uneven outline.

Four central *eyes* form a trapezoid rather wider in front than behind, about as long as broad in front; posterior median pair on oval, greenish spots, sensibly smaller than anterior pair, removed by an interval nearly equal to their space and one-half from laterals, which are one-third smaller than centrals; posited on dark, medium-sized tubercular eminences, separated by an eye's radius.

Falces fulvous, tinge of pea-green; somewhat inwardly inclined, stout, length equal to breadth of ocular area.

Maxillæ yellowish-brown, base dusky-olive; about as long as broad, pointed, inclined over *labium*, which has an olive-brown colour, oval.

Sternum dark mahogany-brown, cordate, moderate eminences opposite coxal joints.

Legs fulvous, more or less tinged with green, few lake-brown streaks and spots; annuli olive-brown, somewhat obscure; thighs of first and second legs display dark patches on inferior surface. Legs rather slender, moderately armed with fine spines and hairs of a yellowish hue.

Palpi and legs concolorous, armature similar.

The *abdomen* of this example was too much shrunken for accurate description, but the species will be readily recognised by the characteristic form of the genital organ. Abdomen broad-ovate in outline, humeral tubercles fairly-well developed. It was not possible to determine whether the central posterior tubercle was accompanied by a lateral pair. Ground-colour yellowish pea-green, flecked with small lake dots; folium has a deeper shade, margins lake-brown, somewhat ill-defined; a subquadrate figure, with a similar tone, occurs midway between humeral tubercles; petiole broad, tapers towards free end, border lake-brown; lateral margins of abdomen approximate to lake-brown, dappled with yellowish-green. Shield on ventral region greenish-brown, border yellowish, quadrate. *Corpus vulvæ*, light amber-colour, passing abruptly above foveæ into lake-brown; pyriform, fully as broad as long; central third occupied by two rather large foveæ, which have prominent beaded margins, divided by a septum about their equal in breadth; corpus above foveæ triangular, somewhat wrinkled, exhibits two small foveæ; superior margin beaded, drawn out into a short point, which projects over the rima genitalis; sides of vulva below the dark area covered by sub-free membranous flaps; upper margin of flaps produced into obtuse-pointed processes which curve over each fovea; hind view of corpus discloses a projecting lip, about twice as broad as long, enclosed on either side by a free membrane.

A single specimen of this species was contained in *Dr. L. Powell's* collection.

Epeira powelli, sp. nov.

Fem.—Ceph.-th, long, 3; wide, 2·2. Abd., long, 4·5; wide, 3·2. Legs, 1, 2, 4, 3 = 12·1, 11·2, 10·2, 6·2 mm.

Cephalothorax brownish tan-colour; a short, broad, yellowish, arrow-shaped mark occurs on basal extremity of caput; areolate; hairs white, silky, adpressed, moderately thick. Broad-ovate, lateral margins of caput sharply constricted; cephalic region moderately convex; ocular eminence prominent; lateral index equals space between fore-outer eyes; height of *clypeus* visibly exceeds diameter of an anterior median eye; thoracic depression rather deep; grooves, more especially radial, somewhat shallow; profile-line rises from petiolum at an angle of 45 degrees; falls with slight incline and curve across cephalic part.

Eyes encircled by fuscous rings; form two recurved lines; four centrals nearly form a square; posterior middle pair largest of eight, somewhat elevated; about their own breadth and a quarter apart; removed from side-eyes by an interval sensibly wider than the space they occupy; anterior median pair one-fourth smaller than hind-centrals, separated by an interval equalling their diameter and one-half, rather less than that distance from hind-pair; laterals less than half size of posterior centrals, seated their breadth apart on separate cup-shaped eminences.

Falces fulvous, probably clouded with green; conical, gibbous, inwardly inclined; about as stout as the pars femoralis of second leg; as long as digital joint of palpus.

Maxillæ fulvous, lightly clouded with brown; rather longer than wide; pointed.

Labium darker than maxillæ; subtriangular; apex turgid.

Sternum deep-fulvous, margins clouded; cordate; eminences opposite coxæ moderately developed.

Legs fulvous, pea-green reflections; tolerably stout; hairs light, fine; spines numerous, brownish.

Palpi fulvous; penultimate and digital joints well spined.

Abdomen oviform; yellowish pea-green; folium cordate, lightly suffused with brown; yellowish tint runs into a wide dorsal band on posterior half; petiole broad, margins yellow, sides mottled with brown, passing into reddish-brown on basal slope. Ventral shield brown. *Vulva* brownish-yellow, prominent, transversely wrinkled, cucullate, drawn out and curved towards the rima genitalis, extremity deeply cleft; margins furnished with a wide, brownish beading. The yellowish, slipper-shaped scapus occupies the space between the rounded projections of the hood, slightly exceeds them in length and breadth.

Single example, *Powell* collection.

Epeira peronginia, sp. nov.

Fem.—Ceph.-th, long, 2·6; broad, 2·1. Abd., long, 4·5; broad, 4. Legs, 1, 2–4, 3 = 13, 11·5, 7·5 mm.

Cephalothorax yellowish, suffused, more especially over cephalic region, with bright pea-green; a fuscous, lance-shaped figure occurs within the thoracic indentation; the brown lines defining the caput striæ are prolonged, and diverge near apex of the above-mentioned mark; marginal band narrow, brown. Hairs whitish, somewhat sparse and coarse. Pars cephalica depressedly convex, sides abrupt; lateral index about equal to breadth of frontal margin; height of *clypeus* fully equal to radius of a fore-central eye; pars thoracica broad-ovate, convex; thoracic indentation acute-ovate, deep; grooves shallow. Profile-contour ascends from petiolum at an angle of 45 degrees; falls with a moderate incline across caput.

Eyes distributed in two rather prominently recurved rows, centrals form a trapezoid widest in front; posterior eyes about one-fourth smaller than anterior pair, separated by about an eye's breadth, an interval which scarcely equals the space dividing them from fore-centrals; laterals one-third smaller than the middle eyes of front row, separated by an interval scarcely equalling their own diameter; fore-eye posited on a strong tubercle.

Falces greenish-brown, clouded with chocolate-brown; linear-conical, distal third curved outwards; project prominently beyond plane of clypeus; inwardly inclined.

Maxillæ darkish-brown, pale margins; broad, round-pointed.

Labium chocolate-brown, apex pale; acute-oval.

Sternum greenish-brown, margins clouded with dark-brown; angular-cordate; eminences opposite coxal joints prominent.

Legs brownish-yellow, suffused with pea-green; humeral joints marked with central, doubly-serrated, broken, fuscous annulations. Hairs pale-yellow, sparse; spines yellowish, spring from dark sockets.

Palpi resemble legs in colour and armature.

Abdomen angular-ovate, pale-brown, suffused with pea-green; folium tapers from the slightly-developed humeral tubercles to anus. Fore-part of the broad, quadrate petiole blue-black, contains a conspicuous, pale, oval spot; posterior third exhibits two large, pinkish, pyriform figures, whose acute extremities converge towards each other; pattern of folium consists—more especially on basal third—of a series of velvety, black-brown, more or less elongated spots, encircled by a whitish ground. Amongst the most observable figures are two dark, somewhat crescentic lines, partially enclosing blackish spots near base of the depressedly-conical humeral tubercles; and five pairs of dark figures which occur on the tapering area; anterior pairs hat-shaped, remainder branched; lateral borders and ventral region dappled, spots run somewhat into lines. *Corpus vulvæ* yellow-brown, passing into a chestnut-brown within foveæ; subfree, reniform; margins prominent, retuse, and transversely rugose, inferior side; superior margins revolute, border dark, partially enclose foveæ; septum, close-lying, large, triangular, extends to margin.

Two examples of this pretty species were contained in *Captain T. Broun's* collection from Waikato.

Fam. OXEOPODÆ.

Læstrygones, gen. nov.

Cephalothorax ovate, lateral constriction slight, moderately convex above, sides slope at an angle of 75 degrees; ocular eminence and clypeus projecting; latter subquadrate, width equals that of second row of eyes, depth equal to about two-thirds of space occupied by first row of eyes; pars cephalica limited by a moderately deep, transverse indentation; thoracic groove longitudinal; striæ of moderate depth; profile-contour rises at an angle of 80 degrees from petiolum, falls with a moderate curve and incline to first row of eyes, from thence dips more abruptly to margin of clypeus. Eyes in four rows; first pair dusky, small, close; eyes of second line far apart, visibly smaller than anterior pair, removed from them by an interval about equal to space occupied by fore-pair; eyes of third line large, scarcely twice their breadth apart, separated from first and second pairs by nearly their own diameter; dorsal eyes furthest apart, seated obliquely on verge of caput; scarcely as large as third pair, form with them a trapezoid nearly as long as broad in front. Falces conical, inclined inwards. Maxillæ dilated, nearly as broad as long, truncated. Labium less than one-half length of maxillæ; similar in form, emarginate. Sternum cordate. Legs, 4, 2, 1, 3, differ but little in length or strength; tolerably stout. Hairs somewhat sparse. Spines long and strong; rather numerous on femoral, tibial, and metatarsal joints. Claws of fourth leg long, slender, moderately curved; teeth close, fine, about twenty, extend from base to middle of claw. Inferior claw fine, rather sharply bent; two small teeth. Abdomen obovate, subdeplanate.

Læstrygones albiceres, sp. nov.

Fem.—Ceph.-th., long, 1·6; broad, 1·2. Abd., long, 2·5; broad, 1·9. Legs, 4, 2, 1, 3. Fourth, second, and first pairs about 4·5–4·4; third, 3·5 mm.

Cephalothorax light yellow-brown, two blackish stripes run in almost parallel lines from apex of falces to verge of thoracic incline, from thence converge to petiolum; a lightly-pencilled band borders the lateral margins. Hairs very sparse, coarse. Ovate, slightly constricted beyond coxæ of first legs; viewed from above the ocular eminence and *clypeus* are seen to project well forwards; latter subquadrate, as wide as second row of eyes; depth equal to space occupied by first row, less diameter of an eye; profile-line ascends from petiolum at an angle of 80 degrees, moderately inclined and arched to first row of eyes; dip more abrupt across clypeus.

Anterior row of *eyes* straight, darkish, encircled by fuscous rings, divided from each other by a space rather exceeding their own breadth, and from eyes of third row by nearly an equal interval; about one-third size of latter pair; eyes of second line about one-third smaller than fore pair, stained with lake; seated obliquely on a blackish-lake collar; plainly more than their own diameter from eyes of third line; dorsal pair have the bright-amber colour of eyes of third row, scarcely equal them in size; posited obliquely, widely apart on verge of caput.

Falces yellowish, medial stripe dusky; conical, base stout, length equals the intervening space between dorsal eyes; strongly inclined towards maxillæ; project from inner side, near base, a long, strong bristle.

Maxillæ pale-fulvous, clouded; length rather exceeds breadth; dilated, truncated, angles rounded, inclined towards each other.

Labium resembles maxillæ both in colour and form; less than one-half their length; perceptibly emarginate.

Sternum pale-fulvous, lightly clouded with slate-colour; shield-shape, small compared with well-developed coxæ.

Legs brownish-yellow; somewhat sparingly furnished with hairs; spines rather numerous.

Palpi colour and armature of legs.

Abdomen broad ovate; fairly well furnished with white hairs. Light brownish-yellow, lightly clouded with olive-green; flecked with rather large, whitish, lobate spots. *Corpus vulvæ* yellowish-orange; form may be best described as bearing a strong resemblance to the under-aspect of a horse's foot;

a low costa, delineated by a lake border, representing the shoe.

Two specimens contained in the collection of the late *Dr. Powell.*

Note on **Lathrodectus scelio** (Katipo).

About a year ago an occasional correspondent of mine, Mr. R. Allan Wight, forwarded to Washington specimens of *Lathrodectus scelio,* accompanied by examples of katipo. To his queries he received last January the following reply from Professor C. V. Riley: "The specimens which you obtained from Mr. Olliff of the Australian *Lathrodectus scelio* I am very glad to see. I showed them to Dr. George Marx, our acknowledged authority on spiders, and he states that there is no question that this is identical with *Lathrodectus scelio* of Koch. It is *undoubtedly* distinct from *Lathrodectus katipo,*" &c.

As the apparently conjoint decision of Professor Riley and Dr. Marx differed from the opinion that I ventured to express on the subject in a paper contained in the Transactions of the New Zealand Institute, vol. xxiv., 1891, I forwarded to Professor T. Thorell examples of *Lathrodectus scelio* obtained from Queensland, New South Wales, and Tasmania, also fresh specimens of katipo—for which I am indebted to T. Kirk, Esq., F.L.S.—requesting his opinion as to whether they were identical or not. In the reply that he kindly furnished me with, dated 22nd June, 1892, he says, "I quite agree with you that *Lathrodectus katipo* and *L. scelio* is one and the same species. I have already expressed that opinion in my 'Ragni Malesi e Papuani,' iii., Ragni delle Austro-Malesia e del Cape York."

Art. XVII.—*Notes on the New Zealand Bats.*

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 28th August, 1893.*]

One of the most remarkable peculiarities of the fauna of New Zealand, and one which has been much commented upon, is the paucity of indigenous land-mammals. Only four have been catalogued—the dog, or "Maori dog," as it is usually called, the native rat, and two species of bats. And if we examine the subject carefully we shall find very good cause for believing that the two bats are the only land-mammals which can undoubtedly prove their claim to be considered aboriginal inhabitants of New Zealand. Take the case of the dog: The early voyagers and first residents of New Zealand all agree in stating that the Maori dog was unknown in the wild state. It was a purely domesticated species, fed by the Maoris on fish and refuse offal, and valued by them for two reasons—for yielding a dainty article of food, and for supplying the material for their much-prized dogskin mats, or providing them with hair for the ornamentation of their *taiahas* or other weapons. Before the arrival of Europeans, as Mr. Colenso remarks, a wild dog would have been just as much unknown to the Maoris as a wild sheep would be in England at the present time. The wild dog about which European settlers have talked in recent times is the descendant of curs introduced by the whalers or first traders, and has no resemblance to the ugly, stupid, and inoffensive animal described by Cook and others. In short, all the reliable evidence that we possess respecting the Maori dog goes to prove that it was a domesticated species that the Maoris brought with them when they first colonised New Zealand.

With respect to the rat, the evidence is not quite so clear. It is a much-debated question whether the rat hunted by the Maoris, and so much prized by them for food that intertribal wars have arisen for the possession of favourite hunting-grounds, is living at the present time or not. Mr. Colenso, whose knowledge of the natural history of New Zealand, and close acquaintance with the Maori race, should give great weight to his opinions, believes that no living European has seen the true Maori rat—that it has vanished from the list of living beings, and has become as extinct as the moa or dodo. Others, whose views are perhaps equally entitled to attention, believe that the small black rat still found in forest districts, and on the outlying islands, and which occasionally makes incursions in considerable numbers into the settled portions of the country, is the true indigenous species. But, whichever of these views is correct, a comparison of skulls found in old Maori eating-places seems to have established the fact that the Maori rat was identical with a species widely distributed in Polynesia, and which has been known to have been unintentionally carried by the Polynesian natives from one group of islands to another. The Maoris have a tradition that they brought the rat with them from Hawaiki, and, until remains of the animal have been found in deposits older than the time of Maori occupation, we must attribute considerable weight to that view.

If, therefore, our bats are the only indigenous land-mammals that we possess, considerable interest ought to attach to them. As already mentioned, we have two species, which are familiarly known by the names of the short-eared bat (*Chalinolobus tuberculatus*), and the long-eared bat (*Mystacina tuberculata*). The first is much the more common of the two, and can easily be recognised by its short ears and by its long tail, which is completely included in a prolongation of the wing-membrane. It is rather more than 2in. in total length, and is thus about the same size as the pipistrelle or "flittermouse," the commonest of the English species. The long-eared bat is slightly larger than the species just mentioned; it has much longer ears, and a curious projecting muzzle; its tail is very short, and is almost entirely free from the wing-membrane. A remarkable peculiarity is that a part of the wing-membrane is thickened, the remaining membranous portion being folded under this when the wings are in repose. The wings, when folded, thus occupy a smaller space than in any other bat.

Up to the present time hardly anything has been recorded respecting the mode of life of the New Zealand bats, a circumstance no doubt due to their shy and recluse habits. The English bats, or most of them, frequent the habitations of man, taking up their quarters in churches and cathedrals, ruined towers, and other buildings, or even sheltering themselves in attics or under the straw thatch of cottages. They are thus regularly under the observation of man, and are familiarly known to most country-people. But the New Zealand species are seldom seen. They are pre-eminently lovers of the forest, and are never found far from its dense shade. To study their habits, or even to see them at all in a living state, it is necessary to dwell in the heart of the forest. It is therefore not at all surprising that it has not yet been decided whether our bats live in communities, as is the case with most of the European species and many others, or are solitary in their habits. Many bushmen incline to the latter view, giving as a reason that they hardly ever find more than one or two bats together. The object of this paper is to prove that the first view is the correct one.

In the year 1881 I spent some time exploring the western portion of the Nelson Provincial District. While stopping near the Graham River, a tributary of the Motueka, which rises in the forest-clad hills near Mount Arthur and Mount Peel, I observed that the short-eared bat was remarkably plentiful. Every evening at dusk scores could be seen flitting across the bush-clearings, and I was much interested in watching their zigzag flight, and in noticing the ease with which they caught their insect prey upon the wing. Conversing about them with the keeper of the accommodation-house, I learned that a bushman called Deacon had lately found a colony of many hundreds in a hollow tree in the Wangapeka Valley. A few months later I visited Wangapeka, and sought out this man, obtaining the following account of his discovery. He was at work with his mate cutting rimu timber for mining purposes. They had selected a tree for felling, but after cutting some distance into it had found that it was hollow, and had therefore decided to leave it and pass on to another. Accidentally they noticed that some bats were flitting about the trunk of the tree, and they soon found that they were emerging from a hole leading from the hollow interior, no doubt having been disturbed by the blows of their axes. Some bunches of dried grass were set on fire and thrown into the cavity, which they also probed with a long rod. The result was that they disturbed an immense number of bats—according to them, several hundreds. They emerged from the hole in a continuous stream, flitted round about the tree in an aimless manner for some time, several remaining an hour or more in the vicinity, but at length disappeared into the adjacent forest. The interior of the tree was slightly charred by the burning grass which the men had thrown into it, and apparently this deterred the bats from resuming possession of their home, for on visiting the tree some months afterwards not a single bat could be found.

Several years after this my friend Mr. J. W. Hall, of the Thames, wrote informing me that some bushmen had found a considerable number of bats in a hollow tree, and that several of them were in the possession of Mr. Price, a local taxidermist. I succeeded in obtaining two of these specimens from Mr. Price for the Museum, and from him and from Mr. Hall I gathered the following particulars of the find: Some four or five bushmen had proceeded to Kerikeri, a few miles from the Thames, for the purpose of collecting wild honey. They found a hive, and cut open the tree to take the honey from it. In doing this they dislodged a considerable number of bats. The number was not estimated; but, as each of the men carried home several, one man in particular having a kerosene-tin filled with them, it must have been large, more especially as the men stated that what they caught was only a small fraction of what escaped. The species was the short-eared bat.

I have now only one other instance to mention. A few months ago a man who gave his name as McDonald came into my office with a box containing twenty-two living bats. I purchased them from him for a few shillings, and he gave me the following account of how he obtained them: He and another man were engaged in bushfelling near Reweti, on the Kaipara Railway. They cut down a tree, the upper portion of which was loaded with creepers and epiphytes. When the tree fell and struck the ground the men were amazed to see numbers of bats fly from the upper branches. Running to the spot they found that clusters of them were still clinging to the branches. They collected about thirty, and could have obtained very many more had they wished. They did not notice that the tree was hollow, and were of opinion that the bats were simply sheltered by the overhanging creepers and epiphytes.

Being anxious to see how they would behave in a room, I closed the doors and windows and liberated them. They took to their wings at once, and commenced to circle round the room with that quick, soft, and noiseless flight which is always so noticeable. The presence of full daylight did not affect them in the slightest degree, for they never made a mistake in estimating their distance from an object. They circled round the room, flying in and out of the corners, skimming just below the ceiling, and hovering over the furniture, but never came into contact with anything. It is worth mention that they did not dash themselves against the window-panes, as a number of birds would have done under similar circumstances, but treated the glass in precisely the same manner as the walls of the room. This fact lends support to the view now generally adopted that much of the power possessed by bats of directing their flight in complete darkness or strong sunlight is due to an exceptional development of the sense of touch, residing specially in the great membranous expanse of the wings. After satisfying themselves that there was no mode of escape from the room they commenced to settle down on the tops of the architraves of the doors and windows, hanging head downwards by the claws of their hind legs. They ultimately collected into little clusters of four or five, cuddling quite close to one another, and were then easily caught and transferred to their cage.

The above facts will make it quite clear that our bats are by no means solitary in their habits, but dwell together in communities, often numbering several hundreds, and usually occupying the hollow interior of some aged forest-tree.

Postscript.—Since the above was written I have seen Sir W. L. Buller's paper on the same subject, printed in vol. xxv. of the Transactions. I am glad to notice that the evidence he has collected is quite in accordance with the facts given above.

ART. XVIII.—*Note on the Occurrence of* Lophotes *in New Zealand Waters.*

By T. JEFFERY PARKER, D.Sc., F.R.S.

[*Read before the Otago Institute, 13th June, 1893.*]

THE genus *Lophotes* forms, according to Dr. Günther, a separate division of Acanthopterygian fishes. I quote his description from "The Study of Fishes," p. 519:—

"SEVENTEENTH DIVISION.—*Acanthopterygii lophotiformes.*

"Body riband-shaped, with the vent near its extremity; a short anal behind the vent; dorsal fin as long as the body.

"Only one species is known of this division or family, *Lophotes cepedianus.* It is most probably a deep-sea fish, but does not descend to so great a depth as the *Trachypteridæ*, its bony and soft parts being well coherent. It is a scarce fish, hitherto found in the Mediterranean, off Madeira, and in the Sea of Japan; its length is known to exceed 5ft. The head is elevated into a very high crest, and the dorsal fin commences with an exceedingly strong and long spine on the head. Silvery, with rose-coloured fins."

To the localities above mentioned must be added Cape Colony, since a fine local specimen is to be seen in the South African Museum, Cape Town. The occurrence of the fish in New Zealand also seems to indicate that, like many other deep-sea fishes, it is practically cosmopolitan.

The present specimen came ashore at the St. Clair Baths, near Dunedin, last December, and was very generously presented to the Museum by the bath-keeper, Mr. Stark. It is 4ft. 8½in. (143cm.) in length, and reached the Museum in an excellent state of preservation, except for the fact that the rose-colour of the fins had faded.

A coloured figure of this very beautiful and interesting fish is given in the illustrated edition of Cuvier's "Règne Animal," Poissons, Atlas, pl. 70.

ART. XIX.—*Notes on Three Moa-skulls, probably referable to the Genus* Pachyornis.

By Professor T. JEFFERY PARKER, D.Sc., F.R.S.

[*Read before the Otago Institute, 14th November, 1893.*]

IN the collection of moa-bones recently made at Enfield, near Oamaru, by Mr. J. Flett, there are three skulls of special interest, which have been handed to me for identification by Mr. A. Hamilton. As I am unable to refer them with certainty to any of the hitherto described species, I append a brief description of each, with measurements.

The terminology and the system of measurement employed are those used in my paper "On the Cranial Osteology, Classification, and Phylogeny of the *Dinornithidæ*," now in course of publication in the Transactions of the Zoological Society of London.*

Skull No. 1.—This is undoubtedly a skull of some species of *Pachyornis*, differing from *P. elephantopus* mainly in its greater size. It has the characteristic vaulted skull, wide squamosal region, prominent mammillar tuberosities, widely-separated optic foramina, large temporal fossæ, narrow, pointed beak, and stout, boldly-curved maxillo-jugal arch. The supra-occipital region is very prominent, and the posterior lambdoidal ridge strongly curved backwards. It is about 10 per cent. larger in nearly all dimensions than *P. elephantopus*, from which I have little doubt that it is specifically distinct. As *P. immanis*, Lyd., at present known only by leg-bones, differs from *P. elephantopus* in its greater dimensions, I think the present specimen may be referred provisionally to that species.

The whole frontal region is marked with shallow feather-pits, and a somewhat rhomboidal area forming the roof of the posterior olfactory region is strongly marked with irregular, probably venous, depressions, which, as Mr. Hamilton suggests, may possibly indicate the possession of a caruncle by this species.

Skull No. 2.—This specimen consists of the cranium only. It has the general characters of *Pachyornis*, but is about 10 per cent. smaller in nearly all dimensions, and is further remarkable for the fact that the wide temporal fossæ are hardly produced on to the roof of the skull, so that what I have called the temporal index (see below) is only about 100:104, instead of 100:130–140, as in *P. elephantopus*. In this respect, therefore, the skull resembles that of *Emeus*, but the great width of the temporal fossa, the prominent mammillar tuberosities, and the distance between the optic foramina, incline me to place it under *Pachyornis*. Unfortunately, the premaxilla, maxillo-jugal arch, and mandible are absent, and without them it is impossible to determine the genus with certainty. I propose to call it provisionally *Pachyornis*, species β.

Skull No. 3.—In this case also the cranium alone is present, and, as will be seen from the table of measurements, is

* See Proc. Zool. Soc., 14th February, 1893.

smaller in most dimensions than No. 2, just described. It is a typical *Pachyornis*, having the large temporal fossæ continued well on to the roof of the skull, as well as the general contour characteristic of that genus. The distance between the optic foramina is, however, not more than half of what is usual in *Pachyornis*, and agrees with what is found in *Emeus* and *Anomalopteryx*. I propose to give this specimen the provisional name of *Pachyornis*, species γ.

TABLE OF ABSOLUTE MEASUREMENTS, IN MILLIMETRES.

—	*Pach. elephantopus.*	*Pach. immanis(?).*	*Pach., sp.* β	*Pach., sp.* γ
Length of cranial roof ..	98	110	91	91
Length of basis cranii ..	40	47	35	35
Width across paroccipital processes	78	73	66	59
Width across squamosal prominences	92	96	82	76
Width across temporal fossæ	57	59	51	46
Distance between temporal ridges	44	44	49	31
Height	55	61	49	43
Width of temporal fossæ	32	30	29	27
Distance between optic foramina	21	24	22(?)	11(?)
Width of orbit.. ..	32	36	30	28

TABLE OF PROPORTIONAL MEASUREMENTS.

Length of basis cranii ..	100	100	100	100
Length of cranial roof ..	234–245	234	260	260
Width across paroccipital processes	151–195	155	188	168
Width across squamosal prominences	208–218	204	234	217
Width of temporal fossa	70–80	80	82	77

TEMPORAL INDEX.

Distance between right and left temporal ridges	100	100	100	100
Width of cranium at temporal fossæ	130–140	134	104	148

Art. XX.—*Result of a Further Exploration of the Bone-fissure at the Castle Rocks, Southland.*

By A. Hamilton.

[*Read before the Otago Institute, 14th November, 1893.*]

Plates XXIII., XXIV.

In the Transactions of last year I gave an account of the Castle Rock fissure, and of the specimens yielded by an exploration of its depths.

This year Mr. Mitchell and myself have, through the kindness of Mr. Barnhill, renewed our work, with very satisfactory results, the anticipations expressed in the previous paper having been fully realised.

It will first be necessary to take this opportunity of making a few corrections and additions to the diagrams as printed in the Transactions, vol. xxv., pl. vii. The letter C (see p. 90) should be placed more to the left of the person looking at the diagram, on the dotted portion. In the diagram it is on the limestone rock. The letters D, E, and F have been omitted altogether. They should occur on the plan, and on the section from 3 to 4, D being just under the figure 4, E at the narrow gap at the other end, and F marking the arm of the cave near the figure 4. A more important error runs through the tables of dimensions (with the exception of that of *Ocydromus*), "Specimen No." being printed for "Number of Specimens."

Considerable preparations were made by us for this trip, as I was fully convinced that the majority of the missing bones of *Harpagornis* were there if we could only find them. Our first efforts were directed to trying to devise some method of taking the soil out of the fissure altogether and spreading it on the surface at the entrance. This necessitated the clearing-away of a number of small bushes and "lawyers" to give an open space on which to spread and examine the soil. This being done, ropes were rigged, and two iron buckets. When filled these were drawn up to the surface, emptied, and raked over, so that any small bones contained might be seen. This gave us a considerable number of small bones which would not otherwise have been obtained, but it was slow work, and was only carried on until sufficient of the loose and previously-worked soil had been brought up to allow of further examination of the "lead" of bones under the rock. When we left off last time the material excavated from the trench kept slipping down again into the trench, and was a source of danger. Now, however, it was possible to go much deeper, and for 8ft. or 9ft. down we obtained bird-bones, principally of the duck and kiwi. At the very lowest depth reached there were still a few of these to be obtained, but there seemed no chance of reaching the actual bottom, so we ceased descending, and went into the small cave through the narrow passage. The floor of this was dug over again, and a number of kiwi-, duck-, and kakapo-bones obtained.

At p. 90 (*loc. cit.*) of the Transactions I mentioned that the lateral arm of the cave (which should have been marked F on the plan) contained a quantity of a wet, soapy deposit consisting of nearly pure carbonate of lime. This was examined to a much greater depth than on the previous occasion, and at least 2ft. of the deposit of carbonate of lime removed from the surface, which did not contain a bone. Beneath this we came on a layer of clay and lime containing bones, and this led us to examine it very carefully, as one of the first bones of any consequence proved to be of *Harpagornis*.

I had the whole of the lime removed first, and then carefully worked out the original floor. The lime was in some places quite hard, like well-set plaster of Paris—in other places quite sodden and soapy. Starting from the corner of the main fissure, bones were found to occur plentifully, and to extend downwards for about 2ft., or about 5ft. below the original surface. The first find of importance was a capital skeleton of an individual moa—a young individual—with skull, pelvis, legs, &c., close together.

Whilst I was numbering and marking these in the light word was passed out from the workers that eagle-bones were being found. Extra candles were lighted, as this arm of the cave was quite dark. I soon found that several important bones were exposed, their smooth yellow surface contrasting with the pure white of the lime, which at this place formed a small "pocket" in the clay floor close to the rock. With a pocket-knife I removed the dirt, and had the pleasure of finding the greater part of the skeleton of the smaller of the two eagles usually known as *H. assimilis*. The skull (Pl. XXIII., fig. 1) was remarkably perfect, lying on its vertex, with the lower mandible in position, and one quadrate. Across it lay a humerus, which had protected the delicate bones of the skull from injury. The legs and both wings were found here. A little further on the sternum was found quite perfect, but slightly cracked (Pl. XXIII., figs. 2 and 3). It was curious to note that in the cranium of the skull there still remained several of the chitinous pupa-cases of the flesh-flies that consumed the fleshy remains of the lordly eagle. A few separated bones of the larger bird (*H. moorei*) were then found; and just as the work of cutting into the hard deposit was being abandoned the workers found a small hole just large enough to admit a hand. This led into a small extension of the fissure, and several other bones were obtained. At the very end, firmly fixed in the hard carbonate of lime, the edge of a large bone appeared, and I recognised this as the sternum of *H. moorei* (Pl. XXIII., fig. 4); so we spent a considerable time in cutting out with an axe sufficient of the sides of the fissure to enable a block to be detached at the end containing the sternum. The block was then carefully removed and packed away. Work at the main fissure was renewed next day, but without much success. Another almost entire skeleton of a young moa (*Anomalopteryx*) was obtained in good preservation, and, as usual, a vast number of small bones of duck, kiwi, kakapo, &c.

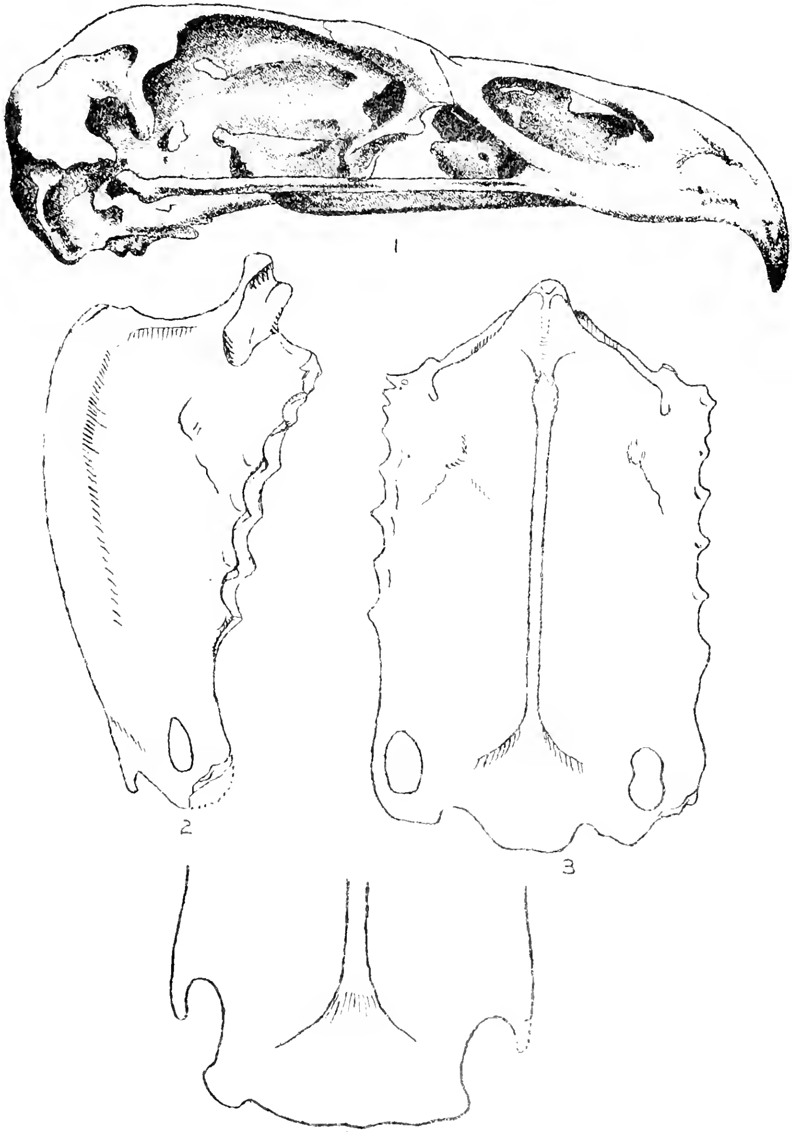
The most curious and interesting specimen found here is the sternum, figured at Pl. XXIV., fig. 1, of *Anomalopteryx didiformis*.

Amongst the remains described in the previous paper was a very good skeleton of an adult *A. didiformis*, which is at present deposited in the Otago University Museum. It is remarkable in having a process on the right side of the upper edge of the sternum of an irregular form, about 25mm. in height (Pl. XXIV., fig. 3). I concluded at the time that it was an occasional or abnormal ossification; but now another specimen has turned up in which the process is present on *both* sides, about 40mm. in height, and corresponding in shape with each other. Having now re-examined the specimen in the Museum, I think there is reasonable ground for supposing that it also possessed two of these processes, the place on the left side corresponding to the base of the process having a surface indicating an irregular articulation, as in *Aptornis*—a non-synovial union.

I have since examined several other sterna of the same species, and many of them appear to have originally possessed something of the same kind of episternal process.

It is quite uncertain what form the scapulo-coracoid took in these small moas, as in the whole series of bones from this fissure I have not found a single bone that can be said with certainty to be a scapulo-coracoid or to belong to the more or less defined pits on the upper edge of the sterna which I have considered coracoid notches. I have carefully examined a number of specimens of the same species from Enfield, and, although I have not seen any with the process remaining, there were several that may possibly have had it, that portion of the sternum being abraded or damaged so that no definite opinion could be formed.

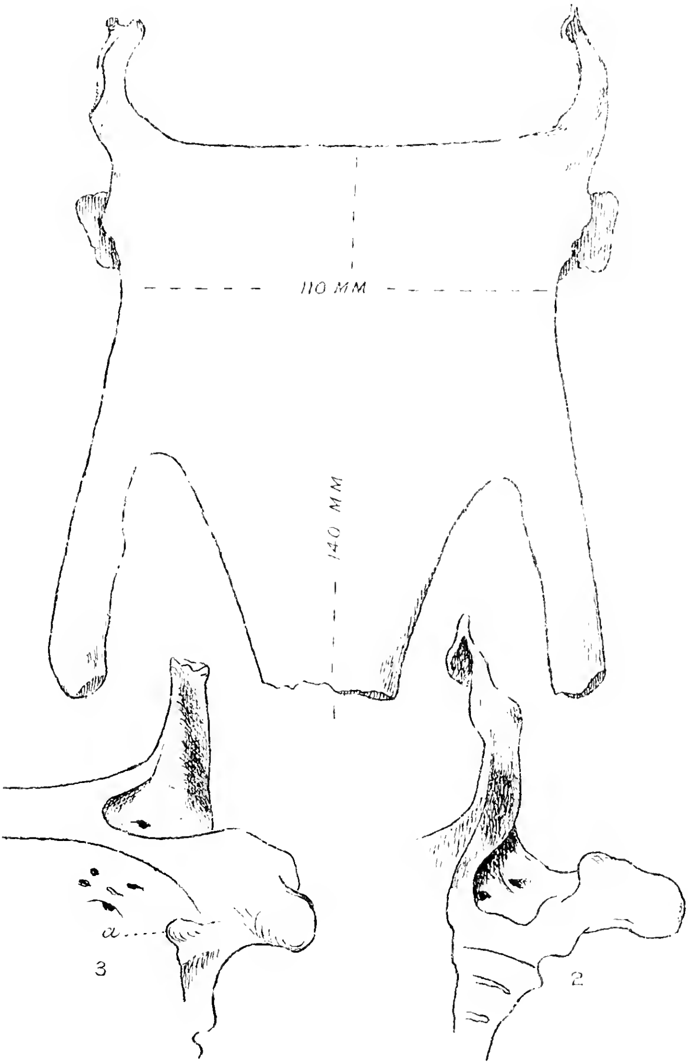
Notwithstanding the apparent coracoid notches at the back of the process, I think these irregular prominences must be anchylosed scapulo-coracoids, and that the depressions, which vary greatly in depth and size, are merely the result of the



A.H del.

Harpagornis

F.H.T lith



Harpagornis

A. H. del.

F. H. T. lith.

development of the adjacent part. It is to be noticed that the foramina at the back of the sternum in this region are excessively variable in size, being larger and more frequent as the indications of a coracoid are greater in the front of them. In the specimen figured (Pl. XXIV., fig. 1) there is quite a large pit or lacuna in the rear of the depression behind the processes. The hinder border of the middle portion of the sternum (No. 256, fig. 3) is deeply notched, as in some sterna of *Apteryx*.

Behind the costal processes on the neural surface of this sternum there are two small processes (*a*, fig. 3) directed inwards. The same process occurs in No. 313, but only on the left side.

Amongst the small bones I have two fragments resembling the processes, one of which may have belonged to the sternum of the specimen in the Museum. In my next paper I hope to give a *résumé* of the whole collection, and to include the references to *Harpagornis* in Dr. Von Haast's third paper, in vol. xiii. of the Transactions, which I seem to have overlooked.

DESCRIPTION OF PLATES XXIII., XXIV.

PLATE XXIII.

Fig. 1. Skull of male *Harpagornis*; extreme length, 150mm.
Fig. 2. Side-view of sternum of male *Harpagornis*.
Fig. 3. Front-view of sternum. Length, 145mm. = 5·7in.; width, 87mm.
Fig. 4. Lower margin of sternum of female *Harpagornis*. Length, 165mm. = 6·5in.; width, 90mm.

PLATE XXIV.

Fig. 1. Sternum of *Anomalopteryx didiformis*, No. 313, from Castle Rock, with anchylosed scapulo-coracoids (?).
Fig. 2. Side-view of left scapulo-coracoid.
Fig. 3. View from the back of the anchylosed scapulo-coracoid on the right side of the specimen No. 256, deposited in the Otago University Museum; *a*, small process from costal.

ART. XXI.—*Materials for a Bibliography of the* Dinornithidæ, *the Great Extinct Birds of New Zealand, usually called Moas*.

By A. HAMILTON.

[*Read before the Otago Institute, 14th November, 1893.*]

THE great increase within the last decade of transactions and proceedings of societies, magazines, and journals has rendered it more difficult than ever for students of natural history to peruse the literature of any subject that he may be working at without the aid of such valuable publications as the "Records." To those resident in the colonies, opportunities of consulting a full set of, say, the "Zoological Review" must be few and far between; and, even if the opportunity offers, a great deal of time must be consumed in the search for that which is required. Having myself experienced considerable difficulty in this way whilst working at the study of the remains of the extinct birds of New Zealand, I thought that the references which I had accumulated would, if systematically arranged, form the basis of a bibliography of what has already been written on the subject of the moa.

I am particular in calling it only a contribution to the subject, as I am well aware that it is practically impossible for a single hand to collect every reference. There will no doubt be many an omission to repair and correction to be made in a future volume; and I shall be extremely grateful to any correspondent who will assist me in completing the bibliography, and thereby facilitate the labours of future workers in this field.

It has been suggested to me that I ought to discriminate, and only enter on the list papers and articles of scientific value and worth; but I take it that this course would totally destroy the value of the work as a bibliography; and, further, that I am hardly justified in saying that a record is valueless because it seems to me, with our present knowledge of the subject, ridiculous or absurd. It will be a long while yet before the last word on the history of the extinct birds of New Zealand is said, or the various questions settled and elucidated.

I desire, therefore, to record newspaper notices, magazine articles, &c., which may, perhaps, seem trivial. The only references that I feel justified in omitting are those in zoological text-books and stories professedly fictitious. When the work is nearer completion I desire to arrange the references under various subject-heads.

To those authors whose writings I have omitted I must tender my apologies, and plead in excuse the discontinuous nature of my work, which has had to be done in odd moments in the intervals of other work and duties; and also the absence of several important works of reference which should have been consulted.

I trust, however, that the list will serve as a basis for further records, and I shall be pleased to receive any corrections and additions that any one will kindly forward to me.

Note.—I have endeavoured as far as I could to give the date of the reading of the paper. In some cases, however, the date is the date of the publication of the volume in which the paper or notice occurs.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Anon. (Dr. Rule) ?	Commenting on Professor Owen's Description of the Type Femur of *Dinornis*	Polytechnic Journal	..	..	..	July, 1843.
Anon.	The Moas of New Zealand. The tarsal scales of *D. ingens* described and figured (original in Otago University Museum)	Nature	XI.	289, 290	Wood-cut	Feb. 11, 1875.
Adams, Davenport	"Life in the Primæval World": A book founded on Meunier's "Les Animaux d'autrefois," in which an account of the Moa is given, based on Hochstetter; also an account of the "York Skeleton"	..	..	186, *et seq.*	..	1872.
Allis, Thomas ..	Notice of a nearly complete Skeleton of a *Dinornis*, presented by Dr. Gibson to the Museum of the Yorkshire Philosophical Society	Proc. Linn. Soc. ..	VIII.	xlvi., 50, 52	..	June 16, 1864
	Portions of the skeleton exhibited at meeting, with ligaments and portion of skin	..	..	..	..	June 16, 1864
——	Abstract of above paper	Nat. Hist. Review ..	..	636	..	1864.
	Also in	Zoologist	..	9195–9197	..	..
Allis, Thomas ..	Further Notes on the Skeleton of *Dinornis robustus*, Owen, in the York Museum	Proc. Linn. Soc. ..	VIII.	140, 141	..	Nov. 17, 1864.
Blainville, De ..	Remarks against Owen's Identification of *Dinornis* Bones	Ostéographie ..	..	..	..	1839.
Booth, B. S. ..	Description of the Moa-bone Swamp at Hamilton, Otago	Trans. N.Z. Inst. ..	VII.	123–138	..	1875.
		And Proc. ..	..	545–549	..	..
" ..	On a Second Discovery of Moa-bones at Hamilton	Trans. N.Z. Inst. ..	IX.	365, 366	..	1877.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Buller, Sir Walter	List of Silver's "New Zealand Birds." Figures of Hochstetter's restoration of *Dinornis* (*D. giganteus*) skeleton, also of a skeleton of *D. elephantopus*, and the leg-bones of *D. maximus*	..	..	..	i.–iv.	..
"	Figure of a *Dinornis* skeleton, and Maori in costume (frontispiece)	Birds of New Zealand	..	..	..	1873.
"	*Dinornis.* See introduction ..	Birds of New Zealand, 2nd ed.	I.	18–35	5 wood-cuts	1888.
"	Supplementary notes, figuring a metatarsus	Birds of New Zealand, 2nd ed.	II.	333–335	2 plates	..
Campbell, W. D.	On the Discovery of Moa-bones near Marsden. (Title only)	Proc. N.Z. Inst. ..	XI.	574	..	..
Chapman, F. R. ..	Notes on Moa-remains in the Mackenzie Country and other Localities. (Describes gizzard-stones)	Trans. N.Z. Inst. ..	XVII.	172–178	..	..
Cheeseman, T. F.	Notice of the Discovery of Moa-remains at Ellerslie, near Auckland	Trans. N.Z. Inst. ..	VIII.	427	..	..
Christie, Rev. J. ..	Adamic Memorials	*N.Z. Presbyterian* ..	..	..	..	Dec. 1, 1888.
" ..	Solution of the Moa Problem ..	Dun. *Evening Star*	..	..	..	Jan. 1889.
" ..	The Exhibition and its Moa-remains	Dun. *Evening Star*	..	..	..	March, 1890.
" ..	The Moa	Dun. *Evening Star*	..	..	..	Apr. 10, 1890.
" ..	Letter to Editor (on the moa) ..	Dun. *Evening Star*	..	..	..	Apr. 24, 1890.
" ..	New School of Natural Science ..	Dunedin *Evening Star* (supplement)	..	..	..	May 31, 1890.
" ..	Otago Institute	*Otago Daily Times*	..	..	..	July 8, 1890.
" ..	Otago Notes	Sydney *Presbyterian*	..	..	..	Sept. 18, 1890.
" ..	Moa-remains	Dun. *Evening Star*	..	..	..	Jan., 1891.
" ..	Moa-bones again	Dun. *Evening Star*	..	..	..	Sept., 1891.

" ..	Enfield Fossils	*Otago Daily Times*	..	..	..	Sept. 7, 1891.
" ..	Extinction of the Moa	*North Otago Times*	..	..	..	Nov. 23, 1891.
" ..	The Glacial Period	*North Otago Times*	..	..	..	Jan. 9, 1892.
" ..	Moa Extinction	*North Otago Times*	..	..	..	1892.
" ..	The Country and Age of the Moa ..	*North Otago Times*	..	..	..	1892.
" ..	Glacial Extinction of the Moa ..	*North Otago Times*	..	..	..	Feb. 3, 1892.
" ..	The Moa	Dunedin *Evening Star* (supplement)	..	..	..	Feb. 3, 1893.
Clarke, Rev. W. B.	*Dinornis* as an Australian Genus ..	Geolog. Mag. ..	VI.	383	..	1869.
"	*Dinornis australis* (*Dromornis*). An Account of the Discovery of the Species in 1869, and the Result of Subsequent Investigations	Proc. Royal Soc. N.S.W.	XI.	41–49	..	..
Cocchi, Professor J.	Catalogi della Collezione Centrale Italiana di Palæontologia, Firenze. Thinks *D. crassus*, *D. elephantopus*, *D. giganteus*, *D. robustus*, and *D. ingens* belong to the Neolithic period	..	..	63	..	1872.
	Quoted by Owen in his 21st Mem., 7th December, 1875, but not in "Extinct Birds of New Zealand"	Zool. Trans. ..	X.	185	..	..
Cockburn-Hood, T. H.	*Dinornis*: Remarks on its Footprints and Recent Extinction	Proc. Royal Soc., Edin.	VIII.	236–240	..	1873–74.
Ditto	Notes respecting the Moa-cave at Earnscleugh, Otago	Trans. N.Z. Inst. ..	VI.	387, 388	..	..
Colenso, Rev. W.	The Moa: An Account of some Enormous Fossil Bones of an Unknown Species of the Class Aves, lately discovered in New Zealand*	Tasm. Journ. Nat. Sc., vol. dated 1843	II.	81–96	..	..

* This paper was forwarded to the secretary of the Tasmanian Society before 1st May, 1842, as the MS. copy published by Owen is dated 1st May, 1812. (See "*Status quo*," Trans. N.Z. Inst., vol. xxiv., pp. 473, 474.) Mr. Colenso states that he first knew of the moa in January, 1838.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
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"	On the Moa, *Dinornis* sp. (Title only)	Trans. N.Z. Inst. ..	XI.	568	..	..
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Cormack, W. E. ..	Note on the Locality affording the Femur of *D. gracilis* in Professor Owen's paper, with woodcut of section at Opito	Trans. Zool. Soc. ..	IV.	145–147	Wood-cut	..
Cotton, Rev. W. ..	Letter addressed to Professor Owen on the Bones of the Moa	Proc. Zool. Soc. ..	..	..	..	1843.
Coughtrey, Professor J. Millen-, and Hutton, Captain F. W.	Remarks on Some of the More Remarkable Moa-remains found in the Earnscleugh Cave	Trans. N.Z. Inst. ..	VII.	138–144	..	..
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Davies, Thomas ..	Report on the Gizzard-stones of Moa (in note)	Extinct Birds of N.Z.	I.	337	..	..
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" ..	Note respecting the Discovery of the Egg of the Moa at the Kaikoura Peninsula	Trans. N.Z. Inst. ..	IV.	403	..	..
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" ..	Preliminary Notice of Additions to the Extinct Avifauna of New Zealand	Trans. N.Z. Inst. ..	XXIV.	185–189	..	..
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″	..	Letter on the Discovery of Cooking-pits and Kitchen-middens in Canterbury Settlement, Middle Island, New Zealand. (Communicated, with remarks, by Professor Owen)	Proc. Zool. Soc. ..	..	53–56	..	1870.
″	..	Remarks on the Extinct Birds of New Zealand	Ibis	..	209–220	..	1874.
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″	..	Geology of Canterbury and Westland: (*a*.) First Appearance of Man on this Island. (*b*.) The *Dinornithidæ*, or Moas. (*c*.) Occurrence of Moa-bones, and Trace of the Extinction of the *Dinornithidæ*. (*d*.) Glenmark	Chap. XVI. ..	..	407–449	..	..
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″	..	Notes on the Moa-hunters' Encampment at Shag Point, Otago	Trans. N.Z. Inst. ..	VII.	91–98	Sec. 1–3	..
″	..	Results of Excavations and Researches in and near the Moa-bone Point Cave, Sumner Road (postscript)	Trans. N.Z. Inst. ..	VII.	528–530	..	..

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" ..	On *Megalapteryx hectori*, a New Gigantic Species of Apterygian Bird. Received April 2, 1885; read June 2, 1885	Trans. Zool. Soc. ..	XII., pt. 7	161–169	xxx.	..
" ..	Researches and Excavations carried on in and near the Moa-bone Point Cave, Sumner Road, in the Year 1872. (*Lyttelton Times* print)	..	..	22	..	1874.
" ..	This pamphlet gave rise to a controversy. (See speeches in Legislative Council, October 19, 1875)	N.Z. *Hansard* ..	XIX.	546–48	..	..
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			XIV.	90, 91	..	..
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" ..	Notes on an Ancient Native Burial-place near the Moa-bone Point, Sumner. (Moa-hunters)	Trans. N.Z. Inst. ..	VII.	86–91	iii., iv.	..
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" ..	On the Deposit of Moa-bones at Te Aute	Trans. N.Z. Inst. ..	XXII.	553	..	..
" ..	Notes on Moa Gizzard-stones ..	Trans. N.Z. Inst. ..	XXIV.	172–175	..	..
" ..	On the Fissures and Caves at the Castle Rocks, Southland; with a Description of the Remains of the Existing and Extinct Birds found in them	Trans. N.Z. Inst. ..	XXV.	88–106	vii. and viii., vii.*a*, vii.*b*, vii.*c*, vii.*d*	..
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" ..	List of Human, Moa, and other Bones found on Miramar Peninsula	Trans. N.Z. Inst. ..	V.	431	..	..
" ..	On the Modes of Occurrence of the Moa-bones in New Zealand	Nature	XII.	441	..	..
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"	Remarks on some Bones recently discovered by H. T. Wharton in Caves at Highfield, Canterbury	Trans. N.Z. Inst. ..	XV.	526	..	..
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"	New Zealand—					
	Kiwi and moa	..	..	173–198	..	..
	Appendix: Dimensions of species	..	..	198	..	..
	Two woodcuts of *D. ingens*, and plans of caves in the Aorere Valley, Nelson. List of localities at which moa-bones had been found is given	..	..	64, 65	..	..
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" ..	The Geology of New Zealand. At Mokau—numerous caves, in some of which bones of the moa have been found	N.Z. Magazine ..	I. (No. 2)	..	..	April, 1850.
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		Froriep. Notizen ..	VIII.	col.209–218	..	1848.
		Extinct Birds of New Zealand		180–183	43, 44, 45	..
	In Extinct Birds, the name of the Ralline skull altered to *Aptornis*	Extinct Birds of New Zealand	I.	173–178	lxvii.	..
" ..	On *Dinornis*. Containing the restoration of the feet of that genus, and of *Palapteryx*, with a description of the sternum in *Palapteryx* and *Aptornis*. Part IV. (Feb. 26, 1850)	Zool. Soc. Trans. ..	IV., pt. 1	1–20	1–4	1862.
		Extinct Birds of New Zealand	I.	187–204	50–51	..

"	..	*Dinornis*. Part V. (Nov. 12, 1850). Containing a description of the skull and beak of a large species of *Dinornis*, of the cranium of an immature specimen of *D. giganteus* (?), and of crania of species of *Palapteryx*	Zool. Soc. Trans. ..	IV., pt. 2	59–68	xxiii., xxiv.	1862.
			Zool. Soc. Proc. ..	..	208–212	..	1850.
			Extinct Birds of New Zealand	I.	205–214	lii., liii.	..
"	..	On *Dinornis*. Part VI. (Nov. 14, 1854). Containing a description of the bones of the leg of *Dinornis* (*Palapteryx*) *struthioides*, and of *D. gracilis*, Owen, with woodcut of section between Wanganui and Turakina	Zool. Soc. Trans. ..	IV., pt. 4.	141–147	xli., xlii.	1862.
			Zool. Soc. Proc. ..	XXII.	244–248	..	1854.
			Extinct Birds of New Zealand	I.	215–222	liv., lv. (woodcut)	..
"	..	On *Dinornis*. Part VII. (April 8, 1856). Containing a description of the bones of the leg and foot of *Dinornis elephantopus*, Owen	Zool. Soc. Trans. ..	IV., pt. 5.	149–189	xliii.–xlv.	1862.
			Zool. Soc. Proc. ..	XXIV.	54–61	..	1856.
			Extinct Birds of New Zealand	I.	223–235	lvi.–lxi.	..
"	..	On *Dinornis*. Part VIII. (April 8, 1856). Containing a description of the skeleton of *Dinornis elephantopus*, Owen. This paper does not seem to have been noticed in the Proceedings	Zool. Soc. Trans. ..	IV.	159–164	xlvi., xlvii.	..
			Zool. Soc. Proc. ..	..	..	..	..
			Extinct Birds of New Zealand	I.	223–235	lxvi., lxx.	..
"	..	On *Dinornis*. Part IX. (Dec. 13, 1864). Containing a description of the skull, atlas, and scapulo-coracoid bone of *D. robustus*, Owen. Figures part of the York skeleton and the Crystal Palace moa, from near Timaru	Zool. Soc. Trans. ..	V., pt. 5	337–358	liii.–lvi.	1866.
			Zool. Soc. Proc. ..	..	648	..	1864.
			Extinct Birds of New Zealand	I.	151	lxii.–lxv. (woodcuts)	..

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Owen, Sir R. ..	On *Dinornis*. Part X. (May 23, 1865). Containing a description of part of the skeleton of a flightless bird, indicative of a new genus and species (*Cnemiornis calcitrans*, Owen), also from Timaru fissure. Mentions having corrected his identification of *Aptornis* skull	Zool. Soc. Trans. ..	V.	395–404	63–67	..
		Zool. Soc. Proc. ..	..	438	..	1865.
" ..	On *Dinornis*. Part XI. (Nov. 28, 1867). Containing a description of the integument of the sole and tendons of a toe of the foot of *D. robustus*, Owen (York moa)	Zool. Soc. Trans. ..	VI., pt. 8	495, 496	lxxxviii.	1869.
		Zool. Soc. Proc. ..	..	891	..	1867.
		Extinct Birds of New Zealand	I.	248, 249	lxxi.	..
" ..	On *Dinornis*. Part XII. (Nov. 28, 1867). Containing a description of the femur, tibia, and metatarsus of *D. maximus*, Owen	Zool. Soc. Trans. ..	VI.	497–500	89, 90	1869.
		Zool. Soc. Proc. ..	..	891	..	1867.
		Extinct Birds of New Zealand	I.	250–252	lxxix., lxxx.	..
" ..	On *Dinornis*. Part XIII. (June 25, 1868). Containing a description of the sternum in *D. elephantopus* and *D. rheides*, with notes on that bone in *D. crassus* and *D. casuarinus*	Zool. Soc. Trans. ..	VII., pt. 2	115–122	vii., viii., ix.	1870.
		Zool. Soc. Proc. ..	..	404	..	1868.
		Extinct Birds of New Zealand	I.	254–260	lxxii.–lxxiv.	..
" ..	On *Dinornis*. Part XIV. (Jan. 28, 1869). Containing contribution to the craniology of the genus, with a description of the fossil cranium of *Dasonis londinensis*, Owen, from the London clay of Sheppey	Zool. Soc. Trans. ..	VII., pt. 2	123–150	x.–xvi.	1872.
		Zool. Soc. Proc. ..	..	59	..	1869.
		Extinct Birds of New Zealand	I.	262–287	lxxv.–lxxxii.	..

"	..	On *Dinornis*. Part XV. (March 10, 1870). Containing a description of the skull, femur, tibia, fibula, and metatarsus of *Aptornis defossor*, Owen, from near Oamaru, Middle Island, New Zealand; with additional observations on *Aptornis didiformis*, on *Notornis mantellii*, and on *Dinornis curtus*. Found in a cave of soft sand about fourteen miles from Oamaru	Zool. Soc. Trans. ..	VII., pt. 5	353–380	xl.–xliv.	1872.
			Zool. Soc. Proc. ..	..	128	..	1870.
			Extinct Birds of New Zealand	I.	290–316	lxxxiii.–lxxxvi.	..
"	..	On *Dinornis*. Part XVI. (May 26, 1870). Containing notices of the internal organs of some species, with a description of the brain and some nerves and muscles of the head of *Apteryx australis*	Zool. Soc. Trans. ..	VII., pt. 5	381–396	xlv.–xlvii.	Jan., 1871.
			Zool. Soc. Proc. ..	..	334	..	1878
			Extinct Birds of New Zealand	I.	326–333	xci., xcii., xciii.	..
"	..	On *Dinornis*. Part XVII. (June 6, 1871). Containing a description of the sternum and pelvis, with an attempted restoration of *Aptornis defossor*, Owen	Zool. Soc. Trans. ..	VIII., pt. 3	119–126	xiv.–xvi.	Sept., 1872.
			Zool. Soc. Proc. ..	..	506	..	1871.
			Extinct Birds of New Zealand	I.	339–346	lxxxviii., lxxxix., xciv.	..
"	..	On *Dinornis*. Part XVIII. (May 7, 1872). Containing a description of the pelvis and bones of the leg of *D. gravis*. In the "Extinct Birds of New Zealand" is table of measurements of bones of the legs of the (then) known species	Zool. Soc. Trans. ..	VIII., pt. 6	361–380	lviii.–lxi.	May, 1873.
			Zool. Soc. Proc. ..	..	605	..	1872.
			Extinct Birds of New Zealand	I.	347, 356–364	xli., xli.*a*, xlii., xlii.*a*	..
"	..	On *Dinornis*. Part XIX. (June 4, 1872). Containing a description of a femur indicative of a new genus of large wingless bird (*Dromornis australis*, Owen) from a Post-tertiary deposit in Queensland, Australia	Zool. Soc. Trans. ..	VIII.	381–384	lii., liii.	..
			Zool. Soc. Proc. ..	..	682	..	1872.
			Extinct Birds of New Zealand	I. (Ap.)	1–7	..	..

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Owen, Sir R. ..	On *Dinornis*. Part XX. (December, 2, 1873). Containing a restoration of the skeleton of *Cnemiornis calcitrans*, Owen, with remarks on its affinities in the Lamellirostral group	Zool. Soc. Trans. ..	IX., pt. 3	253–272	xxxv.–xxxix.	May, 1875.
		Zool. Soc. Proc. ..	..	763	..	1873.
		Extinct Birds of New Zealand	I.	365–384	ci., cii., ciii., civ., xcv.	..
" ..	On *Dinornis*. Part XXI. (June 15, 1875). (*Harpagornis*.) Memoir on the bones of the trunk and limbs of a gigantic bird of prey (*H. moorei*, Von Haast)	Zool. Soc. Proc. ..	..	470	..	1875.
		Extinct Birds of New Zealand	I.	141	cv., cvi., cvii.	..
" ..	On *Dinornis*. Part XXII. (Dec. 2, 1875). Containing a restoration of the skeleton of *Dinornis maximus*, Owen, with an appendix on additional evidence of the genus *Dinornis* in Australia. This paper is really No. 22 of the series, though called Part XXI., at p. 147 of vol. x., Zool. Soc. Trans. Pl. xcvii. of "Extinct Birds of New Zealand" gives the restored skeleton, with Professor Owen standing beside it	Zool. Soc. Trans. ..	X., pt. 3	147–188	xxxi.–xxxiii.	Oct. 1, 1877.
		Zool. Soc. Proc. ..	..	634	..	1875.
		Extinct Birds of New Zealand	I.	391–426	Woodcut, xcvii.	..
			I. (Ap.)	1–4	c.	..
" ..	On *Dinornis*. Part XXIII. (Jan. 3, 1882). Containing a description of the skeleton of *Dinornis parva*, Owen, found in a cave forty miles north-west of Nelson	Zool. Soc. Trans. ..	XI., pt. 8, No. 1	233–254	li.–viii.	Jan., 1883.
		Zool. Soc. Proc. ..	I.	..	..	1882.

" ..	On *Dinornis*. Part XXIV. (June 20, 1882). Containing a description of the head and feet, with the dried integument of an individual of the species *D. didinus*, Owen. The Queenstown specimen said to be noticed in the *Tuapeka Times* of Nov., 1878	Zool. Soc. Trans.	XI., pt. 8, No. 4	257–261	59–61	Jan., 1883.
" ..	On *Dinornis*. Part XXV. (March 18, 1884). Containing a description of the sternum of *Dinornis elephantopus*	Zool. Soc. Trans. ..	XII., pt. 1, No. 1	1–3	i.	Feb., 1886.
" ..	*Dromornis australis*	Quart. Journ. Geol. Soc. L.	XII.	111	iii.	Aug., 1856.
" ..	Also	Extinct Birds of New Zealand	I. (App.)	5–7	cxviii.	..
" ..	Memoir on *Gastornis*, with characters of *Dinornis*	Quart. Journ. Geol. Soc. L.	XII.	210	iii., fig. 2	1856.
" ..	Report of lecture on wingless birds, by ——	*Athenæum* ..	..	..	..	No. 850.
" ..	See also	*Quarterly Review* ..	..	402	..	No. 90.
" ..	Memoirs on the Extinct Wingless Birds of New Zealand. 2 vols.	..	..	..	..	1879.
" ..	Remarks on Dr. Haast's letter *re* discovery of cooking-places, &c., in Canterbury	Zool. Soc. Proc. ..	..	53–57	..	1870.
" ..	Note on a New Locality of *Dinornithidæ* (Hamilton Swamp) ..	Zool. Soc. Proc. ..	..	..	..	Feb. 1, 1875.
" ..	Memoir on the eggs of species of *Dinornis*	Extinct Birds of New Zealand	I.	317–320	cxvii., xcix.	..
" ..	Restoration of *D. gravis*	Extinct Birds of New Zealand	I.	385–387	cx.	..
" ..	Restoration of *D. robustus*	Extinct Birds of New Zealand	I.	388–390	cxvi.	..

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Owen, Sir R. ..	Course and Range of Variation in species of *Dinornis*. Gives a review of the generic characters of *Dinornis*, and a table of admeasurements of seven species	Extinct Birds of New Zealand	I.	427–435	cviii.–cxiii.	..
" ..	On the Integument and Plumage of *Dinornis*, with woodcut of feather	Extinct Birds of New Zealand	I.	440–450	cxiv.	..
" ..	On the *Ornithichorites*, or Footprints of *Dinornis*	Extinct Birds of New Zealand	I.	451–453	cxvi.	..
" ..	On the Food, Nests, and Traditions of the Moas (*Dinornis*), and on the Extinction and Origin of the Species of *Dinornis*	Extinct Birds of New Zealand	I.	454–465	..	..
Parker, Dr. T. J.	On a Specimen of *D. casuarinus* found at Green Island	Proc. N.Z. Inst. ..	XXI.	523	..	..
"	On the Presence of a Crest of Feathers in certain Species of Moa	Trans. N.Z. Inst. ..	XXV.	3–6	..	..
"	Additional Note on the Presence of a Crest of Feathers in some Species of Moa	Trans. N.Z. Inst. ..	XXV.	539	..	..
"	On the Classification and Mutual Relationships of the *Dinornithidæ*	Trans N.Z. Inst. ..	XXV.	1–3	..	..
"	On the Cranial Osteology, Classification, and Phylogeny of the *Dinornithidæ*	Trans. Zool. Soc. ..	..	..	..	..
		Proc. Zool. Soc. ..	..	..	..	Feb. 14, 1893.
		Nature	..	431	..	Mar. 2, 1893.
Parker, W. K. ..	On the Struthious Skull	Phil. Trans. Roy. Soc	..	163–170	..	1866.
" ..	On the Shoulder-girdle	Publ. Ray Soc. ..	..	189, 190	..	1868.
Plant, John ..	Footprints of *Dinornis*. Bones of *Dinornis* and Dodo	Proc. Lit. and Phil. Soc., Manchester	XVI.	181, 182	..	1877.

Polack, J. S. ..	New Zealand. (See note about moa)	..	I.	303, 307, 308	..	1838.
Purnell, C. W. ..	The Maori and the Moa	*Victorian Review* ..	I.	570–586	..	1880.
Pyke, Vincent ..	On the Moa, and the Probable Cause of its Extinction. Also in pamphlet form, published at *Evening Post* Office, Wellington	Trans. N.Z. Inst. ..	XXIII.	627	..	July, 1890.
Quatrefages, A. de	Les Moas et les Chasseurs de Moa ..	Journal des Savants	..	..	..	1883.
	See also	Pop. Sci. Monthly..	XXX.	662	..	..
"	Translation of above by Miss Buller..	Trans. N.Z. Inst. ..	XXV.	17–49	..	..
Reichenbach ..	Avium Systema Naturale	..	..	34, 35	..	..
" ..	Das Naturliche System der Vögel ..	..	XXX.	..	..	1849–1850.
Roberts, W. H. S.	Notes on the Moa	Trans. N.Z. Inst. ..	VIII.	548, 549	..	..
Robson, C. H. ..	Notes on Moa-remains in the Vicinity of Cape Campbell	Trans. N.Z. Inst. ..	VIII.	95–97	..	..
	Discussion on above	Proc. N.Z. Inst. ..	..	413	..	..
" ..	Further Notes on Moa-remains ..	Trans. N.Z. Inst. ..	IX.	279, 280	..	..
Rowley, C. H. ..	*Dinornis:* Figures of Moa-stones and Eggshells. Plate of eggs of *D. ingens* and *D. crassus*	Ornithological Miscellany	III.	240	..	1878.
" ..	Remarks on the Gigantic Extinct Birds of Madagascar and New Zealand	Ornithological Miscellany	III.	237–247	cxii., cxv.	..
Rule, Mr. ..	Cites tradition of giant eagle, or movie	Polytechnic Journal	..	..	..	July, 1843.
Russell, J. C. ..	The Gigantic Birds of New Zealand, with Author's Experience of Moa-caves	Amer. Naturalist ..	XI.	11–21	..	1877
Rutland, Joshua..	Did the Maori know the Moa? ..	Jour. Polynesian Soc.	II., No. 3	156	..	1893.
Sclater, P. L. ..	On the *Struthionidæ*	Zool. Soc. Trans. ..	IV.	72	..	..

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
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Smith, W. W. ..	On Moa and other Remains from the Tengawai River, Canterbury	N.Z. Journal of Science	II.	293	..	1884.
Stack, Rev. J. W.	Some Observations on the Annual Address of the President of the Philosophical Institute of Canterbury	Trans. N.Z. Inst. ..	IV.	107–110	..	..
"	Notes on the Word "Moa," in the Poetry of the New-Zealander	Trans. N.Z. Inst. (Appendix)	VII.	xxviii., xxix.	..	1875.
Spencer, G. S. ..	*Dinornis* sp. (?). Remains found at Waingongoro have undergone the process of cooking	Zool. Soc. Proc. ..	..	638	..	1867.
Stevens, S. ..	*Dinornis ingens*. An egg supposed to belong to this species exhibited	Zool. Soc. Proc. ..	..	617, 618	..	1865.
S. S. (Stevens, S.)	Particulars of the finding of the Moa-egg	*Zoologist*	..	34	..	1865.
"	Discovery of Fossil Remains of a Gigantic Bird in New Zealand (probably Reptilian Remains)	*Zoologist*	..	97	..	1865.
Taylor, Rev. Richard	Note to a Paper on the Geology of New Zealand (Meurant's Moa of 1823)	N.Z. Magazine ..	I., No. 2	107	..	April, 1850.
	Cf. Jardine's Contribution to Ornith.	..	..	9	..	1851.
"	Letter to Sir Everard Home (Feb. 14, 1844) *re* moa at Turakina. Bones at mouth of Whangaehu	Owen's "Extinct Birds of New Zealand"	I.	135	..	..
"	An Account of the First Discovery of Moa-bones	Trans. N.Z. Inst. ..	V.	97–101	..	..

Taylor, Thomas ..	Analysis of the Composition of Ostrich- and *Dinornis*-bones	Extinct Birds of New Zealand	I.	108	..	..
Thomson, Dr. A. S.	Account of the Cave in which Recent Moa-remains were found	Trans. N.Z. Inst. ..	IV.	378, 379	..	1872.
"	Story of New Zealand. Figure of *D. elephantopus*	..	..	32	..	..
"	Description of Two Caves in the North Island of New Zealand containing Bones of the Moa	Edinburgh New Phil. Journal	LVI.	268–295	..	1854.
Thomson, J. R. ..	Notice of moa-bones in a report on the northern and interior districts of Otago	*Otago Witness* ..	..	..	..	Jan. 31, 1858.
Thorne, G. ..	Notes on the Discovery of Moa and Moa-hunters' Remains at Pataua River, near Whangarei	Trans. N.Z. Inst. ..	VIII.	83–94	..	1876.
Travers, W. T. L.	Notes on the Extinction of the Moa, with a review of the discussion on the subject published in the Trans. N.Z. Inst.	Trans. N.Z. Inst. ..	VIII.	58–83	..	1876.
"	Anniversary Address to the Wellington Philosophical Society, 2nd February, 1878. Discusses the date of the extinction of the moa	Trans. N.Z. Inst. (Proc.)	X.	539–544	..	..
Tregear, E. ..	The Maoris and the Moa	Jour. Anthrop. Inst.	XVII.	292–304	..	1888.
" ..	The Extinction of the Moa ..	Trans. N.Z. Inst. ..	XXV.	413–426	..	..
	Discussion on above	Proc. N.Z. Inst. ..	XXV.	530	..	..
Webber	On certain Finds of Moa-bones ..	Trans. N.Z. Inst. ..	XVI.	571	..	..
Weetman, Sydney	Notes on some Moa-remains found at the Great Barrier Island during February, 1886	Trans. N.Z. Inst. ..	XIX.	193, 194	xxii.	..
White, John ..	History of the Maori: Extermination of the Moa	..	III.	189	..	1881.

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White, Taylor ..	Notes on Moa-caves, &c., in the Wakatipu District	Trans. N.Z. Inst. ..	VIII.	97–102	..	..
" ..	Remarks on the Feathers of Two Species of Moa	Trans. N.Z. Inst. ..	XVIII.	83, 84	..	..
" ..	On the Remains of the Moa in the Forest	Trans. N.Z. Inst. ..	XXV.	504, 505	..	..
Williams, W. ..	Letter to Dr. Buckland from Poverty Bay, New Zealand, 28th February, 1842, quoted by Owen in	Extinct Birds of New Zealand	I.	75	..	..
Williams, W. L. ..	On the Occurrence of the Footprints of a Large Bird found at Turanganui, Poverty Bay	Trans. N.Z. Inst. ..	IV.	124–127	..	1872.
Wonfor, T. W. ..	On Wingless Birds	Brighton Nat. Hist. Soc., 22nd Ann. Rep.	..	50, 51	..	..
Anon.	Note on the Existence of Man with the *Dinornis* in New Zealand	Nat. Hist. Review ..	VII.	343	..	1862.
"	The Last of the Moas	*Chambers's Journal*	XLI.	115	..	1864.
"	Living Moa at Nelson	*Wanganui Chronicle* *Otago Witness* ..	.. ..	.. ..	.. ..	May 20, 1858. Oct. 2, 1858.
"	Dr. Nelson's supposed Moa-bones at Mount Brown	*Otago Witness* ..	..	..	..	Jan. 12, 1858.
"	Moa-feathers (Eben. Baker's) ..	*Otago Daily Times*	..	..	..	Apr. 5, 1873.
"	Report of the Discovery of a Live Moa in the Waiau District	*Otago Daily Times*	..	..	..	Apr. 16, 1873.
"	Moa-skeleton found in Old Botanic Gardens, South Dunedin (*D. casuarinus*)	*Otago Daily Times*	..	..	..	Mar. 30, 1864.

"	..	..	Moa found at Queenstown in the Garvie Mountains by Mr. Wilmot during 1884	New Zealand Journal of Science	II.	394	..	..
"	..	..	Moa's egg, ex Ravenscraig (Mount Fyffe specimen). Bought by British Museum, £120	*Otago Witness* quotes from *Australasian*	..	..	..	Feb. 10 and Mar. 31, 1866.
"	..	..	Skeleton of Moa. Mr. Squire, of Lawrence (says *Tuapeka Times*), purchased the moa found at Queenstown. (Description given)	*Otago Daily Times*	..	..	..	Nov.27,1878.
"	..	..	Moa-bones, with skin and flesh, presented to the Clyde Athenæum by Mr. Sims	*Otago Daily Times*	..	..	..	Nov. 8, 1878.
"	..	..	The Moa Bird, or *Dinornis* ..	*Chambers's Journal*	LIV.	578	..	1877.
"	..	..	Otago Museum Catalogue. Guide to collections. See Moa	..	..	..	..	1878.
"	..	..	Progress of Comparative Anatomy. See note by Reviewer *re* moa-bones, and Rev. W. Colenso, &c. (pp. 401–405)	*Quarterly Review* ..	XC.	362–413	..	March, 1852.
"	..	..	Gold-felder and Fossile Knochen in Neu-Seeland	Ausland	No. 14	..	..	1860.
"	..	..	Woodcut of dried skin of leg and toes in Otago Museum	Nature	..	..	..	Feb.11,1875.
			Copied from .. .. .. And said to have been sent by Haast to Milne-Edwards. Again reproduced by Buller in 2nd edition of "Birds of New Zealand."	La Nature ..	..	..	..	..

II.—BOTANY.

Art. XXII.—*Description of a New Species of* Pimelea.

By T. Kirk, F.L.S.

[*Read before the Nelson Philosophical Society, 11th December, 1893.*]

Pimelea suteri, n.s.

Stems suberect or spreading 4in.–10in. high, much branched, branches slender, naked and scarred below, bark black; sparingly silky above with rather long straight hairs. Leaves about $\frac{3}{8}$in. long, erecto-patent, sessile, narrow linear-lanceolate, more or less concave above, with ciliated margins and apices, scarcely acute. Flowers small, in 5–8 flowered capitula rarely exceeding the leaves; perianth silky or villous. Fruit baccate, ovate-acuminate, hairy at the apex, opaque, red.

Hab. South Island: Dun Mountain, Nelson, alt. 3,000ft. *P. Lawson!* (1868). *W. T. L. Travers! R. I. Kingsley!*

This species is most nearly related to *P. prostrata*, Vahl., and *P. urvilleana*, A. Rich.; but the fruit is quite unlike that of any other species. Mr. N. E. Brown, of the Kew Herbarium, who has kindly compared my plant with type specimens of various species, informs me that he considers it specifically distinct, although it is identical with *P. prostrata*, var. γ, of the "Handbook of the New Zealand Flora." It differs, however, from that form in the leaves never being ovate, truly acute, or glabrous: in all the specimens examined the hairs are confined to the margins and apices of the leaves.

As in all the New Zealand species with small leaves, the flowers of *P. suteri* are functionally diœcious, although apparently hermaphrodite. The staminate flowers may be distinguished at a glance by the greater length of the perianth; the erect anthers are distinctly exserted and produce abundance of pollen, while the short style, with its small abortive stigma, is invariably glabrous.

In the pistillate plant the anthers are invariably abortive, and are hidden in the tube of the perianth; the large capitate stigma, thickly clothed with short papillose hairs, is prominent at the mouth of the tube, where it takes the place of the anthers in the proper staminate plant.

My specimens do not show any instance in which the style in the proper staminate plant is bent on one side and protruded beyond the anthers, as is the case in the large-flowered forms of *P. prostrata*.

The remarkable dimorphism of the flowers in this genus has long been observed, but is not yet fully understood; it is occasionally correlated with slight differences in the habit and leaves of the plant, so that the different sexes in certain localities may be distinguished at sight over large areas. This was first observed at Great Omaha in 1864, when I forwarded specimens of *P. arenaria* showing this feature to Sir Joseph Hooker, who was greatly interested in the phenomenon, although unable to account for it at that time. In many localities, however, there is no obvious difference between the staminate and pistillate flowers except the smaller size of the latter; and at present it is not proved that the occasional difference in habit and foliage is permanent, although its occurrence over large areas is certainly striking. I have never met with true hermaphrodite specimens; in all forms with perfect anthers the stigma is invariably glabrous and abortive so far as my observations extend, but it must be admitted that wider observation is necessary.

It affords me great pleasure to connect the name of the Right Rev. Dr. Suter with this species, and to acknowledge the help he has frequently rendered in forwarding specimens of various New Zealand plants.

Art. XXIII.—*Description of New Cyperaceous Plants, chiefly from the Nelson Provincial District.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 21st February, 1894.*]

Eleocharis neo-zelandica, C. B. Clarke, MS.

A small species with short creeping rhizomes; culms 1in.–2in. high, striate spreading, sheath membranous, mouth oblique, mucronate; spike broadly-ovate $\frac{1}{5}$in. long, glumes ovate, obtuse, almost keeled, midrib stout, not extending to the apex, margins membranous; stamens 3, bristles 0, style-arms 2. Nut broadly pyriform, slightly convex, or almost plano-convex, smooth.

Hab. South Island: Cape Farewell, Nelson (1884). *T. K.*

Mr. Clarke, who has for some years been engaged on a revision of the *Cyperaceæ*, kindly examined my specimens of this curious little plant, for which he suggests the name here adopted. In his letter he states, "This belongs to my subgenus *Eleogenus*. In the absence of setæ, and in the very small style-base, it approximates to some of the New Zealand species of *Scirpus*."

I need only add that small specimens of *E. acuta*, R. Br., approach this species very closely in general appearance, but may easily be distinguished by the truncate mouth of the sheath with its foliaceous mucro, the presence of bristles, and the trigonous nut.

Gahnia robusta, n. s.

A robust species, with erect culms, 6ft.–7ft. high, as thick as the little finger. Leaves 5ft.–6ft. long, more or less involute, excessively scabrous, produced into long filiform pendulous points. Panicle 2ft.–3ft. long, dense, striate, narrow, erect; lower branches 5in.–10in. long; stem-leaves narrow with long filiform points. Spikelets narrow-lanceolate; outer bract lanceolate-acuminate; strongly 3-nerved; empty glumes 4, coriaceous, with a strong nerve. Outer flowering-glume closely enwrapping the flowers, broadly ovate, obtuse, faintly nerved; inner flowering-glumes similar, but more membranous; lowest flower male, stamens 6, filaments united at the base, flattened, flexuous and elongating; upper flower hermaphrodite, stamens 5, ovary fusiform, style-arms 2. Nut ovoid, black or brownish-black, shining, transversely furrowed within.

Hab. North Island: Mungaroa, Wellington. *T. K.*

This species has the strict habit of *G. rigida*, T. Kirk, but is more robust. Its affinities are with *G. setifolia*, Hook. f., and *G. xanthocarpa*, Hook. f.: it differs from both in the erect culms, the strict panicle, and the number of style-arms; it is more robust than the former, from which it differs essentially in the larger black ovoid nut. From *G. xanthocarpa* it differs also in the nut being smaller, shorter, and broader.

Carex dallii, n. s.

A small, slender, tufted species. Culms about 6in. high. Leaves shorter than the culms, $\frac{1}{15}$in.–$\frac{1}{12}$in. broad, involute. Spikelets 3–5, distant, $\frac{3}{8}$in.–$\frac{5}{8}$in. long, narrow, the lowest basal on a long slender peduncle, the uppermost female, sessile, with a few male flowers at base, rarely at apex. Glumes membranous, ovate-acuminate, the lower shortly awned. Style-arms 3. Utricles (immature) ovate-fusiform, shortly bifid. Bracts overtopping the culms. Male spikelet longer than the female.

Hab. South Island: Near the source of the Heaphy River, Nelson. *J. Dall.*

This species is related to *C. lucida*, Boott, from which it differs in the bifid stigmas and fusiform utricles. Better specimens are badly wanted, those forwarded by Mr. Dall being immature.

Carex traversii, n. s.

A slender, tufted species, 6in.–9in. high, culms suberect, or prostrate, almost filiform. Leaves much shorter than the culms, $\frac{1}{30}$in. broad, filiform at the tips, involute. Spikelets 2 – 4; terminal male, shortly pedunculate; the others female, with one or two male flowers at base; sessile, $\frac{3}{8}$in.–$\frac{1}{2}$in. long, broadly-ovate, approximate, except the basal one, which is sometimes distant, and carried on a capillary peduncle; glumes ovate or ovate-lanceolate, many-nerved, with a stout midrib produced into a short awn. Utricle slightly fusiform, bifid at the apex, scaberulous. Style-arms 3.

Hab. South Island: Dun Mountain, &c.; 3,000ft.–4,000ft. *W. T. L. Travers.*

This species bears considerable resemblance to *C. novæ-zelandiæ*, Petrie, which is distinguished by its bifid stigmas and plano-convex utricles.

Carex australis, n. s.

Culms tufted, slender, slightly compressed, 1½ft. high, pale. Leaves involute, equalling or exceeding the culms, $\frac{3}{16}$in.–$\frac{1}{4}$in. broad, with long filiform points. Spikelets 4–5, broadly-ovate, sessile, $\frac{3}{8}$in.–$\frac{1}{2}$in. long, glumes broadly-ovate-acuminate, shortly awned. Utricles broadly-ovate, equalling the glumes, plano-convex, with a short broad bifid beak, nerves prominent. Style-arms 3.

Hab. Stewart Island. *C. Traill* and *T. Kirk* (1882).

Allied to *C. longiculmis*, Petrie, but distinguished by the slender habit, narrow leaves, short spikelets, shorter broader glumes, and broader utricles, which are not stipitate.

The following species of *Carex* are not enumerated either in Mr. Cheeseman's excellent catalogue of the plants of the Provincial District of Nelson,* or in my list of additional plants† found in the Nelson District.

Carex lagopina, *Wahl.*
Dun Mountain, &c. *W. T. L. Travers!*

C. teretiuscula, *Good.*
Rotoiti, &c. *T. K.*

* Trans. N.Z. Inst., vol. xiv. (1881), p. 224.
† *Ibid.*, xviii. (1885), p. 322.

C. trachycarpa, *Cheesem.*
 Mount Owen. *T. F. C.*
C. muelleri, *Petrie.*
 Valley of the Stanley, Amuri, &c. *T. K.*
C. buchanani, *Berg.*
 Amuri, Spenser Mountains, &c. *T. K.*
C. dipsacea, *Berg.*
 Motueka Valley, &c. *T. K.*
C. devia, *Cheesem.*
 D'Urville Island; *H. B. Kirk!* Dun Mountain; *R. I. Kingsley!*
C. wakatipu, *Petrie.*
 Amuri. *T. K.*
C. uncifolia, *Cheesem.*
 Wairau Valley. *T. F. C.!*
C. comans, *Berg.*
 Amuri, Spenser Mountains. *T. K.*
C. petriei, *Cheesem.*
 Mount Arthur District. *T. F. C.*
C. litorosa, *Bailey.*
 Nelson Harbour. *T. K.*
C. solandri, *Boott*, in Fl. N.Z., i., 284.
 Westport, Richmond, &c. *T. K.*

In the "Handbook of the New Zealand Flora" this species is erroneously united with *C. neesiana*, Endlicher, of Norfolk Island, from which it differs in the more slender habit, narrower leaves, ♀ spikelets slender, distant, pendulous, on long filiform peduncles; the glumes are almost papery, and the awn is very short, or 0, more especially in the faintly nerved, narrow-ovate, black, shining utricles.

C. flava, *L.*, var. cataractæ.
 Mount Captain Range, Amuri; Spenser Mountains; Lake Guyon.

Art. XXIV.—*Remarks on the New Zealand Sow-thistles, with Description of a New Species.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 21st February, 1894.*]

In all probability there are no common New Zealand plants about which the ideas of local botanists and agriculturists are so confused as the sow-thistle. The range of variation in the habit and foliage of some species is so great that an ordinary observer may be excused for doubting the specific identity of several of the forms comprehended under the same name: for instance, the plant named *Sonchus asper* by Fuchs exhibits in many instances rigid leaves with crisped and waved margins so closely fringed with brittle spines as to fully justify the application of the trivial name when incautiously handled. By its side may be seen another form with flat, soft, membranous leaves, more or less deeply cut into broad or narrow lobes, utterly destitute of spines. A complete series of gradations may, however, be found between the two forms, and, as their flowers and fruit present no differential characters of the slightest importance, both plants, notwithstanding their dissimilarity, must be referred to the same species.

In the "Flora Novæ-Zelandiæ," and the "Handbook of the New Zealand Flora," Sir Joseph Hooker recognises one species—*S. oleraceus*, L.—of which he considers *S. asper*, Fuchs, to be a variety. Bentham adopts the same view in the "Flora Australiensis." Both the type and the variety vary to a great extent in the outline, cutting, and texture of the leaves, but may be briefly characterized as under:—

Sonchus oleraceus, L., sp. 116. Forst., Prodr. n. 282.

α. oleraceus.

Leaves clasping, almost entire, or toothed, or deeply pinnatifid. Cauline leaves, with large sagittate auricles. Achenes with 3–5 longitudinal ribs, finely muricate, glabrous.

β. asper. *S. asper*, Fuchs, Hist. 674.

Leaves clasping, almost entire or lobed, or deeply pinnatifid, sharply toothed, sometimes rigid, with the margins crisped and spinulose. Achenes longitudinally ribbed, glabrous.

Both forms are common in cultivated land throughout the colony.

Sir Joseph Hooker considers that var. *β* is certainly indigenous in New Zealand, as it was collected by Banks and Solander. It is, however, certain that seeds of both forms must have been repeatedly introduced since that period, and that cross-fertilisation has taken place, since fruits of the typical form exhibit all degrees of murication—some showing only faint traces, while others are covered with small but strongly-marked pittings.

The Rev. W. Colenso, F.R.S., considers this var. *β* to be the puwha of the Maoris, who formerly used it for food, but abandoned it for the introduced European plant, which is less bitter. There is, however, a still more striking form which may also have been utilised by the Maoris. Although widely distributed it is somewhat local, and rarely occurs in large quantity. I do not know any European form with which it exactly agrees. Its characters will be found in the following description :—

Sonchus oleraceus, L., γ. *littoralis.*

Robust, stems 1ft. to 1½ft. high, sparingly branched, radical leaves sessile, ovate-oblong, entire or sparingly lobed, obtuse, finely or coarsely toothed, somewhat fleshy, rosulate, and closely appressed to the ground; cauline leaves few, acute, auricles rounded or subacute. Outer involucral bracts acute, inner obtuse; achenes glabrous, 3-5-ribbed.

Hab. On maritime cliffs from Auckland to Stewart Island, but often local, and rarely occurring in great abundance.

The uniformly undivided, rosulate, slightly fleshy leaves, the more robust habit, and copious milky juice are well worthy of notice, as is the large fleshy root. I have never seen this form on cultivated land, and, as far as I am aware, it is absolutely restricted to maritime localities. The singular absence of variation is a remarkable feature when this plant is compared with the typical form and variety β.

It seems not unlikely that the plant observed by Banks and Solander is identical with var. *littoralis*, the fruits of which resemble those of var. β, but are slightly larger. This point could doubtless be settled by an examination of the specimens in the Banksian Herbarium. It is worthy of note that Dr. Anderson, who acted as naturalist in Cook's third expedition, mentions the occurrence of "sow-thistles" in Queen Charlotte Sound: there can be but little doubt that the plant observed by him was var. *littoralis*.

Shortly before my old friend Mr. J. D. Enys, F.G.S., left the colony he made a hasty trip to the Chatham Islands, where he obtained specimens of a handsome sow-thistle, with leaves upwards of 2ft. in length, and large flower-heads, which he kindly sent to me, but unfortunately they were in such a bad state of decay when they came to hand that I was unable to dissect them. However, on examining the type collection of Chatham Island plants in the herbarium of the Colonial Museum I found two specimens, one of which was *S. oleraceus*, L.; the other proved to be identical with the plant collected by Mr. Enys. In justice to Mr. Buchanan, who arranged the type collection, it should be mentioned that both specimens are small, and in bad condition. Unhappily, my efforts to obtain good specimens so far have failed, although a valued correspondent sent me a strong root, which, however, failed to grow. It was therefore with no little pleasure I learned that the plant had flowered in the rich collection of native species cultivated by Messrs. Adams and Sons, of Christchurch, and I am indebted to these gentlemen for their kindness in sending the shrivelled receptacles and ripe fruits.

Unlike the forms mentioned in the early part of this paper, it is a strongly-marked species, as will be seen from the appended description.

Sonchus grandifolius, n. s.

A succulent herb, 2ft.–4ft. high, rhizomes stout, fleshy, creeping, sometimes 2½in. diameter. Radical leaves erect, 1½ft.–2ft. long, 4in.–7in. broad, petiole 6in.–9in. long, stout, dilated at base, but not clasping, blade oblong or ovate-oblong, deeply lobed, pinnatifid or pinnate; segments 4–6 on each side, broad, lobulate, often overlapping, coarsely doubly serrate or dentate, almost coriaceous, scabrid above. Lower cauline leaves petiolate, upper broadly sessile, not auriculate. Heads large, 1in.–1½in. diameter, peduncles white, with cottony wool. Involucral leaves in 3–4 series, broad, subacute, outer with a median line of spinous or almost foliaceous processes. Achenes large, broad, with 1 or 2 stout median longitudinal ribs, and about 4 finer ones, margins broad.

Hab. Chatham Islands.

The ligulate florets appear to be yellow, tinged at the apices with faint salmon-colour or purple. It is a noble addition to the New Zealand flora, and adds another remarkable species to the singular group of endemic plants on the Chatham Islands.

The fleshy rhizome may possibly prove valuable for cattle-food.

Art. XXV.—*Descriptions of New Native Plants, &c.*

By D. Petrie, M.A., F.L.S.

[*Read before the Otago Institute, 13th June, 1893.*]

1. **Ranunculus novæ-zelandiæ**, sp. nov.

A rather small glabrous fleshy glaucous plant. Rootstock covered by the withered fibres of decayed petioles, and sending down many rather stout fibrous roots.

Leaves all radical; petioles about 1in. long, flattened, expanded and provided with broad membranous wings at the base; blades ternately divided, the lower leaflets sessile and subdivided into two or three deeply 3-lobed crenate segments; upper leaflet distant, broadly petiolate, subdivided into three deeply 3-lobed crenate segments.

Scapes solitary, or very few, one-flowered, glabrous, rather stout, 1in. to 2½in. long.

Sepals broadly oblong, obtuse, the back purplish and bordered with yellow. Petals twice as long as the sepals, cuneate, rounded at the top, the upper part bright-yellow, the lower third greenish and more membranous; veins of the back evident; gland broad, shallow, crescent-shaped near the very base.

Ripe achenes not seen.

Hab. Rough shingly stations at the summit of the Rock and Pillar Range, opposite Middlemarch, and similar stations on the Old Man Range, at 4,000ft. and upwards. I found it very plentiful in the former habitat, and rare in the latter. This species seems most nearly alied to *R. gracilipes*, Hook. f. The leaves, are, however, very different, and the stems neither creep nor give off creeping stolons. It flowers during the first half of November.

2. **Geum leiospermum**, sp. nov.

A small silky or villous perennial herb, with short rosulate leaves, and slender prostrate or ascending stems.

Leaves 1¼in. long or less, pinnate; leaflets about eight pairs, gradually diminishing to the base, the terminal one suborbicular or broadly ovate, ½in. in diameter or less, all closely, acutely, and unequally toothed at the margin.

Stems few, slender, 4in. long or less, densely clothed with fine villous hairs mixed with rather numerous long soft ones.

Flowers small, white, solitary in the axis of the lower bracts, and subpaniculately arranged at the top of the stem, at first almost sessile, but with slender pedicels ⅓in. long when in fruit.

Stamens 10; achenes about 20, on a nearly flat receptacle which is clothed with long silky hairs, perfectly smooth and glabrous, less than $\frac{1}{12}$in. long, narrow elliptic, slightly compressed, and ending in a short slender recurved style about one-third the length of the achene.

Hab. Mount Cardrona (4,000ft.), Dunstan Mountains (2,000ft.-4,000ft.), Upper Waipori (1,800ft.).

The smooth glabrous achenes of this species, which strongly resemble those of many kinds of native *Ranunculus*, readily distinguish it from the other two species that are native to our colony. The flowers, so far as I have seen, are invariably white.

3. **Coprosma pubens**, sp. nov.

A much-branched, slender, leafy decumbent or rambling shrub.

Twigs pale-brown, finely and densely pubescent.

Leaves very uniform, about ⅓in. long and ⅛in. wide, narrow obovate, broadly rounded at the apex and often submucronate, the edges slightly recurved when dry, and the lower half gradually narrowing into a sort of petiole; veinless above, the veins below indistinct and diverging but slightly from the midrib.

Stipules prominent, white, membranous, connate into a rather long ciliate triangular lobe between the petioles; in age ruptured by the growth of the twigs.

Flowers not seen.

Drupes solitary, often in opposite pairs, sessile or sub-sessile in the axils of the opposite leaves on the younger lateral shoots, deep-red, but not so dark as the drupes of *C. rhamnoides*, A. Cunn., which they closely resemble but somewhat excel in size.

Hab. Arthur's Pass (3,000ft.), and Kelly's Hill (2,500ft. to 3,500ft.), both in Westland.

This is a very distinct plant. It is, perhaps, most closely related to *C. depressa*, Colenso—a species which also occurs on Kelly's Hill, differing in its broader obtuse leaves, long white stipules, red drupe, and rambling habit. It has been compared at Kew with the plants recently described as new species by Mr. Colenso, F.R.S., but it has no resemblance to any of these forms of the genus.

4. **Coprosma retusa,** sp. nov.

A slender, sparingly-branched, procumbent shrub, emitting a very disagreeable odour when crushed.

Bark of twigs pale-grey, marked by two opposite broad bands of pubescence, the planes of which lie at right angles in successive internodes.

Leaves $\frac{1}{3}$in. long and about half as broad, close-set, spreading, obovate-cuneate, retuse, coriaceous, nerveless, recurved at the edges, and fringed by a delicately erose membranous border; depressed above, and strongly keeled below. Stipules coriaceous, connate into short broad ciliated sheaths investing the twigs, 3-lobed, the lobes forming prominent, pale, horn-like processes.

Flowers terminal on the short lateral shoots of the main twigs, rather large; males, $\frac{1}{3}$in. long; calyx cupular, 4-lobed, two opposite lobes rather long and acute, the others short and subulate; corolla campanulate deeply 4- or 5-lobed; filaments long, anthers pendulous: females rather larger than the males; calyx tubular, short, with 4 remote subulate teeth on the limb; corolla narrow campanulate, deeply divided into 4 narrow acute lobes; styles 2, long, stout, diverging.

Drupes orange, ovoid, $\frac{3}{8}$in. long, the top crowned by the persistent calyx teeth.

Hab. Clinton Saddle, Lake Te Anau (3,000ft.), and Kelly's Hill, Otira River, Westland (3,500ft.).

The present species is intermediate between *C. cuneata*, Hk. f., and *C. serrulata*, Buchanan. Its disagreeable odour recalls *C. fœtidissima*, which it further resembles in its large terminal flowers. Mr. L. Cockayne informs me that the drupes smell as vilely as the crushed leaves. The erose membranous margins of the leaves distinguish the present plant from all the native species except *C. serrulata*, from which its smaller retuse leaves at once mark it off.

5. **Celmisia armstrongii**, sp. nov.

A species growing in large tufts, with very many leaves, and numerous flower-scapes.

Leaves 9in. to 12in. long (exclusive of the sheaths), $\frac{1}{2}$in. to $\frac{2}{3}$in. wide, linear-ensiform, tapering regularly from below the middle to the acute point, rigid, entire, strongly recurved at and near the top, the lower part less recurved, longitudinally wrinkled when dry, midrib stiff and prominent; upper surface greenish-yellow, with a broad yellow band down the middle, and covered by a very delicate pellicle of greenish-grey tomentum; under surface not wrinkled, clothed except on the midrib with a dense layer of white smoothly-appressed tomentum; midrib broad and ribbed at the base, and tapering uniformly to the apex; sheaths broad, many-nerved, glabrous on the inner surface, the back densely covered with white cottony hairs which are continued beyond the edge as a delicate fringe.

Scapes as long as, or slightly longer than, the leaves, rather slender, everywhere clothed with white cobwebby tomentum; bracts numerous, linear, acute, fringed with a membranous border of tomentum.

Heads $1\frac{1}{2}$in. across, or less; involucral scales glabrous, linear-subulate, more or less reflexed, pale-brown. Achenes finely pubescent, grooved.

Hab. Arthur's Pass (3,000ft.) and Kelly's Hill (3,000ft.–4,000ft.). This is the most abundant species above the bush-line in Westland.

I have long had it from Mr. J. B. Armstrong, who referred it to *C. munroi*, Hk. f., but I learn from the Director of the Kew Herbarium that it is quite distinct from that species.

6. **Euphrasia cockayniana**, sp. nov.

A short sparingly-branched plant, 2in.–3in. high, and everywhere more or less pubescent with articulate glandular hairs. Branches solitary, or in opposite pairs.

Leaves in opposite pairs, sessile, quadrate-ovate in outline, about $\frac{1}{3}$in. long by $\frac{1}{4}$in. broad, the lower half cuneate and entire, the upper cut into 5–7 short obtusely rounded teeth, glandular pubescent, especially at the slightly-recurved margin.

Flowers ½in. long, shortly pedicelled, in opposite pairs in the axils of the upper leaves, bright yellow. Calyx campanulate, divided to the middle into 4 lanceolate acute lobes, not recurved, rather membranous, clothed with articulate glandular hairs which form a ciliate fringe all round the edge. Corolla about twice the length of the calyx, funnel-shaped, with narrow tube and widely-dilated throat; lower lip large, deeply 3-fid; upper erect, hooded, shortly and broadly 2-lobed.

Anthers shortly mucronate, the lower cell of the lower anther spurred. Apex of style linear and somewhat crotchet-shaped.

Capsule as long as the tube of the calyx, broad, shortly mucronate at the apex, which is never retuse.

Hab. Kelly's Hill, Otira River (4,000ft.).

A very pretty little species, easily distinguished from its New Zealand congeners by its conspicuous yellow flowers. I found but a few flowering specimens on Kelly's Hill. Mr. Cockayne has kindly sent me ripe capsules, and he mentions that the plant grows abundantly on the low spurs leading up to Mount Rolleston from Arthur's Pass.

7. **Pterostylis oliveri,** sp. nov.

A rather stout leafy species 6in. to 12in. high. Leaves reticulately veined, bright glossy-green, amplexicaul or shortly sheathing; radical several, narrow-ovate, acute, narrowed into a rather broad petiole, 2½in. to 3½in. long, ¾in. to ⅞in. wide; cauline several, amplexicaul, sessile, almost acuminate, the upper gradually diminishing in size.

Flowers usually solitary and terminal, a second flower occurring but rarely in the axil of the uppermost cauline leaf, about 2in. long, curved forward and downward in front almost to the level of the ovary. Upper sepal boat-shaped, broad, tapering gradually to an acute point, the free lobes of the lower sepals broadly obcuneate and produced into very slender erect filaments 1¼in. in length. Petals falcate, 1¼in. long, ¼in. broad, acuminate. Claw broadly linear, brown, of nearly uniform width to the base; appendage much narrower than the claw, terminating in numerous very narrow filaments. Column ¾in. long.

Hab. Open scrub and low bush on the banks of Kelly's Creek, Otira River (1,100ft.). In flower in the early part of January.

I have much pleasure in dedicating this plant to Professor D. Oliver, F.R.S., of Kew, in acknowledgment of valued assistance in my botanical studies.

8. **Danthonia pallida,** sp. nov.

A short densely-tufted alpine grass.

Culms branched at the base, leafy below, slender, erect, smooth, 10in. high or less.

Leaves distichous, glabrous, about one-third the length of the culms; sheaths inflated, slightly grooved; blades involute, wiry, tapering to a very slender point, deeply grooved above, rough at the edges; ligule a narrow ciliate or jagged ridge with a few long ciliate hairs at each end.

Panicle ovate, 1½in. long or less; branches few, solitary, filiform, smooth, bearing one or two spikelets, and having a few ciliate hairs at their origin.

Spikelets $\frac{5}{16}$in. long and half as broad, pale, 4–5-flowered, cuneate in outline. Outer glumes unequal, subacute, membranous and hyaline, nerves very obscure or wanting, almost as long as the spikelets. Flowering-glumes very membranous, with many faint nerves, cut at the top into two subtriangular acute nerveless lobes, between which lies the rather broad reflexed untwisted awn, lower edges fringed with long ciliate hairs, which also sparingly clothe the lower half of the midrib; basal pedicel densely pilose. Palea bifid at the top, with ciliate nerves and long delicate hairs fringing its lower edges.

Hab. Kelly's Hill, Otira River (4,000ft.).

This plant differs from its nearest ally, *D. australis*, J. Buchanan, in its untwisted awn, the unawned lobes of the flowering-glume, and the glabrous branches of the panicle. It flowers very sparingly.

9. **Poa dipsacea,** sp. nov.

Culms stout, smooth, glabrous, 6in. to 18in. high, leafy below, branched and decumbent at the base, and rooting at the lower joints.

Leaves considerably shorter than the culms, narrow involute, or incurved at the edges, smooth, deeply striate, sheaths inflated, twice as broad as the blades; ligule broad, very short, rather membranous.

Panicle broadly ovate, 2½in. to 4½in. long; the branches usually in pairs, divaricating, glabrous, bearing few large spikelets near their ends.

Spikelets pale-brown, about ⅜in. long and half as broad, 5–8-flowered. Outer glumes as long as the flowering, membranous, pale-brown, acute or subacute, obscurely 3-nerved. Flowering-glumes yellowish-brown, acute or subacute, 5- to 7-nerved, membranous at the sides, the base with a tuft of long straight hairs reaching to the middle of the midrib, the upper half of which is finely scabrid; the outer nerves more or less clothed with fine hairs. Palea somewhat shorter than the glume, with strongly-ciliate nerves.

Hab. Sources of Broken River, Canterbury alps (4,000ft.).

This grass attains great luxuriance of growth on spray-washed rocky faces. In wet ground with inferior drainage more stunted forms are found. It is somewhat closely allied to *Poa mackayi*, Buchanan, from which it is distinguished by the involute or incurved leaves, the short ligule, the broad panicle with smooth divaricating branches, the larger size of the spikelets, and the different colour, clothing, and texture of the flowering-glumes. The nerves are much less prominent than in that species, and the glumes are never scabrid. I have to record my thanks to Mr. Buchanan for allowing me to compare it with the type of his species.

10. **Asprella aristata**, sp. nov.

Culms slender, smooth, leafy below, 10in. to 20in. long. Leaves bluish-green, much shorter than the culms, narrow, flat, membranous, softly villous (especially on the sheaths); cauline leaves nearly glabrous; ligule short, membranous, irregularly toothed or jagged.

Spike 2in. to 4in. long, broadly linear, of 15 or fewer spikelets.

Spikelets pale bluish-green, sessile, solitary, 2- to 4-flowered. Empty glumes narrow, obliquely falcate, concave, strongly nerved, aristate, usually toothed on one side only, membranous at the edges; the midrib and edges of the arista scabrid.

Flowering-glumes lanceolate, coriaceous, rounded on the back, smooth, 3- to 5-nerved, the apex shortly and in general obliquely toothed and produced into a tapering scabrid arista half as long as the glume; the upper half of the midrib scabrid and more or less keeled.

Palea coriaceous, nearly as long as the glume, with finely-ciliate nerves.

Upper half of ovary densely villous; styles two plumose to the base. Scales broadly triangular, entire, glabrous.

Hab. Sources of Broken River (4,000ft.), and valleys of Mount Torlesse (3,500ft.), Alps of North Canterbury.

This species is well marked by its soft villous leaves, short and rather stout spike, broader falcate nerved outer glumes, and the larger number of flowers in the spikelet. I am not sure that it should be included in *Asprella*, as it has many characters in common with the genus *Agropyrum*, Beauv. It may even be doubted if any of the New Zealand grasses referred to *Asprella* are really members of that genus.

11. **Gastrodia sesamoides**, R. Br.

This Australian orchid has not hitherto been recorded from New Zealand, but I am now able to add it to the species truly native to our Islands. I found it growing in considerable abundance in sparse scrub, at Kelly's Creek, Otira River (1,100ft.), in January of the present year. *G. cunninghamii*, Hook. f., grows pretty plentifully in the same district, but it flowers some weeks earlier. It was this difference in the time of flowering that led me to examine critically the flowers of the present plant, and recognise its independence. Unfortunately but one or two spikes had come into flower when I had to leave Kelly's Creek, but these exactly match the excellent figure given in Sir Joseph Hooker's "Flora Tasmaniæ."

G. sesamoides is very similar to *G. cunninghamii*, but an observer is at once struck by its stouter stems, and their paler mottled-grey colour. It is not so tall as Hooker's plant, and does not seem to affect such deep shade.

The undoubted species of *Gastrodia* occurring in New Zealand are thus raised to three, for Mr. Buchanan's *G. hectori* clearly does not belong to this genus, and it seems doubtful if the species described by Mr. Colenso, F.R.S., are really different from *G. cunninghamii* and the present plant.

12. **Helichrysum purdiei**, D. Petrie.

This pretty plant has been in cultivation for some years in several gardens in Dunedin. It forms large circular patches of densely-compacted twigs, spread flat on the ground. The patches reach a diameter of 3ft. or 4ft. in three or four years, and as the prostrate branches, which are often as stout as a goose-quill, readily strike root, they give promise of growing to a much larger size. The plant is found wild only near the seaside, and it is very sensitive to frost, which, in situations that are at all exposed, kills off the younger growth every winter. In habit it differs widely from the other species of *Helichrysum* native to New Zealand. Mr. W. T. Thiselton Dyer, F.R.S., Director of the Kew Gardens, informs me that its nearest ally is a South African species. It seems to be almost extinct about Dunedin, where it was plentiful on seaside slopes in the early days, as Mr. A. C. Purdie informs me. From its slight power of resisting frost, it is not unlikely that its head-quarters lie more to the north, though it has not yet been reported from any other place than the shores of Otago Harbour. In cultivation it shows no sign of want of constitutional vigour, but it flowers much more sparingly than in a wild state.

13. **Juncus obtusiflorus**, Ehrhart.

This European rush was found by me some years ago at Lake Waihola, and this year I met with it again near the mouth of the Avon River, at New Brighton, a suburb of

Christchurch. In both stations it occurs near long-frequented routes of traffic, and is most likely introduced, though it is quite possible that it may be native. It will, however, have to be found under less equivocal conditions before its indigenous character can be regarded as certain. In both localities it is firmly established.

14. **Juncus gerardi**, Loisel.

This European species is now well established on the muddy beaches of Otago Harbour, near Anderson's Bay. I have watched it for some seasons, but have never found it set fruit, a peculiarity for which I am unable to account. Mr. A. C. Purdie informs me that in former years it grew at the mouth of the Kaikorai Lagoon, in the Green Island district, but I have not had opportunity to verify his observation.

15. **Gastrodia minor**, D. Petrie.

In the fruiting state of this species, the flowers, which are at first almost pendulous, become erect and parallel with the axis of the spike. It seems to be parasitic on the roots of *Leptospermum ericoides*, A. Rich., but I have not been able to satisfy myself on this point. It has flowered very sparingly this season.

Art. XXVI.—*On Four New Species of New Zealand* Musci.

By T. W. Naylor Beckett, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 4th October, 1893.*]

Plates XXV.-XXVIII.

Phascum austro-crispum, sp. nov.

Autoicous. Densely gregarious, minute. Stem short, much divided. Leaves, when dry, curled and contorted, with the margins incurved, curved, from an oval base linear-lanceolate; lower leaves smaller; perichætial leaves much longer, slightly secund, 2–2¼ lines long. Nerve canaliculate, very stout, excurrent in a stout mucro, margins entire. Cells of lower part of leaf hyaline lax long-rectangular, above quadrate and densely chlorophyllose. Seta short, yellow, same length as the capsule. Capsule immersed, oval or roundish-oval (rarely two in one perichætium). Operculum conical, produced into a stout, short, blunt, inclined or straight beak. Calyptra dimidiate, smooth, base entire, reaching below the middle of the capsule. Cladautoicous, the male inflorescence terminal on a special branch, bracts broadly oval at base, tapering gradually into a point, nerved, paraphyses few.

Hab. On clay-banks.

Loc. Dyer's Pass Road, Lyttelton Hills. Abundant in the Malvern district, Canterbury, on sod-banks, No. 407 (named by Dr. Müller), *T. W. N. B.* North-east Valley, Dunedin, *W. Bell.*

Braunia novæ-seelandiæ, sp. nov.

Monoicous. Plants wide creeping, irregularly branched; branches patulous and somewhat clavate at the apices. Leaves, when dry, closely appressed and imbricated, when wet patulous, olive-green above, brown below, the lower parts of the stem denuded, concave, broadly ovate, acute, tapering somewhat suddenly into a blunt point, nerveless; 0·06in. to 0·065in. long, 0·02in. to 0·0325in. wide, margins loosely revolute with a row of incrassated marginal cells. Stolons on lower part of stem, divaricate, 3 to 4 lines long; leaves small from an ovate base, tapering gradually into a long flexuous point, interspersed with red-brown radicles. Cells very uniform over the whole leaf, small, oval, those at the base in the centre long, and of a bright orange colour. Female inflorescence terminal, perichætial leaves longer, ovate-lanceolate, waved, margins flat, nerveless, archegonia numerous (20 or more). Male inflorescence axillary, bud-like, globose antheridia short-stalked, very numerous, with few paraphyses.

Hab. Growing on dry rocks, mixed with *Hedwigia ciliata.*

Loc. Selwyn Gorge, Canterbury, September, 1892; No. 417; *T. W. N. B.* (named by Dr. K. Müller).

Quite distinct from *Braunia humboldtii*, and very different from it in appearance. My specimens are not in fruit, but have well-developed archegonia and antheridia.

Hypnum (Lembophyllum) micro-vagum, sp., nov.

Stem creeping, procumbent, vaguely and irregularly branched. Leaves not altered when dry, dull grey-green, very small, broadly ovate, very concave, apex rounded, minutely toothed, quite nerveless. Cells long, slightly sigmoid, round-ended, very distinct, roundish at margin and apex of leaf, papillose at back. Perichætial leaves much larger, quite entire, inner ones convolute, apices pointed and spreading. Seta smooth, brown, 8 lines long. Capsule inclined or horizontal, short, ovate. Endostome, processes carinate, perforated, with two or three long-jointed cilia between.

Hab. Creeping on stones in dry forest.

Loc. *Fagus* forest, Ben More, North Canterbury, alt. 4,000ft., No. 366 (named by Dr. Müller), *T. W. N. B.* Kenepuru, Pelorus Sound; *J. Rutland.* McKinnon's Pass, Otago (collected by — Triggs); *T. G. Wright*, No. 963. Greymouth (collected by W. J. Gulliver); *T. G. Wright*, No. 874.

The perichætium and fruit are very large when contrasted with the very minute leaves.

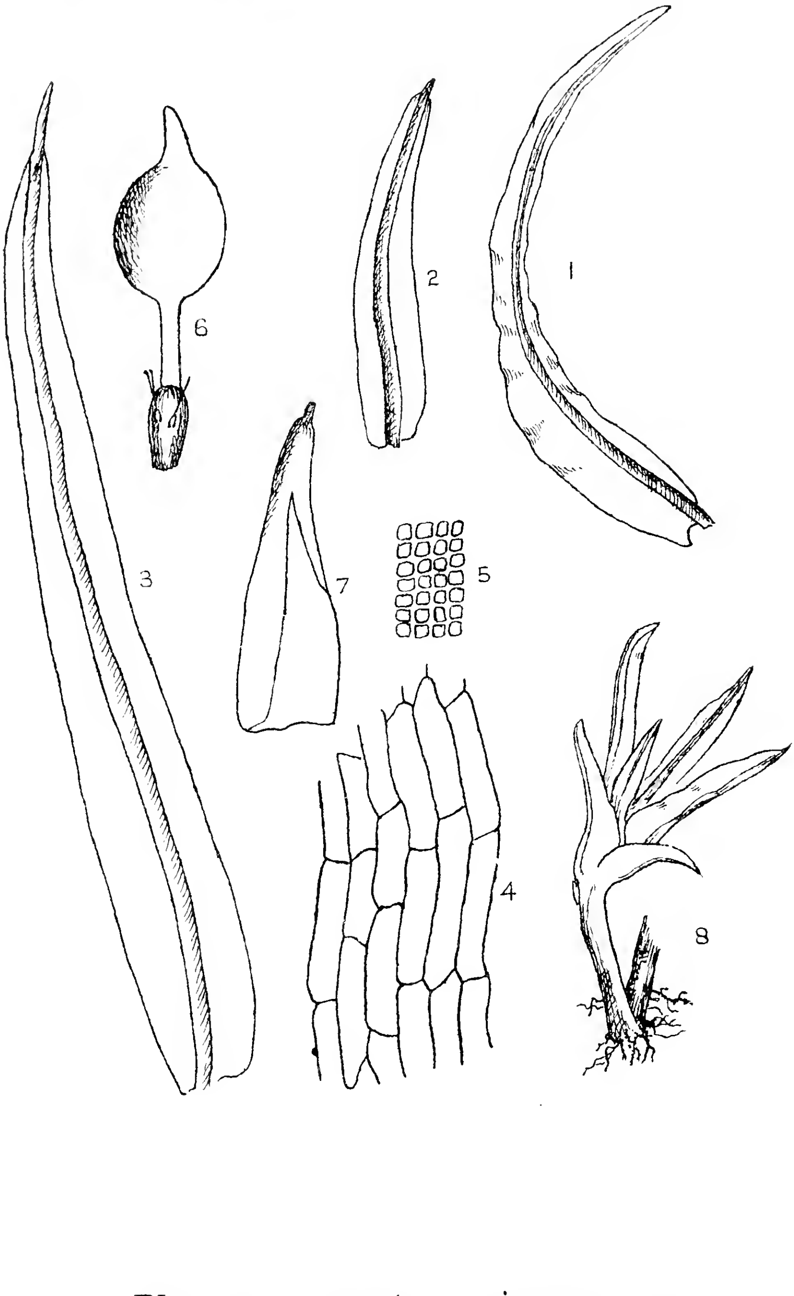
It is allied to, and in some respects resembles, *Hypnum vagum*, Hornsch., but it materially differs in the form of the cells, which in *H. vagum* are prosenchymatous. It is also separated by its round-ended leaves and entire absence of nerve.

Daltonia straminea, sp. nov.

Dioicous. Stems crowded, fastigiately branched, 1in. to 1½in. long, golden-yellow. Leaves imbricated, appressed but not altered when dry, linear-lanceolate, tapering gradually to a point, concave, puckered within the edge. Nerve canaliculate, golden-brown, thin but well defined, the apex of the leaf frequently twisted. Margin entire, revolute. Cells long-oval and uniform over the whole leaf, a row at the base of a golden colour, cells of margin very long, narrow-ended. The revolute portion of the margin consists of about one-third of this band of prosenchymatous cells. Perichætial leaves half the length of stem leaves, oval, shortly and inconspicuously nerved, not margined. Seta 1½ lines long, smooth. Capsule slightly inclined, lying close to the underside of the foliage, oval-oblong, the lower part verrucose. Teeth of peristome linear, with a strongly-marked divisural line, trabeculæ very prominent and extending beyond the edge of the teeth; endostome divided to the middle into lanceolate carinate processes, not papillose. When dry the inner peristome is erect, and forms a cone, with the teeth of the outer peristome incurved. Operculum with a long straight subulate beak. Calyptra conical, deeply fringed at base, apex darker. Male inflorescence gemmiform in the axils of the leaves all up the stem, abundant: bracts numerous, inner ones with their apices curved outwards and truncate. Antheridia short and broad, mouth wide, areolation very distinct, paraphyses 0.

Loc. Stewart Island, January, 1889; *W. Bell.*

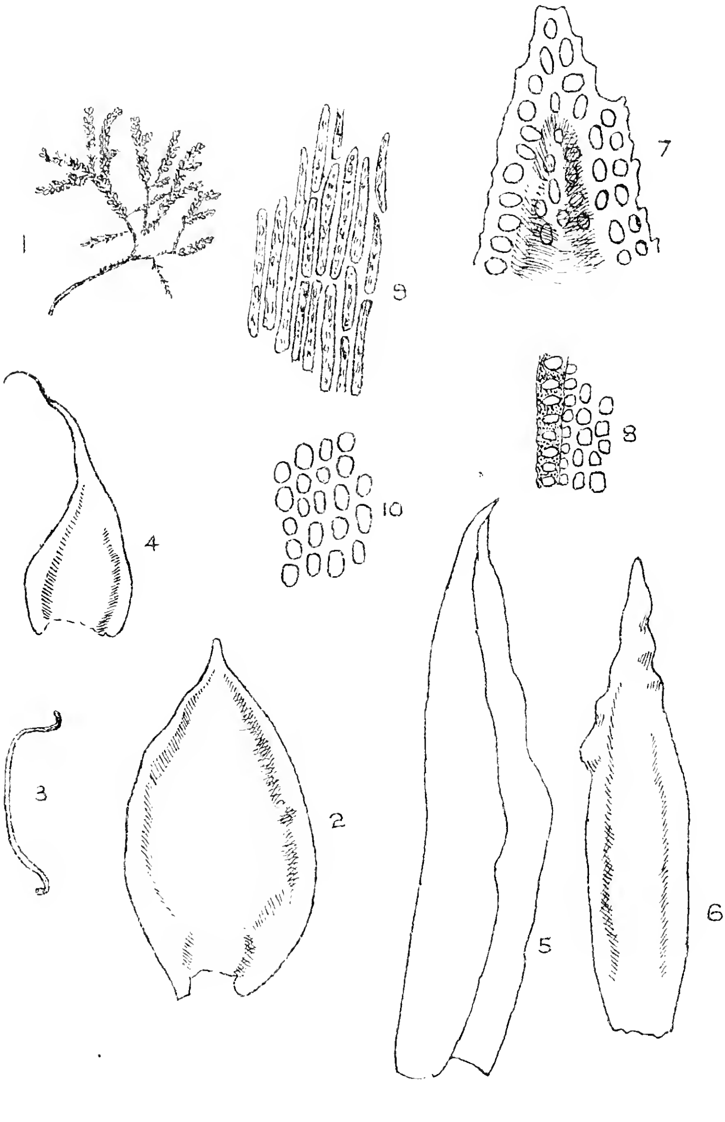
This very handsome moss is of a beautiful golden straw-colour, specimens growing in exposed places having a coppery sheen. It was found by Mr. William Bell on smooth-barked trees, in one gully only, Half-moon Bay, Stewart Island. He sent it to Mr. Mitten, who decided that it was a new species "distinct from *D. nervosa*." The dioicous inflorescence clearly separates it from that species.



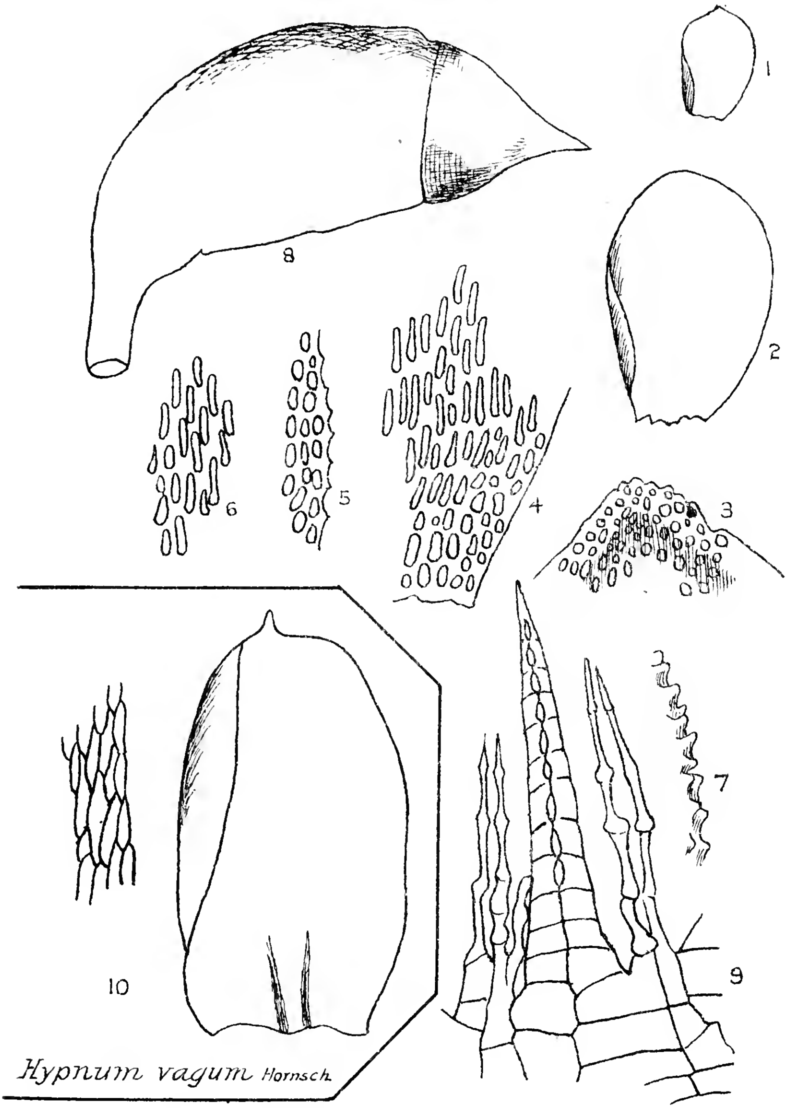
Phascum austro-crispum, sp. nov.

T.W.N.B. del.

F.H.T. lith.

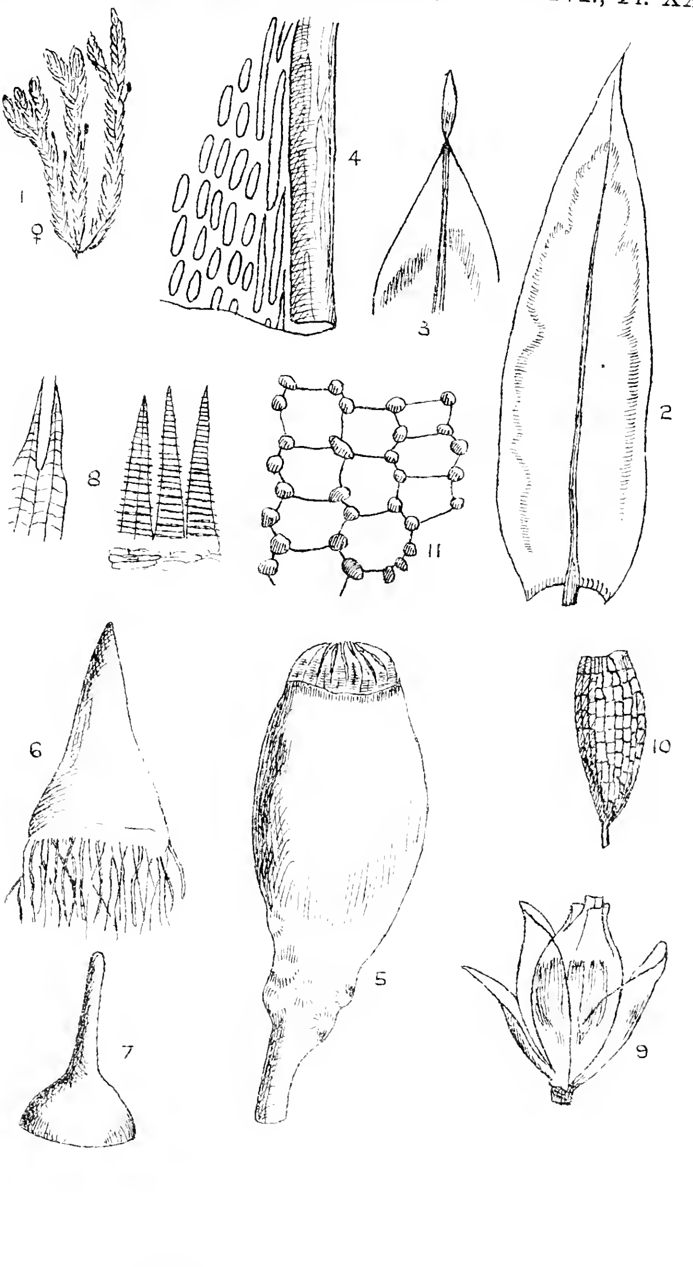


T. W. N. B del. *Braunia novæ-seelandiæ, sp. nov.* F. H. T. lith



Hypnum (Lembophyllum) micro-vagum, sp. nov.

W. N. B del.^t F. H. T lith.



T. W. N. B. del. *Daltonia straminea*, sp. nov. F. H. T. lith.

EXPLANATION OF PLATES XXV.-XXVIII.

PLATE XXV.

Phascum austro-crispum.

Fig. 1, 2, Two leaves, × 32.
„ 3. Perichætial leaf, × 32.
„ 4. Cells at base of leaf, × 270.
„ 5. Cells of leaf, × 270.
Fig. 6. Capsule and seta, × 32.
„ 7. Calyptra, × 32.
„ 8. Special branch bearing male infl., × 32.

PLATE XXVI.

Braunia novæ-seelandiæ.

Fig. 1. Plant, nat. size.
„ 2. Leaf, × 32.
„ 3. Section of leaf, × 32.
„ 4. Leaf of stolon, × 32.
„ 5, 6. Perichætial, × 32.
Fig. 7. Apex of leaf, × 270.
„ 8. Marginal cells, × 270.
„ 9. Cells at middle of leaf at base, × 270.
„ 10. Leaf-cells, × 270.

PLATE XXVII.

Hypnum micro-vagum.

Fig. 1. Leaf, × 32.
„ 2. Leaf, × 70.
„ 3. Apex of leaf, × 270.
„ 4. Base of leaf, × 270.
„ 5. Marginal cells, × 270.
„ 6. Leaf-cells, × 270.
Fig. 7. Papillæ at back of leaf, × 270.
„ 8. Capsule, × 32.
„ 9. Endostome, × 270.
„ 10. Leaf, × 32, and cells, × 270, of *Hypnum vagum.*

PLATE XXVIII.

Daltonia straminea.

Fig. 1. Plant, nat. size.
„ 2. Leaf, × 32.
„ 3. Apex of leaf, × 32.
„ 4. Revolute margin and cells, × 270.
„ 5. Capsule, × 32.
„ 6. Calyptra, × 32.
Fig. 7. Operculum, × 32.
„ 8. Peristome and endostome, × 70.
„ 9. Male inflorescence, × 32.
„ 10. Antheridia, × 70.
„ 11. Cells of capsule, × 270.

ART. XXVII.—*On some little-known New Zealand Mosses.*

By T. W. NAYLOR BECKETT, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 4th October, 1893.*]

Plates XXIX.-XXXc.

IN the following paper I continue my notes on little-known New Zealand mosses, and give descriptions, gleaned from various sources, of fourteen species which have not hitherto been recorded as belonging to our moss-flora. Through the kindness of Messrs. Wesley and Son, scientific publishers, London, I have obtained MSS. copies of the descriptions of Dr. Müller's and Dr. Hampe's mosses published at various times in the pages of "Linnæa" and the "Botanische Zeitung"—works which are not to be found in any of our libraries.

Professor V. F. Brotherus, of Helsingfors, has described many new Australian mosses in "Ofversigt af Finska Vet. Soc.

Forh." I am indebted to him for copies of his papers, in which I found two of our undescribed mosses. Authentic specimens of the mosses from their discoverer, Mr. Weymouth, of Hobart, enabled me with certainty to determine them.

Pleuridium gracilentum, Mitten.

"Monoicum, habitu *P. alternifolii*, gracile, foliis inferioribus e basi ovali subulato-lanceolato-acuminatis, nervo subulam superiorem totam occupante, margine ad basin partis subulatæ indistincte crenulato vel lævi, cellulis inferioribus oblongis parallelogrammaticis superioribus minoribus, perichætialibus thecam non tegentibus, patulis anguste ellipticis subulato longe attenuatis canaliculatis apice parce denticulatis integerrimisve laxe areolatis, theca in pedunculo brevi subglobosa leptodermi, operculo brevissimo, calyptra cucullata ad thecæ mediam descendente. *Hab.* Tasmania and King George's Sound. Excepting that the perichætial leaves are less straight and bristly, in general appearance scarcely different from *P. alternifolium*, but its leaves are of a different form."—W. Mitten, in Lin. Soc. Proc., iv., p. 65.

Phascum gracilentum, Hook., Fl. Tasm., ii., 164, T. 171, f. 3. *Astomum gracilentum*, C. Müll.

Hab. Growing amongst *Acaulon apiculatum* on clay-banks, Dyer's Pass, Lyttelton Hills; August, 1892; No. 88; *T. W. N. B.* (Identified by Dr. K. Müller.)

Dicranum sub-pungens, Hampe.

"Dense cæspitosum, subbiunciale, flavo-viride rufescens; caulis strictiusculus attenuatus, parce diviso-ramosus, subfastigatus, basi fuscescente tomentosus, apico comoso-falcatus, nitidus; folia convoluta, e basi vaginante latiore lanceolato-subulata, undique erecto-patentia, superiora longiora, parum falcata, apice dense serrulata, nervo tenui obscuro percurso; perichætialia convoluta emersa; seta brevis (semi-uncialis) erecta; theca adscendens curvato-cylindrica, evidenter strumosa, lævis, sub ore constricta, operculo elongato-conico-subulato thecam fere superante, dentibus peristomii parum conniventibus, ferrugineis, usque ad medium bifidis. *Hab.* In Mont. Grampian, William et Victoria Ranges. *Obs.* *Dicrano pungenti* simile, theca breviore strumosa satis differt."—"Muscorum frondosorum Floræ Australasiæ auctore Dr. Ferd. Müller," "Linnæa," xxx., 1859–60, p. 629.

Flagstaff Hill, Dunedin; *W. Bell;* No. 379a (identified by Dr. K. Müller). Auckland; *T. Kirk.*

Mitten, in his "Catalogue of Australian Mosses," p. 5, gives this as a synonym of *Dicranum pungens*, H. f. and W. ("Flora Antarctica," i., 129, t. 59, f. 1.), a plant found in the Lord Auckland and Campbell Islands.

Our New Zealand moss is a very handsome species, with stems 5in. to 7in. long, growing in dense masses at the base of trees.

Dicranum leucolomoides, C. Müll.

"Dioicum?; cæspites subelati laxe cohærentes, pallide lutescentes; caulis ascendens elatus subflaccidus flexuosus, ramis longiusculis subrecurvo-flexuosis, apice secundis divisus, inferne tenuis parce foliosus vel radiculosus; folia caulina laxe conferta subsecunda, pallide lutescentia, e basi late oblonga, cellulis alaribus creberrimis laxe parenchymaticis intense fuscis, dein marcescentibus albidis teneris, planis reticulata sensim longiuscule acuminata, apice denticulata, marginibus erectis vel apice conniventibus inferne tenuissime flavide marginatis, nervo tenui excurrente apice dorso denticulato, cellulis ubique valde incrassatis elongatis, parietibus haud conspicuis præditis; perich. in cylindrum exsertum congesta longe convolutacea lata, apice rotundata et acumine brevi stricto terminata, subintegerrima, enervia, basi laxius reticulata; theca in ped. terminali vel ob innovationem novam laterali breviusculo læve rubro recto suberecta, e collo brevi angusto strumoso cernuo-oblonga, breviuscula, operc. conico oblique subulato breviori, annulo nullo, calyptra robusta straminea; perist. d. densissimi robustissimi longi, inferne grosse cellulosi, rubri, in crura duo vel plerumque tria robusta apice hyalina subrugulosa, apice tantum libera ad basin usque divisi. *Patria*, Nova Seelandia, ad truncos arborum et rupes humidas sylvarum prope portum Kaipara: Coll. No. 715. A *D. scopario* gracillitate majore notisque illustratis longe differt. Ob marginem pallidum *Leucolomati* simile, sed diversum cellulis ubique elongatis."—C. Müller in "Botanische Zeitung," 1851, p. 549.

Hab. In large patches on the ground in *Fagus* forests, Kowai, Mount Torlesse; No. 165b (identified by Dr. Müller). Rough Gully, Bealey River; *T. W. N. B.*

Mitten, in his "Australian Mosses," p. 4, gives *D. leucolomoides*, C.M., as a synonym of *D. dicarpum*.

Dicranum angustinerve, Mitten.

"Dioicum, *D. billardieri* simile, caulibus brevibus ramosis, foliis patentibus subsecundis e basi subovali elongata sensim angustatis, nervo angusto percurrente dorso marginibusque apicem versus serrulatis, cellulis elongatis angustis alaribus oblongis quadratisque flavide fuscis in massam quadratam utrinque dispositis, perichætialibus convolutis internis vaginantibus subito in acumen breve setiforme angustatis, theca in pedunculo breviusculo semiunciali arcuata inclinata basi strumosa, peristomio dentibus rubris dicranis.

"*Hab.* Tasmania, on dead wood. Nearly allied to *D. billardieri*, but with somewhat the aspect of *D. reflexum*. It differs from *D. billardieri* in the form of the wider portion of its leaves being more elongate, and the narrow upper part being shorter; the internal perichætial leaves are also furnished with a bristle-like point, which seems wanting in *D. billardieri*."—Mitten, in Proc. Lin. Soc., iv., p. 68.

I am indebted to Mr. T. Kirk for specimens of this moss from Great Barrier Island (No. 46), which were identified by Mr. Mitten.

Campylopus bicolor, Hornsch. (In Musc. Siber. No. 9—Dicranum). Flora N.Z., ii., 69. Plate XXIX.

The cells of the leaf are oval, distinct, and disposed in very regular lines at an angle of 30° to the nerve. The laminæ of the leaf at the base are narrow and membranaceous and hyaline, and there are no inflated alar cells. The nerve is thin and conspicuous, occupying the greater part of the leaf; lamina 0·006in. broad; nerve 0·018in. This moss, in colour and the blunt cymbiform foliage, greatly resembles *C. kirkii*, but the leaves are smaller and the lamina much narrower than the nerve. The comal leaves do not form large heads. The fruit is unknown in New Zealand, but Müller describes it as slightly immersed and the operculum as having a curved beak.

Hab. Great Barrier Island; *T. Kirk.*

I am indebted to Mr. Kirk for authentic specimens of this and the following species identified by Mr. Mitten. I have lately received from Mr. W. A. Weymouth very fine specimens of this moss from Port Arthur, Tasmania, which were identified by Professor V. F. Brotherus.

Campylopus kirkii, Mitten. Plate XXX.

Stems 3in. to 4in. long, upper leaves yellowish-green, lower dark-brown, comal leaves in a round congested head, larger, broadly ovate-lanceolate, quite entire, cymbiform, apex blunt and concave. Stem leaves smaller, erect and appressed, lanceolate, obtuse, apex concave. Nerve thin, continued to the apex about one-fifth the width of the leaf, the lamellæ from the middle upwards branching off into the leaf. Lamina of leaf 0·019in. broad, nerve 0·008in. Cells of lower part of nerve long, narrow, rectangular, well defined; alar cells large, inflated, bladdery, when young hyaline, but at maturity chestnut-brown; the wings above transparent and very thin; cells of leaf roundish. Perichætial leaves, 4 inner ones long, convolute, towards the apex tapering to a narrow point, 12 outer ones gradually decreasing in size, lower part broad and vaginant, contracted suddenly into a ligulate point, all nerved to apex. Seta cygneous, 5 lines long. Capsule pachydermous, mouth small, oval, gradually tapering into the seta, where it is slightly verrucose. Calyptra with a fringe about a quarter its length. Operculum conic, tapering evenly to a point. Peristome long, erect, teeth cleft to the middle, the undivided portion chestnut-brown, strongly trabeculate, legs long, slender, hyaline.

Hab. Golden Bay; No. 111; *Dr. L. Boor.* Great Barrier Island; *T. Kirk.* Named by Mr. Mitten.

Mr. Kirk informs me that he has also collected this moss on Stewart Island.

This beautiful moss differs from its near congener *C. bicolor* in its narrower nerve, in the presence of large inflated alar cells, and in the much more obscure leaf-cells. The seta is longer, and carries the capsule well above the comal leaves.

Dicnemon obsoletinerve, Hp. and C.M. Dicranum fasciatum, Hook., Fl. N.Z., ii., 66 (not Hedwig). Plate XXXA.

"Caulis humilis decumbens parce divisus laxissime-foliosus flaccidus; folia caulina patentissima longissima subsecunda latiuscule lanceolata longissime acuminata spiraliter torta valde concava, nerva ubique obsoleto angustissime pallescente excurrente, margine albescente erecto apice serrato, cellulis alaribus magis laxis aureis parenchymaticis, cæteris elongatis angustis laxis lævissimis; perichætialia in cylindrum exsertum congesta vaginantia; theca in pedicello brevi rubente lævi latere perichætii breviter emersa substrumosa oblonga cernua; dentes peristomii purpurei vix ad medium bifidi. Operculum et calyptra desunt. *Patria,* Nova Seelandia. Ex analogia ad *Dicnemon* revocavimus. Habitus perfecte dicranoideus; calyptra desiderata!"—"Linnæa," 1853, p. 496.

The seta are very generally twin. The operculum has a long, slender, and slightly-curved beak; the calyptra is cucullate and rough at the apex.

Hab. On tree-ferns, Fisher's Bush, Oxford; No. 19 (identified by Dr. Müller). Waimate Bush and Peel Forest, also on the stems of tree-ferns; *T. W. N. B.* Petane, Hawke's Bay; *A. Hamilton.* Stewart Island; *W. Bell.*

Obs. Hooker had doubts about the identity of this plant with Hedwig's *Dicranum fasciatum,* and observes, in Flora of N.Z., ii., p. 66, "If the specimens are rightly named, Hedwig's figure and description are very inaccurate"; and in a note in Handbook (p. 412) states, "The figure of Hedwig is indifferent, and Wilson thinks that it may indicate a different species."

Orthotrichum lateciliatum, Venturi, n. sp.

"Cæspituli tumescentes, caules erecti, 2cm. alti. Folia siccitate curvata et laxe crispata, humiditate erecto-patentia ex ovata basi longe lanceolata, carinata, 3·33mm. longa, apice plus minusve acuminata, margine ad apicem usque recurvo, nervo in apice soluto. Areolatio superne rotundato-hexagona, parietibus haud incrassatis, papillis prominentibus, simplicibus vel bifurcatis ornata; inferne cellulæ elongatæ, angustæ, cum parietibus haud incrassatis basin conficiunt. Folia perichætii intima minora, margine plana. Inflorescentia monoica, lateralis; gemmulæ masculæ parvulæ, antheridia pauca, ovato-oblonga, pedicellata, eparaphysata. Vaginula cylindracea, parce pilosa, ochrea distincta pedicello adhærens. Pedicellus emergens, 3·20mm. longius siccitate torquescens. Capsula cum collo brevi, cito defluente ovato-cylindrica, 1·75mm. longa. Striæ ad medium sporangii productæ, e 4–5 seriebus cellularum latiorum compositæ, siccitate prominentes et capsulam ad medium usque sulcatam efficientes. Stomata emersa, in parte inferiore sporangii. Annulus bi-tri-seriatus, persistens. Peristomii dentes externi 8, rufi, siccitate laxe recurvi, bigeminati, integri, ad apicem obtusum crura connata, articulata, articulis brevissimis, densissime papillosis. Cilia 8, breviora, obtusa, papillosa, dimidiam dentium et ultra attingentes ex 3–4 articulis conflata. Sporæ 24–26 micromill. diametro metientes. *Patria*, Tasmania, ad arbores (W. A. Weymouth, n. 895 et n. 897). Species *O. tasmanico*, H. f. and W., affinis, sed statura multo majore, striis distinctis aliisque notis satis superque distincta."—"On some New Species of Australian Mosses," by V. F. Brotherus, Helsingfors.

Orthotrichum fasciculatum, Mitt., MSS.—Otago; *Buchanan*, Diamond Lake; *W. Bell*. *Orthotrichum beckettii*, C.M., MSS.—On stems of *Discaria toumatou*, Mount Torlesse; April, 1892; No. 382; Arthur's Pass, Selwyn Gorge; *T. W. N. B.*

In 1889 Mr. William Bell sent this moss to Mr. Mitten, who decided that it was new, and wrote: "I have marked a part of Buchanan's specimen of *O. tasmanicum*, *O. fasciculatum*, but it wants more observation. It seems to have a tuft of short branches at the top of its stems with many smaller fruits. The calyptra I am not sure about. Its leaves seem narrower."

It was amongst the mosses I sent to Dr. Müller last year, and he honoured me by calling it *O. beckettii*. As, however, these names are in MSS. only, Dr. Venturi's name takes precedence. I have to thank Mr. Weymouth for authentic specimens.

Orthotrichum hortense, Boswell.

"Habitus *O. affinis*, sed laxior irregulariter cæspitosum; caulis dichotome innovans ramosus. Folia erecto-patentia et recurvata, in statu sicco erecta laxe contorta, e basi dilatata anguste lanceolata, marginibus ad medium reflexis, ad basin et apicem planis, breviter papillosa; cellulis superioribus densis, rotundatis, inferioribus elongatis, pellucidis, ad margines dilatatis quadratis. Calyptra mitrata, acuminata, straminea, nitida, hirsuta, apice purpurea. Capsula in pedicello brevi, cylindraceo-oblonga, anguste striata, sicca plicata, sub ore lato coarctata. Peristomii dentes bigeminati, rufo-aurantii, sicci reflexi.

"On trees in a garden, Hanmer Plains, New Zealand; *Mr. Roper*. This, with much the general appearance of average *O. affine*, has the leaves more acute, more spreading and subsquarrose, and when dry somewhat twisted; the seta is rather longer and the capsule more exserted; the calyptra more hairy, paler, glossier, yellower, with a purplish apex, like that of *O. straminea*. The exserted capsules give some resemblance to *O. speciosum*, while the red peristome is suggestive of *O. pulchellum*."—"On New Exotic Mosses," by Henry Boswell, M.A., "Journal of Botany," Ap., 1892, xxx., p. 97.

Macromitrium retusum, H. f. and W. Flora N.Z., ii., 79, t. 85, f. 6. Plate XXXB.

Hooker, in Fl. N.Z., figures this moss with retuse leaves, and describes them as "retuse and 2-fid at the apex," omitting any reference to the very remarkable hair-like points with which they are terminated. This was doubtless due to the fact that these points are very fragile, and in the "few barren specimens" from which he drew up his diagnosis they had in all probability fallen off. Their long bristle-like points are articulated at the apex of the leaves, and when they are broken off leave the apex of the leaf with a deep notch. They may be observed in the young comal leaves, and are to be found in great numbers loose in the paper in which the plant has been dried. The moss grows in situations exposed to the vicissitudes of the weather, and the repeated expansion and contraction of the leaves caused by the alternation of moisture and drought causes the points to fall off. I have never seen this moss in fruit.

Hab. On trees, Studholme Bush, Waimate; No. 114c; *T. W. N. B.* (identified by Dr. K. Müller). Lyttelton Hills; *R. Brown*. Tarawera, Hawke's Bay; *H. Hill*. Maungatui, Dunedin, and Wyndham Valley, Southland; *W. Bell*.

Cyathophorum densirete, Broth.

"Dioicum; gracile, viride vel lutescenti-viride, nitens; caulis repens, dense rufo-fusco-tomentosus stipitibus sparsis, erectis, gracilibus, flexuosis, apice plus minusve attenuatis, simplicibus, nigris, dense foliosis; folia sicca vix mutata, humida patula, asymmetrica, basi latere superiore ventricosa, ovata, acuta, marginibus erectis, e medio ad apicem grosse argute serratis, nervo brevissimo latiusculo, furcato, cellulis rhombeis pachydermibus, superioribus ·045–·06 mm. longis et ·015–·020 mm. latis, marginalibus angustis, limbum indistinctum formantibus; amphigastria multo minora, symmetrica, rotundata, acumine recto, acutissimo, nervo obsoleto; bracteæ perichætii e basi vaginante subito angustatæ, acutæ, apice parce sed grosse serratæ, enerves. Cætera ut in *C. pteridioidi*. *Patria*, Tasmania, W. A. Weymouth (862). A *C. pteridioidi* statura multo minore, areolatione multo densiore et nervo brevissimo differt."—"On some New Species of Australian Mosses," by V. F. Brotherus, Helsingfors.

Hab. On trees, damp forest, Kelly's Range, Westland (446ft.). Arthur's Pass; *T. W. N. B.*

I have received authentic and original specimens of this moss from Mr. W. A. Weymouth (No. 862), but I cannot consider it more than a small form of *C. pennatum*. In many of my specimens of *C. pennatum* of large size the cell-walls are as dense as in the Tasmanian plant, and the length of the nerve is a very unstable character. Mr. T. Kirk, to whom I referred the specimens, writes: "I fully agree with you as to the great range of size and luxuriance of *C. pennatum*. I have seen sterile specimens over 5in. in length, and others under $\frac{3}{4}$in."

Hypnum (Cupressina) mossmanianum, C.M.

"Monoicum; *H. cupressiformi* simillimum, caulis gracillimus, filiformis, longe attenuatus apice vix uncinatus, ramos multos capillares exserens; folia dense conferta lutescentia, angustiuscula, e basi oblongâ in acumen longum, maxime reflexo-falcatum producta, pallida, margine integerrima erecta, obsolete brevissime binervia, cellulis angustissimis densis pallidis, alaribus in ventrem parvum distinctum congestis, fuscidulis; perich. ext. multo latiora, reflexa, intima in cylindrum angustissimum convoluta, longe vaginantia, apice falcata, inferne elongate densiuscule areolata, theca in ped. longiusculo tenui flexuo rubro suberecta, cylindrica arcuata, tenuis; perist. d. ext. breviusculi angusti lutescentes, intus cristati rugulosi, int. æquilongi perforati albidi rugulosi, ciliis capillaribus singulis longis, læviusculis." *Patria*, Nova Seelandia, ad saxa et truncos arborum putridos siccos sylvarum prope portum Kaipara: Coll. No. 711. Van Diemen's Land, ad rupes, Fern-tree Valley, montis Wellington; No. 832."—Carl Müller, in "Botanische Zeitung," 1851, p. 565.

On dead wood, Otira (alt., 1,450ft.), Westland; *T. W. N. B.*; No. 202 (identified by Dr. K. Müller). Waimate, South Canterbury; *T. W. N. B.* Mount Earnslaw and Diamond Lake, Otago; *W. Bell.* Tasmania; *Weymouth;* No. 368.

Obs. Hooker ("Handbook N.Z. Flora," p. 476) considers this to be a form of *Hypnum cupressiforme*, L.; and this view is supported by Mitten in his "Australian Mosses," p. 39, where he gives it as a synonym of *H. cupressiforme*, var. *minor*, H. f. and W. ("Fl. Tasm.," ii. p. 212).

Pilotrichella billardieri, Hampe (*Neckera*).

"Caulis turgidus, elongatus, pendulus, inordinate ramosus, ramis brevibus, usque uncialibus turgidis, obtusiusculis, folia turgide imbricata, ex basi cordata cochleariformia (basi et apice inflexa) integerrima, nervis binis brevioribus distantibus notata, seta brevis, crassa, basi foliis paucis lanceolatis involuta; theca brevis ovata, operculo conico obtuso, peristomii dentibus rubris. *Hab.* Ad arbores Apollo Bay. *Obs.* Huc *Isothecium flexile*, Brid., ii., p. 362, ex Nova Hollandia, La Billardière. *Neckeræ miquelianæ*, C.M., ex habitu convenit; ab *Neckera molle* differt; habitu robustiore foliis binervibus et operculo obtuso."—"Linnæa," 1859–60, p. 637.

The leaves are often nerveless, as in *Pilotrichella molle*, and I was unable to detect any nerve in the leaves of the specimen in Herb. Helms., identified by Dr. Müller. The very robust habit, the turgid foliage, and the more obtuse and blunter ramuli form the most distinctive characters. Mitten, in his "Catalogue of Australian Mosses," p. 34, recognises this as distinct from *P. molle*.

Hab. Hanging from trees in damp forests. Fisher's Bush, Oxford. Long Creek, Mount Fife, Kaikoura; No. 13B (identified by Dr. Müller). Kelly's Range, Westland. Peel Forest; *T. W. N. B.* Nelson: *Grant.* Greymouth, Westland; No. 41; in Herb. Helms.; named by Dr. Müller.

Polytrichum (Pogonatum) australasicum, Hp. and C.M.—*Polytrichum tortile*, Hooker in Flora N.Z., ii., 96, non Swartz.

"*P. tortili* simillimum. Dioicum, folia e basi sub-vaginante brevi sub-laxe areolata pellucida lanceolata obtusiuscula planiuscula apicem versus spinulosa serrulata, dorso spinulosa, suprema conformia, omnia siccitate intense viridia, nervo lato multo-lamelloso apicem folii fere totum occupante; theca cylindraceo-oblonga subcernua fusca ubique lævis, operculum conico-apiculatum obtusum breve. In Australia Felici sub No. 25, sine loco indicato. A *P. tortile*, Sib., Fl. Ind. Occid. distinguendum."—"Linnæa," 1853, p. 500.

The Australasian plant seems to be quite distinct from Swartz's *P. tortile* of the West Indies, being distinguished by its more obtuse leaves, its comal leaves being of the same form as the others, and particularly by its smooth cylindric capsule. Mitten, in Musci Austro-Amer., p. 418, describes the capsule of *P. tortile*, Sw., as being "shortly oval and plicate." Hooker, in Flora N.Z., says that Swartz's original specimens in Herb. Hook. are too imperfect to render the identification of the New Zealand specimens certain.

Hab. In clay. Teremakau, Westland. Hapuka Bush, Kaikoura; No. 250 (identified by Dr. Müller). Peel Forest; *T. W. N. B.* Greymouth; *Gulliver.* Found also in Australia and Tasmania.

Anisothecium, Mitten. (Journ. Lin. Soc., xii., 39, 1869.)

Mosses resembling *Dicranella* in habit. Leaves gradually narrowed, or from a sheathing base, abruptly subulate, carinate, with the margin plane or recurved, and nerve narrow and well defined below. Capsule always smooth, pachydermous, curved as in *Hypnum*, rarely suberect or less oblique, the cells of the exothecium regularly rectangular-quadrate, with non-flexuose walls. Peristome larger, thicker, deep-purple, more papillose (Lindberg). Deriv. ἄνισος unequal, θήκη a capsule.

The absence of inflated cells at the basal angles of the leaf at once separates *Anisothecium* from *Dicranum*.

Anisothecium clathratum, Mitt. ("Handbook of New Zealand Flora," p. 411—*Dicranum.*)

Hab. On dripping rocks. Mount Torlesse, No. 242B (identified by Dr. K. Müller). Arthur's Pass. Castle Hill, Canterbury; *T. W. N. B.* Tarawera, Hawke's Bay; *H. Hill.* Campbell Island; No. 308; *T. Kirk.*

Anisothecium jamesoni. (Taylor, in Hook. Lond. Journ., vi., 332—*Dicranum.*)

"Cæspitosum; caule elongato. Folia laxe inserta, e basi brevi erectiore subquadrata, cellulis elongatis laxiusculis pellucidis, subito in subulam patentem elongatam obscuram contracta, nervo in subula a folii lamina indistincto, integerrima; perichætialia basi latiora, duplo longiora, obovata. Theca in pedunculo rubro elongato, oblonga, inclinata operculo subulato. *Angstræmia hookeri*, C. Müll., Syn., ii., p. 607. *Hab.* Andes Quitenses, *Jameson*; Fuegia, *Lechler;* Hermit's Island, *Hooker.* Caulis ½–1½ uncialis. Folia fulva. Pedunculus subuncialis."—Mitten, "Musci Austro-Americani," p. 39.

This is not *Dicranum jamesoni*, Hook., Ic. Pl., i., 179, which Mitten refers to *Campylopus concolor*, Hook. (*Dicranum*). I received from Mr. Kirk authentic specimens of this moss, which were identified by Mr. Mitten. Whangapehatu; *Kirk;* No. 299. I have it also from Greymouth, collected by Mr. Gulliver; *Wright*, No. 804: and from the Bealey River (alt., 2,500ft.); *T. W. N. B.*

Anisothecium gracillimum, sp. nov. Plate XXXc.

Dioicous, small, simple, densely gregarious. Leaves erect, patent, somewhat secund; stem leaves small, base not vaginant, tapering evenly and gradually to the apex, margins quite entire; perichætial leaves semi-vaginant, from near the base narrowing rapidly into a long subulate apex, which is almost entirely occupied by the nerve. Cells large, long, pellucid. Seta red. Capsule erect, regular, short, turbinate, not strumose. Operculum broadly conical, erect, and longer than the capsule. Male plants shorter. Infl. terminal, an innovation frequently springing from below the bracts.

Hab. On clay, Pine Hill, Dunedin; *W. Bell* (named by Dr. Karl Müller). On damp earth, Patterson Creek, Mount Torlesse; No. 396; *T. W. N. B.*

Distinguished by its erect capsule, by its non-vaginant leaves, and by the narrow bases of the perichætial leaves. This species belongs to the group containing *Anisothecium schreberi, A. campylophyllum,* and *A. jamesoni,* "an intricate series of forms," as they are designated in the Flora of New Zealand.

EXPLANATION OF PLATES XXIX.-XXXc.

PLATE XXIX.

Campylopus bicolor.

Fig. 1. Comal leaf, × 32.
Fig. 2. Stem leaf, × 32.
Fig. 3. Base of leaf, × 70.
Fig. 4. Cells of leaf, × 270.

PLATE XXX.

Campylopus kirkii.

Fig. 1. Comal leaf, × 32.
Fig. 2. Stem leaf, × 32.
Fig. 3. Base of leaf, × 70.
Fig. 4. Cells, × 270.
Fig. 5. Perichætial leaf (outer), × 32.
Fig. 6. Capsule, × 32.
Fig. 7. Operculum, × 32.

PLATE XXXA.

Dicnemon obsoletinerve, Hp. and C.M.

Fig. 1. Perichætium and fruit, slightly magnified.
Fig. 2. Capsule and operculum, × 32.
Fig. 3. Leaf, × 32.
Fig. 4. Apex of leaf, × 32.
Fig. 5. Base of leaf, × 32.
Fig. 6. Cells of leaf, × 270.
Fig. 7. Apex of perichætial leaf, × 32.

Plate XXXb.

Macromitrium retusum, H.f. and W.

Fig. 1. End of branch, × 32.
Fig. 2. Comal leaf, with hair-point uninjured, × 32.
Fig. 3. Leaf with hair-point partially broken off, × 70.
Fig. 4. Lower leaf, back view, with "retuse" apex, the bristle broken off.
Figs. 5, 6, 7. Leaves copied from "Flora of New Zealand," t. 85, f. 6.

Plate XXXc.

Anisothecium gracillimum, sp. nov.

Plant nat. size.
Fig. 1. Leaf, × 70.
Fig. 2. Apex of same, × 270.
Fig. 3. Cells from middle of leaf, × 270.
Fig. 4. Perichætial leaf, × 70.
Fig. 5. Capsule and operculum (immature), × 32.
Fig. 6. Capsule, ripe, × 32.
Fig. 7. Male infloresence, × 32.

Art. XXVIII.—*Notes on New Zealand Mosses: Genus* Pottia.

By R. Brown.

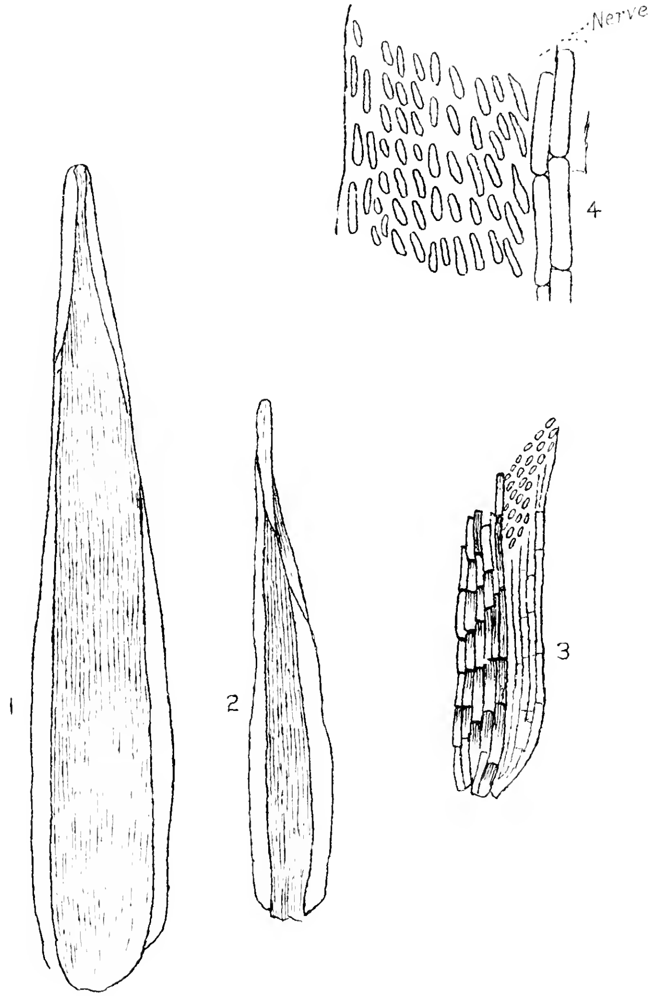
[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Plates XXXI.-XXXIV.

The species composing this genus may be readily distinguished from those comprised in *Gymnostomum*, as the former are either annual or biennial plants, and the leaves have large cellular tissue.

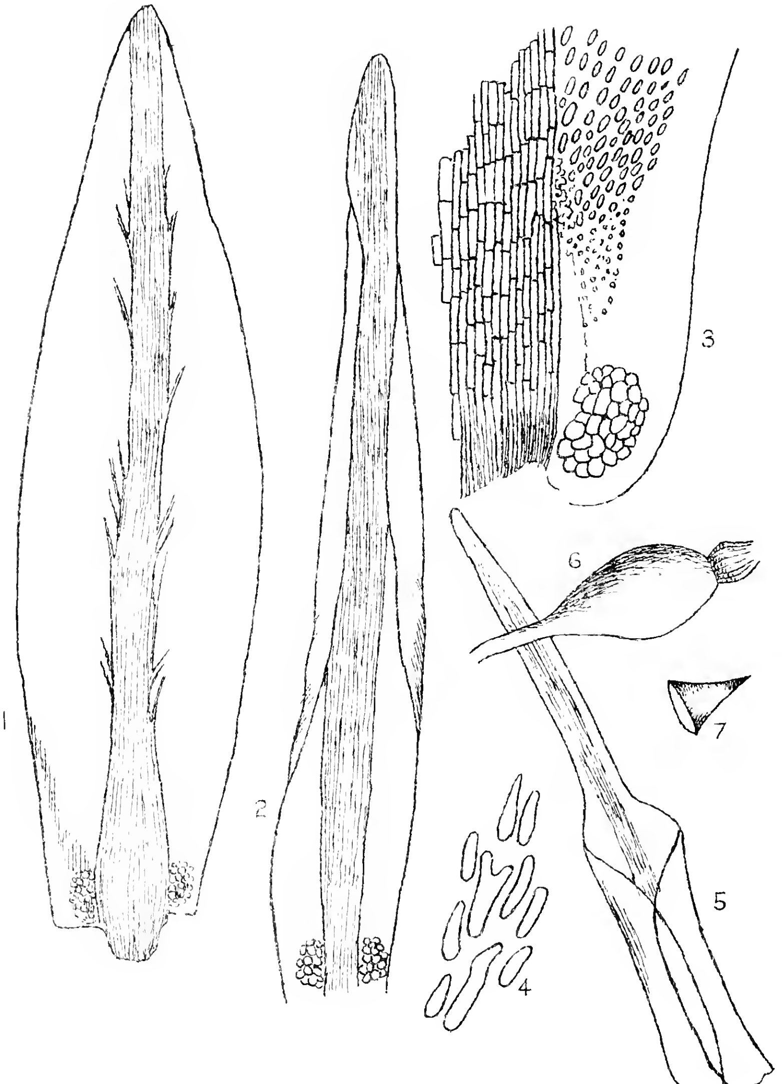
The members of this genus appear to have been entirely overlooked by botanists, as witness the Rev. J. Berkeley, who, in his introduction to "Cryptogamic Botany," actually says, "*This genus does not occur in New Zealand.*" This may possibly be accounted for by the minuteness of the plants, also by the short time it takes them to arrive at maturity.

They are to be found growing on steep damp clayey banks, where the earth during the hot summer months crumbles away, leaving a fresh surface for the spores of those plants to germinate on during the following winter; as their vigorous growth takes place only on freshly-turned soil, too much organic matter in the soil does not suit them. They speedily become extinct in those habitats; when this takes place a higher class of vegetation follows; they therefore form a section of the pioneers of vegetable life.



Campylopus bicolor, Hornschuch.

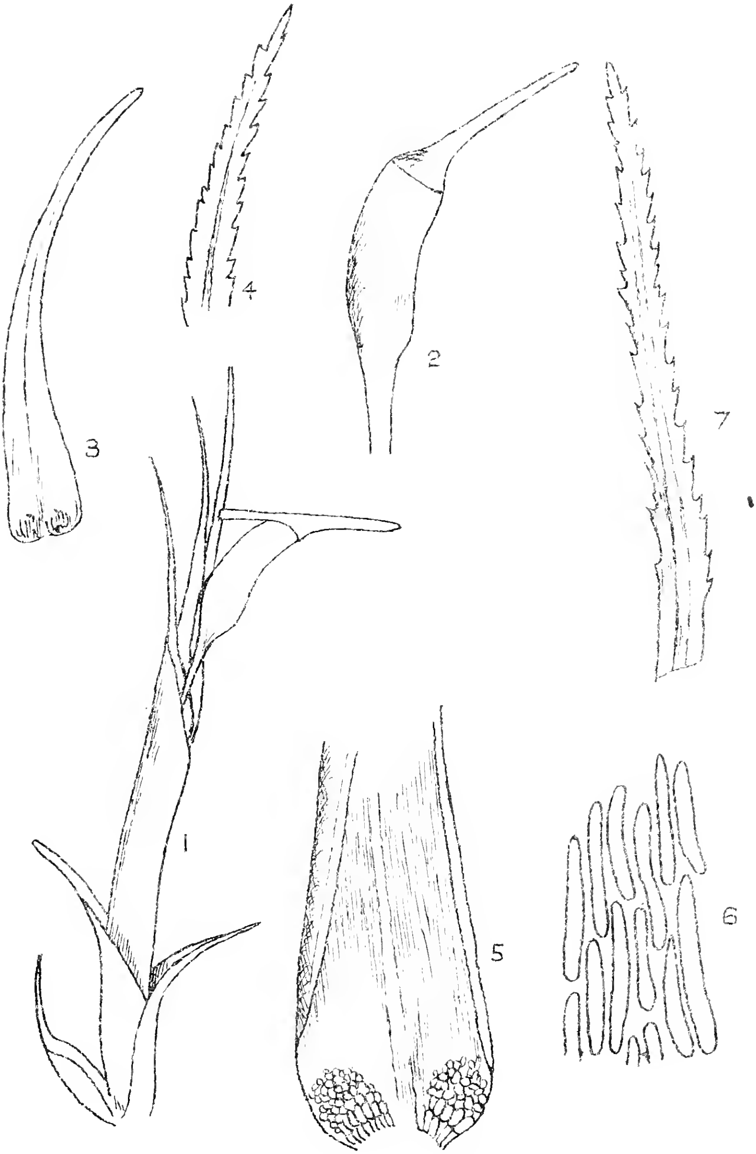
T. W. N. B. del. F. H. T. lith.



Campylopus kirkii, Mitten

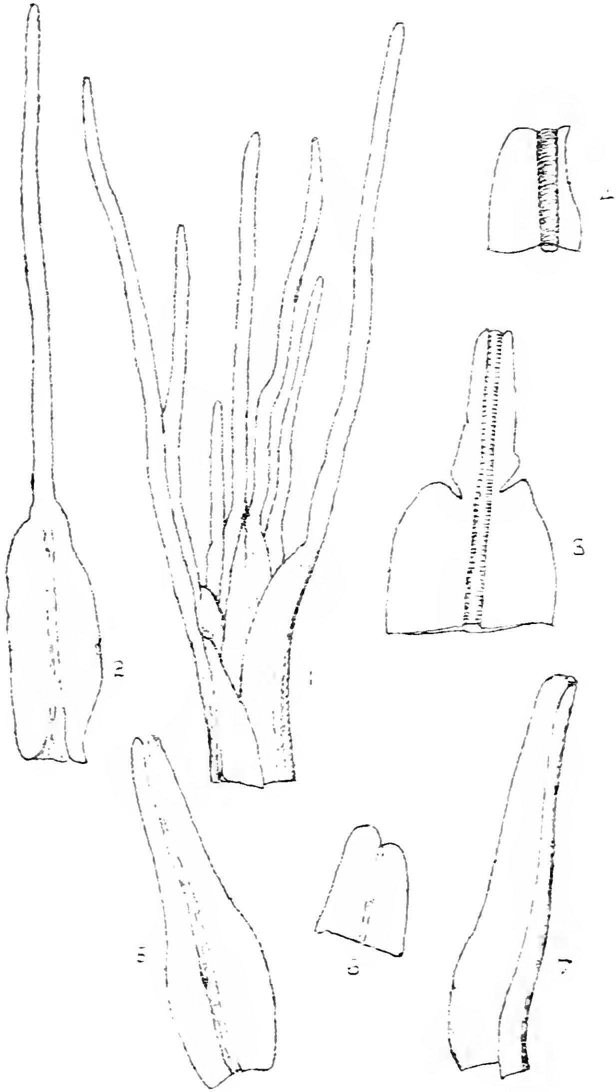
T.W.N.B. del.

F.H.T. lith.



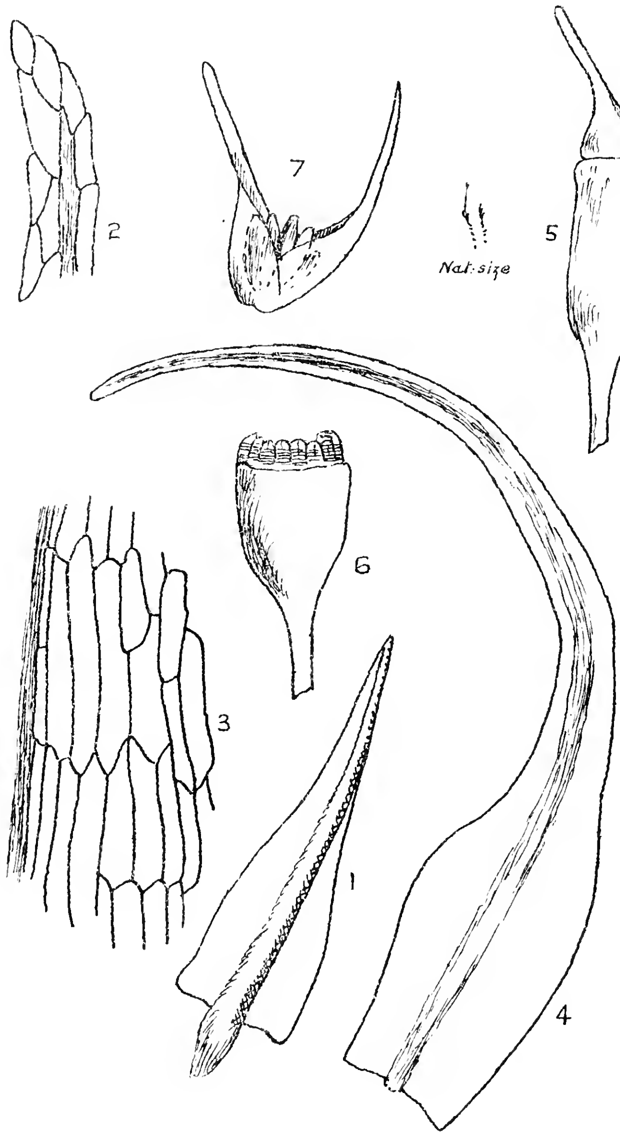
Dicnemon obsoletinerve. Kp & C.M.

T.W.N.B del: F.H.T lith.



Macromitrium retusum H.F. & W.

T.W.N.B. del. F.H.T. lith.



Anisothecium gracillimum. sp. nov.

T.W.N.B. del. F.H.T. lith.

The best time for their successful collection is in wet or very damp weather, for on other days their leaves are generally curled up and appear dead, and then it is with great difficulty that they are discovered.

The first record of any species belonging to this genus having been discovered in New Zealand which I have been able to find is that one described by Mr. Charles Knight as *Gymnostomum areolatum* in vol. vii., Trans. N.Z. Inst., p. 355.

In another paper I have pointed out the anomalous position this particular moss (*G. areolatum*) holds, and proposed to place it in the genus *Pottia*, as being more in harmony with its character.

The only other species which is said to belong to the genus *Pottia* is one described by Mr. T. W. Naylor Beckett in a paper contributed to the Philosophical Institute of Canterbury on the 5th October, 1892, and recorded in vol. xxv., p. 290, of the Trans. N.Z. Inst., and there named by him *P. marginata*.

This plant has no actual existence, being a combination of a new species previously described by me in a paper read before the Philosophical Institute on the 7th September, 1892, and recorded in vol. xxv. of the Transactions, p. 286, and there named *Hennedia microphylla*, and a new species of this genus *Pottia*.

The points of resemblance between these two species are many, both being found in the same situations, growing together in the same patches, having very similar leaves, and bordered margins. Here, however, the resemblance ends; *H. microphylla* having a simple stem, a mitriform calyptra covering the whole capsule tightly, and narrowed at the base; the *Pottia* having a cucullate calyptra, and only covering about one-half of the capsule. The cell tissue of the former is at least double the size of the latter. The capsule of the former has a straight, short, stout, conic operculum, while that of the latter has a long oblique one. It is unfortunate that Mr. Beckett has confounded these two species, as it necessitated his formulating a new development theory to explain his description of this moss.

He knew that I had previously described this moss with the mitriform calyptra as *H. microphylla*, and, as he has attempted to give this moss a new generic and specific name, and has omitted to make any reference to *H. microphylla*, I am very reluctantly compelled, in order to prevent any confusion, to put this matter straight.

I should like to have called the new species of *Pottia*, which he has confounded with *Hennedia microphylla*, *Pottia marginata*, in Mr. Beckett's honour; but, as under the circumstances this name would be quite inappropriate, I have named it *Pottia grata*.

According to my usual practice, my drawings of the mosses described below are to one scale, to facilitate comparison. In this genus it will be found specially valuable on account of their minuteness.

I have drawings of a few more plants which belong to this genus, but as I have mislaid my specimens I think it unwise to publish them until I have been able to compare further.

The following arrangement of the species places them in their nearest relative position to each other:—

Pottia areolata, *Knight*.
" acaulis, *nov. sp.*
" alfredii, *nov. sp.*
" wrightii, *nov. sp.*
" stevensii, *nov. sp.*
" serrata, *nov. sp.*
" longifolia, *nov. sp.*
" bickertonii, *nov. sp.*
" macrocarpa, *nov. sp.*
" douglasii, *nov. sp.*
" leonardi, *nov. sp.*
" grata, *nov. sp.*
" assimilis, *nov. sp.*
" obliqua, *nov. sp.*

Pottia acaulis, nov. sp. Plate XXXI.

Plants minute, annual, almost stemless, simple, growing in small patches, gregarious. *Leaves* few, spreading. *Upper stem-leaf* $\frac{1}{32}$in. long, oblong, rounded at the apex into a short acuminate point, concave. *Margins* entire. *Nerve* nearly continuous. *Areola* large; *upper* pentangular; *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves $\frac{1}{32}$in. long, oblong-obovate or subspathulate, rounded into an acute point. *Fruitstalk* $\frac{3}{32}$in. *Capsule* small, ovate, symmetrical. *Peristome* none. *Operculum* conico-rostrate, slightly oblique, about two-thirds of the length of the capsule. *Calyptra* cucullate.

Hab. On limestone rocks, at Castle Hill; and on Port Lyttelton Hills, on clayey banks. Collected by R. B.

Pottia alfredii, nov. sp. Plate XXXI.

Plants small, annual, growing in dense patches. *Stem* about $\frac{1}{8}$in. long, unbranched. *Leaves* densely imbricating, numerous; *upper* nearly erect, *lower* spreading, shortly oblong-lanceolate, acute or apiculate, incurved near the apex, concave. *Margins* entire, recurved to near the apex. *Nerve* stout, excurrent, or ending at the apex. *Upper* areola slightly dense, pentagonal; *lower* oblong-quadrate. *Perichætial* leaves slightly shorter, scarcely recurved on the margin, otherwise similar to the stem ones. *Fruitstalk* inclined, terminal, $\frac{3}{32}$in. long. *Capsule* ovate. *Peristome* none. *Operculum* and *calyptra* not found.

Hab. On damp banks, Port Lyttelton Hills. Collected by R. B.

Pottia wrightii, nov. sp. Plate XXXI.

Plants small, annual, growing in small patches, gregarious. *Stems* simple, about $\frac{1}{32}$in. long. *Leaves* few, erecto-patent, oblong-lanceolate, acuminate, slightly incurved at the apex, concave. *Margins* entire. *Nerve* disappearing at the apex. *Areola, upper* pentangular, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves nearly erect, slightly narrower than the upper-stem ones, otherwise similar. *Fruitstalk* terminal, inclined, about $\frac{1}{8}$in. long. *Capsule* oval, symmetrical, mouth small. *Peristome* none. *Operculum* slender, slightly oblique, about half the length of the capsule. *Calyptra* cucullate.

Hab. On damp banks, Lyttelton Hills. Collected by R. B.

Pottia stevensii, nov. sp. Plate XXXI.

Plants minute, annual, growing in small loose gregarious patches. *Stem* extremely short. *Leaves* few, erecto-patent, broadly oblong-lanceolate, apiculate, slightly incurved near the apex, concave, margins entire. *Nerve* excurrent, lower leaves smaller, but otherwise similar to the upper. *Areola* small, *upper* pentagonal, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves smaller, the innermost one smallest, oblong-lanceolate, apiculate. *Fruitstalk* terminal, inclined, $\frac{3}{16}$in. long, slender. *Capsule* ovate, symmetrical. *Peristome* none. *Operculum* oblique, conico-rostrate, two-thirds of the length of the capsule. *Calyptra* cucullate.

Hab. Damp ground, in the Public Domain, Christchurch; not common. Collected by R. B.

Pottia serrata, nov. sp. Plate XXXII.

Plants small, growing in loose patches, gregarious. *Stem* simple or branched. *Leaves, upper* stem erecto-patent, oblong-lanceolate, acute or apiculate; *lower* small oblong-lanceolate, acute, slightly incurved near the apex, concave. *Margins* serrated towards the apex. *Nerve* excurrent. *Areola, upper* pentangular, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves, *outer* oblong-lanceolate, apiculate, serrated near the apex; *inner* smaller than the outer. *Fruitstalk* terminal, about $\frac{1}{8}$in. long. *Capsule* ovate, symmetrical.

Peristome none. *Operculum* oblique, convexo-rostrate. *Calyptra* cucullate.

Hab. On damp banks, Port Lyttelton Hills. Collected by R. B.

Pottia longifolia, nov. sp. Plate XXXII.

Plants small, pale-green, annual, growing in loose patches, gregarious. *Stem* simple or branched, about $\frac{1}{32}$in. long. *Leaves* few, erecto-patent, *upper* large, oblong-lanceolate, acute; *lower* small, oblong-lanceolate, acute, very concave. *Margins* entire. *Nerve* ending at the apex. *Areola, upper* pentangular, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves smaller than the upper-stem ones, oblong-lanceolate, acute, otherwise similar. *Fruitstalk* terminal, about $\frac{1}{8}$in. long, erect. *Capsule* ovate, symmetrical, mouth small. *Peristome* none. *Calyptra* cucullate.

Hab. On damp clay-banks, at the head of Governor's Bay; July, 1882. Collected by R. B.

Pottia bickertonii, nov. sp. Plate XXXII.

Plants small, annual, yellowish-green, growing in patches, gregarious. *Stem* simple, about $\frac{1}{32}$in. *Leaves* few, erecto-patent, *lower* linear-lanceolate, acute, middle oblong-lanceolate, acute; *upper* broadly oblong-lanceolate, acute, crisp when dry. *Areola, upper* pentagonal, *lower* oblong-quadrate. *Perichætial* shorter than the upper leaves, broadly ovate-lanceolate, acute, semiconvolute. *Fruitstalk* terminal, inclined, $\frac{1}{8}$in. long. *Capsule* oval, symmetrical. *Peristome* none. *Operculum* slender, oblique, convexo-rostrate. *Calyptra* cucullate.

Hab. Port Lyttelton hills, on damp banks. Collected by R. B. (Named in honour of Professor Bickerton, of Canterbury College, Christchurch.)

Pottia macrocarpa, nov. sp. Plate XXXIII.

Plants annual, growing in dense patches, gregarious. *Stem* simple, about $\frac{1}{8}$in. long. *Leaves* numerous, closely imbricating; *upper* oblong-lanceolate, apiculate, or oblong rounded at the apex, apiculate, concave. *Margins* entire. *Nerve* excurrent. *Lower* stem-leaves smaller, but otherwise similar to upper ones. *Areola, upper* pentagonal, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves slightly shorter, otherwise similar to the stem ones. *Fruitstalk* terminal, nearly erect, $\frac{3}{32}$in. long. *Capsule* large, ovate, subsymmetrical. *Peristome* none. *Operculum* stout, conico-rostrate, slightly oblique, nearly half the length of the capsule. *Calyptra* cucullate.

Hab. Damp clay-banks, Port Lyttelton hills. Collected by R. B.

Pottia douglasii, nov. sp. Plate XXXIV.

Plants dark-green, perennial. *Stem* short, $\frac{1}{8}$in., branched. *Branches* short, $\frac{1}{8}$in. *Leaves* erecto-patent, ovate-lanceolate, acuminate. *Nerve* excurrent. *Margin* minutely toothed near the apex by the excurrent cells. *Areolæ* lax, quadrate below, pentangular towards the apex. *Perichætial* leaves longer, otherwise similar, incurved when dry. *Fruitstalk* nearly erect, $\frac{3}{8}$in. to $\frac{1}{2}$in., red, twisted to the right when dry. *Capsule* obconic or turbinate, red. *Operculum* oblique, conico-subulate. *Columella* adherent to the operculum, and falling away with it. *Calyptra* cucullate.

Hab. Hagley Park, on marshy ground, growing along with *Physcomitrium pyriforme*; in fruit November, 1878; found by myself then, and afterwards by T. G. Wright in the same locality. This habitat has since been destroyed through the place having been drained, and now used as a racing-track. I have not been able to find this moss in any other locality.

A specimen plant was deposited by me in the Museum, 1885.

Pottia leonardi, nov. sp. Plate XXXIII.

Plants very small, annual, pale-green, growing in small loose patches. *Stem* about $\frac{1}{32}$in., simple. *Leaves* few, closely imbricating, erecto-patent. *Upper* lanceolate acute, narrowed towards the base, concave. *Margin* entire. *Nerve* continuous. *Areola, upper* pentagonal, *lower* oblong-quadrate, crisp when dry. *Perichætial* leaves slightly smaller than the stem ones, otherwise similar. *Fruitstalk* terminal, $\frac{1}{8}$in. long, inclined. *Capsule* ovate, symmetrical. *Peristome* none. *Operculum* oblique, conico-rostrate, stout or slender, two-thirds the length of the capsule. *Calyptra* cucullate.

Hab. Damp clay-banks, Port Lyttelton hills; August, 1892. Collected by R. B.

Pottia grata, nov. sp. Plate XXXIII.

Plants small, pale-green, annual, growing in patches, gregarious. *Stem* most minute, simple or branched from near the base. *Branch* fastigiate. *Leaves* imbricating, erecto-patent, oblong-lanceolate acute or ovate-lanceolate acute, concave. *Margin* having a border of quadrate pellucid cells, and serrated near the apex, crisp when dry. *Areola, upper* small, pentagonal, *lower* oblong-quadrate. *Perichætial* leaves ovate-lanceolate, acute. *Margin* bordered with quadrate cells, serrated near apex. *Nerve* continuous. *Fruitstalk* terminal, inclined, $\frac{1}{8}$in. long. *Capsule* elliptic. *Peristome* none. *Operculum* stout, oblique, conic, about half the length of the capsule. *Calyptra* cucullate, covering about half the capsule.

Hab. Damp banks, neighbourhood of Christchurch. Collected by R. B.

(NOTE.—This is the plant which Mr. Beckett has confounded with *H. microphylla.*)

Pottia assimilis, nov. sp. Plate XXXIV.

Plants small, annual, dark-green, growing in dense patches. *Stem* $\frac{1}{16}$in. long, branched near the base. *Branches* fastigiate. *Leaves* many, densely imbricating, erecto-patent, oblong-lanceolate, acute, crisp when dry; *upper* broadly oblong-lanceolate, acute, concave. *Margin* entire. *Nerve* ceasing at the apex. *Areola, upper* pentangular, *lower* oblong-quadrate. *Perichætial* leaves short, otherwise similar to those of the stem. *Fruitstalk* terminal, $\frac{3}{32}$in. long, inclined. *Capsule* obliquely ovate, unsymmetrical, mouth narrow. *Peristome* none. *Operculum* oblique, conico-rostrate, half the length of the capsule. *Calyptra* cucullate.

Hab. On damp banks, Merivale, near Christchurch. Collected by R. B.

Pottia obliqua, nov. sp. Plate XXXIV.

Plants very small, annual, pale-green, growing in loose patches, gregarious. *Stem* extremely short, simple or branched close to the base. *Leaves* few, spreading, or erecto-patent, incurving near the apex, oblong-lanceolate, acuminate, slightly narrowed towards the base, concave. *Margins* entire, nerved towards the apex, crisp when dry. *Areola, upper* pentagonal, *lower* oblong-quadrate. *Perichætial* leaves oblong-lanceolate, acuminate. *Fruitstalk* terminal, pale, inclined obliquely, $\frac{1}{8}$in. long. *Capsule* ovate, nearly symmetrical. *Peristome* none. *Operculum* conico-rostrate, half the length of the capsule. *Calyptra* cucullate.

Hab. On damp ground, Port Lyttelton Hills. Collected by R. B.

EXPLANATION OF PLATES XXXI.-XXXIV.

PLATE XXXI.

Pottia acaulis.

Fig. *Pottia alfredii.*

1. Upper portion of plant, with capsule and perichætial leaves.
2. Upper stem leaf.

Pottia wrightii.

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaf (upper).
5. Stem leaf (middle).
6. Stem leaf (lower).

Pottia stevensii.

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaves (upper).

Plate XXXII.

Fig. *Pottia serrata.*

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaves (upper).

Pottia longifolia.

1. Capsule and operculum.
2. Calyptra.
3. Perichætial leaf (inner).
4. Stem leaf (upper).
5. Stem leaf (lower).

Pottia bickertonii.

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Stem leaf (upper).
4. Stem leaf (middle).
5. Stem leaf (lower).

Plate XXXIII.

Fig. *Pottia macrocarpa.*

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Stem leaf (upper).
4. Stem leaf (middle).
5. Stem leaf (lower).

Pottia leonardi.

1. Capsule and operculum.
2. Calyptra.
3. Perichætial leaf (inner).
4. Perichætial leaf (outer).
5. Stem leaf (upper).

Pottia grata.

1. Capsule and operculum.
2. Calyptra.
3. Perichætial leaf (inner).
4. Perichætial leaf (outer).
5. Stem leaf (upper).

Plate XXXIV.

Fig. *Pottia assimilis.*

1. Capsule and operculum.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaf (upper).
5. Stem leaves (middle).

Fig. *Pottia obliqua.*

1. Capsule and operculum.
2. Perichætial leaf (outer).
3. Perichætial leaf (inner).
4. Stem leaves (upper).

Pottia douglasii.

1. Capsule and operculum.
2. Calyptra.
3. Perichætial leaf (inner).
4. Perichætial leaf (outer).
5. Stem leaf (upper).

Art. XXIX.—*Musci: Notes on the Genus* Gymnostomum, *with Descriptions of New Species.*

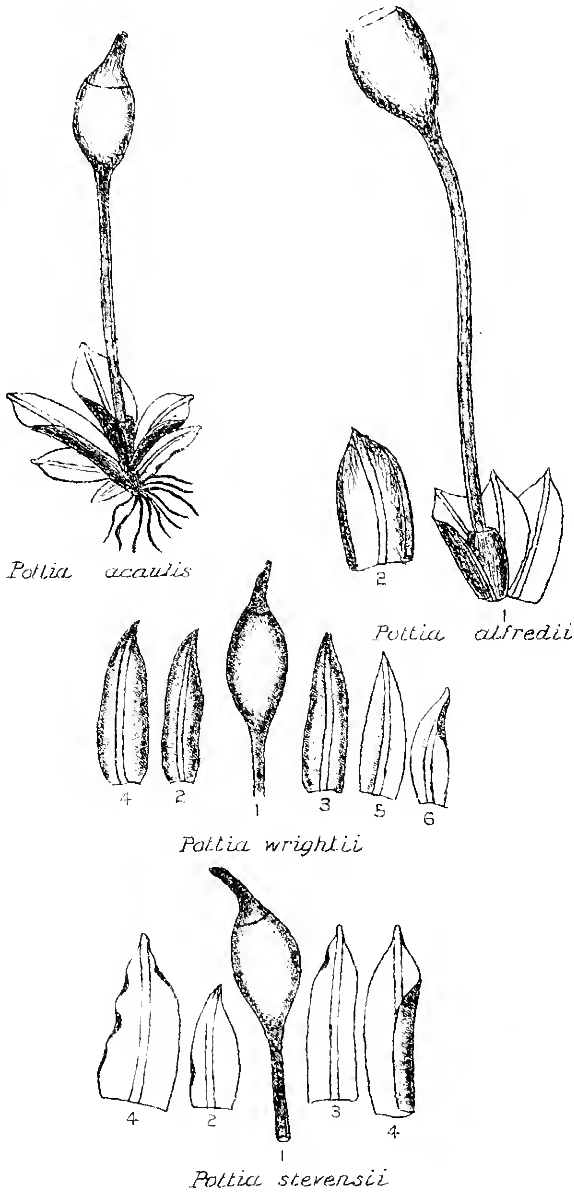
By Robert Brown.

[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Plates XXXV.–XXXVII.

The genus *Gymnostomum* is distinguished from the other allied genera of mosses by its species being *perennial*, and the cellular tissue of the upper portion of their leaves being small and dense; also in the absence of a peristome. In the genus *Pottia*, which is closely allied to it, the peristome is also absent, but species of the latter are either *annual* or *biennial*, and the cellular tissue is large and more succulent. In all other respects these two genera are similar, having also the same habitats, and being similar in appearance, which will account for Mr. Charles Knight (in his description of certain mosses, published in vol. vii. of the "Transactions and Proceedings of the New Zealand Institute," p. 354) placing *G. areolatum* in the genus *Gymnostomum* instead of that of *Pottia*, to which, from its large cell-structure, it probably belongs. These mosses are generally found on damp banks, on the ground, and are in fruit from October till February or March. Species of both genera are often seen growing on the same bank.

Since the publication of the "Handbook of the Flora of New Zealand" I have discovered no record of any new species of the genus *Gymnostomum* excepting Mr. Knight's descriptions referred to above. It is to be regretted that fuller details of some of these mosses were not given, as it appears from the descriptions that two of them do not belong to this genus, but to other genera. I have therefore not


Pottia acaulis
2
1
Pottia alfredii
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Pottia wrightii
4
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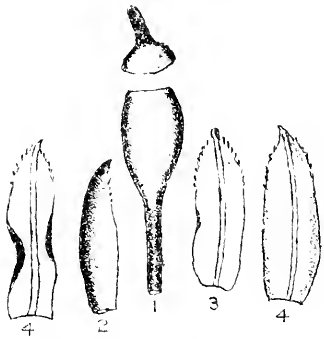
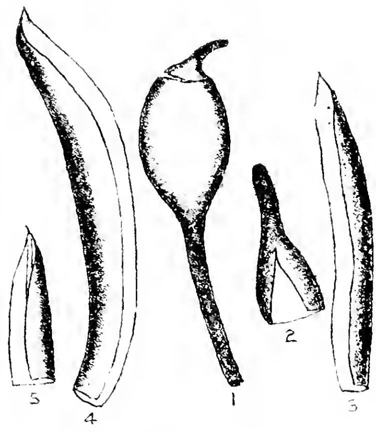
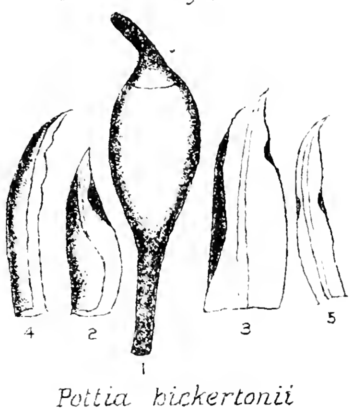
1
Pottia stevensii



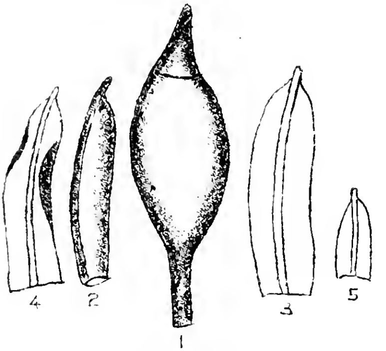
Pottia serrata



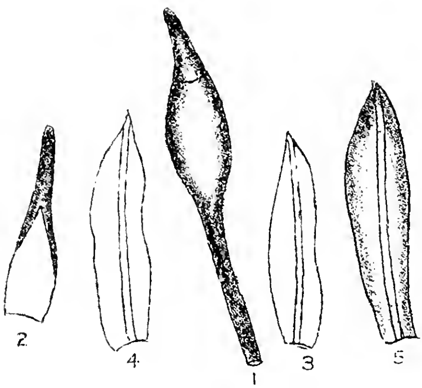
Pottia longifolia.



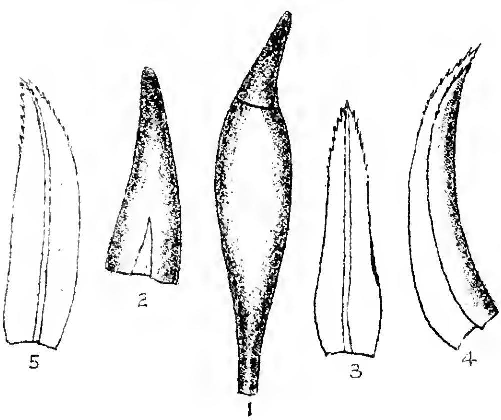
Pottia bickertonii



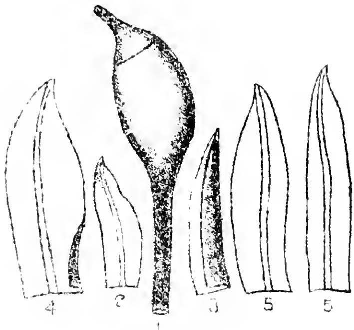
Pottia macrocarpa



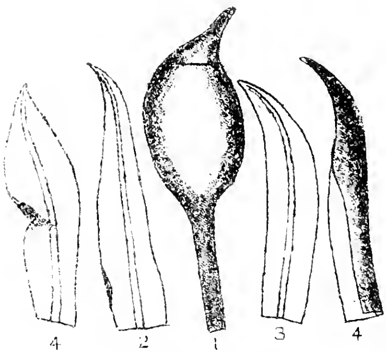
Pottia leonardi



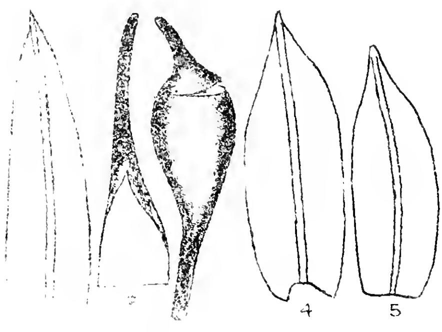
Pottia grata



Pottia assimilis



Pottia obliqua



[illegible]a douglasii

included them in this paper, but have left them to be placed in their proper position hereafter.

There are but two species described in the Handbook—viz., *G. tortile* and *G. calcareum.*

G. tortile is distinguished from all the other New Zealand species yet found by the regular incurving of the margins of its leaves. It is also a native of Britain and other parts of Europe.

G. calcareum I have collected at Castle Hill on the West Coast Road, and also at the Weka Pass. It was found on wet banks, in dense, irregular pulvinate patches, often very large, fruiting sparingly. The plant I have identified as *G. calcareum* I have drawn on Pl. XXXV.

Mr. Knight describes five species of this genus in the paper before referred to—viz., *G. patulum*, *G. knightii*, *G. sulcatum*, *G. areolatum*, and *G. angustatum.* He also describes a variety of *G. calcareum* which he has named var. *intermedia.*

G. patulum.—There is a note attached to the description of a moss (*Weissia flavipes*) in Hooker's Handbook, p. 404, which states that Mr. Wilson, who examined the Auckland form of this moss very carefully, suggested that it was probably a different species from *W. flavipes*, on account of his finding no trace of a peristome, and proposed to name it *Gymnostomum patulum.* Mr. Knight does not mention whether it is this particular moss or another species which he has thus named (*G. patulum*). Knight's plant is described as having the mouth of the capsule closed by a membrane, and having crisp leaves. These two characters would make this plant a most distinct species; but in the figure representing the whole plant the fruitstalk is drawn twice the length of the leaves, while in the description it is described as no longer than the leaves. Also, in the enlarged drawing of a leaf (vol. vii., pl. xxviii., fig. *c*) it is drawn as if the margins of the leaf had a thickened border, or were either incurved or recurved, which is also not described, leaving it doubtful which is correct.

G. knightii is one of the most distinct species in this genus, and is readily identified. It grows in Hagley Park, in the Domain, and round the neighbourhood of Christchurch.

G. calcareum, var. *intermedium.*—In the enlarged figure of the leaf of this plant a thickened border is shown, which is not described. This is evidently a mistake, as *G. calcareum* has not a thickened margin.

G. sulcatum.—This plant occupies a rather anomalous position by being placed in the genus *Gymnostomum*, as the furrowed capsules of this moss point to the genus *Zygodon* as being the proper place for it, there being a gymnostomous section in that genus which has also sulcate capsules and small cellular tissues. I have not seen this plant, but from its description am of the opinion that it belongs to the latter genus. A reference to the figure given also confirms my idea. I do not therefore propose to treat it as a *Gymnostomum*.

G. areolatum.—This moss is also in much the same position with regard to its genus as *G. sulcatum*. The large cellular tissue described as belonging to this plant, and the drawing thereof, show that it is a true member of the genus *Pottia*, which is composed of annual or biennial plants, having large cell-structure. I therefore propose to place this moss in the latter genus.

G. angustatum.—I was under the impression that I had discovered this moss, but on closely examining my specimens I found traces of sixteen teeth, and, although it corresponded in every respect with Mr. Knight's description of *G. angustatum*, with the exception of these teeth, it therefore could not possibly be the same moss.

The following is the proposed arrangement of the species of this genus as discovered to date:—

Gymnostomum calcareum, *Nees and Hornsch.*
" " *var.* intermedia, *Knight.*
" tortile, *Schwægrichen.*
" patulum, *Knight.*
" knightii, *Schimper.*
" angustatum, *Knight.*
" pygmæum, *nov. sp.*
" ligulatum, *nov. sp.*
" waimakaririense, *nov. sp.*
" magnocarpum, *nov. sp.*
" stevensii, *nov. sp.*
" longirostrum, *nov. sp.*
" wrightii, *nov. sp.*
" " *var.* A.

Gymnostomum pygmæum, nov. sp. Plate XXXV.

Plants very small, perennial, growing in dense patches. *Stem* extremely short, branched. *Branches* fastigiate, $\frac{1}{32}$in. long. *Leaves* minute, erecto-patent or erect, linear-lanceolate, acuminate. *Margins* entire. *Nerve* faint, disappearing below the apex. *Lower areola* oblong, quadrate; *upper* small, crisped when dry. *Perichætial* leaves half as long as the upper-stem leaves, erect, entire, otherwise similar to the stem-leaves. *Fruitstalk* inclined, $\frac{3}{16}$in. high. *Capsule* ovate, symmetrical. *Mouth* narrowed. *Peristome* none. *Operculum* oblique, conico-rostrate, two-thirds length of capsule. *Calyptra* cucullate.

Hab. Damp limestone rocks, near Castle Hill. Collected March, 1891, by R. B.

Gymnostomum ligulatum, nov. sp. Plate XXXV.

Plants small, perennial, growing in dense patches, darkish-green. *Stem* short, $\frac{1}{16}$in., branched. *Branches* fastigiate, $\frac{1}{16}$in. *Leaves* crowded, spreading, or erecto-patent, ligulate rounded at the apex, apiculate by the excurrent nerve, keeled. *Margins* entire. *Nerve* same colour as the leaf, excurrent. *Perichætial* leaves much smaller than stem ones, otherwise very similar. *Fruitstalk* slightly longer than the leaves. *Capsule* large, ovate, subsymmetrical. *Operculum* oblique, conic, tapering to the point, two-thirds the length of the capsule. *Calyptra* not found.

Hab. Port Lyttelton Hills, on damp banks, fruiting from November to January. Collected, 1882, by R. B.

This plant differs from *G. patulum*, Knight, principally in the mouth not being closed by a membrane, and in the perichætial leaves being shorter than the stem ones.

Gymnostomum waimakaririense, nov. sp. Plate XXXVI.

Plants small, perennial, growing in dense patches. *Stem* $\frac{3}{16}$in., branched. *Branches* fastigiate, $\frac{1}{16}$in. *Leaves* close-set, erecto-patent. *Upper* leaves recurving, lanceolate, sharply acuminate, semi-convolute, keeled. *Margins* entire. *Nerve* excurrent. *Upper areola* dense, *lower* oblong-quadrate. *Perichætial* leaves one-third longer than stem ones, linear-lanceolate, very acuminate, tapering from a broad base. *Nerve* excurrent. *Fruitstalk* $\frac{1}{8}$in. long, shorter than the perichætial leaves. *Capsule* subimmersed, ovate, symmetrical. *Operculum* conico-rostrate, more than half the length of the capsule. *Calyptra* cucullate.

Hab. Damp ground, among willows, at the River Waimakariri. Collected, September, 1885, by R. B.

Gymnostomum stevensii, nov. sp. Plate XXXVI.

Plants small, perennial, growing in dense patches. *Stem* very short, branched. *Branches* fastigiate, $\frac{1}{16}$in. long. *Leaves* closely crowded, spreading, or erecto-patent, linear-lanceolate or acuminate, semi-convolute, slightly cucullate, and incurved at the apex, keeled. *Margins* entire, sometimes slightly incurved. *Nerve* excurrent, almost apiculate. *Upper areola* dense, *lower* oblong-quadrate, crisped when dry. *Perichætial* leaves very long, linear-lanceolate, acuminate, nerved. *Fruitstalk* pale, $\frac{5}{16}$in. long. *Capsule* large, oval. *Operculum* oblique, short, conico-rostrate. *Calyptra* not found.

Hab. Damp banks, Port Lyttelton Hills. Collected in 1882, by R. B.

This plant is conspicuous, and easily distinguished by its large capsule and long perichætial leaves. I have named it in compliment to a member of the Institute, Joseph Stevens, Esq., of Christchurch.

Gymnostomum magnocarpum, nov. sp. Plate XXXVI.

Plants small, perennial, growing in dense, olive-green patches. *Stem* $\frac{3}{16}$in., branched. *Branches* fastigiate, $\frac{1}{8}$in. *Leaves* closely imbricating, spreading, or erecto-patent, slightly recurving, oblong-lanceolate, acuminate, occasionally rounded to an apiculus, concave. *Margins* entire, sometimes slightly incurved. *Nerve* excurrent. *Areola, upper* dense, *lower* oblong-quadrate, crisped when dry. *Perichætial* leaves shorter than the stem ones, narrow, lanceolate from a broader base, acuminate. *Nerve* excurrent. *Fruitstalk* $\frac{3}{16}$in., pale, inclined. *Capsule* ovate-symmetrical. *Operculum* convexo-rostrate, about two-thirds length of capsule. *Calyptra* cucullate.

Hab. Damp banks, Governor's Bay. Collected, August, 1881, by R. B.

Gymnostomum longirostrum, nov. sp. Plate XXXVII.

Plants small, perennial, growing in dense yellowish-green patches. *Stem* short, $\frac{1}{16}$in., branched. *Branches* fastigiate. *Leaves* crowded, erecto-patent, linear-lanceolate, acuminate or apiculate, concave, keeled. *Margins* entire. *Nerve* pellucid, continuous or excurrent. *Areola, lower* half oblong-quadrate, *upper* dense, crisped when dry. *Perichætial* about the same length as the upper leaves, nearly erect. *Fruitstalk* pale, slender, inclined, $\frac{1}{4}$in. long. *Capsule* ovate, unsymmetrical, narrowed towards the mouth. *Operculum* oblique, slender, conico-rostrate, as long as the capsule, sometimes longer. *Calyptra* long, cucullate.

Hab. Damp banks, on Port Lyttelton Hills, 1873; and in the Valley of the Clinton, 1889; fruiting from December to February. Collected by R. B.

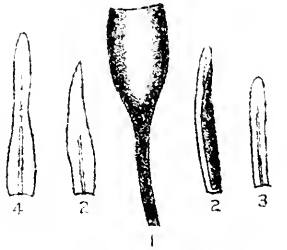
Gymnostomum wrightii, nov. sp. Plate XXXVII.

Plants small, perennial, growing in dense patches. *Stems* $\frac{1}{16}$in., branched. *Branches* $\frac{1}{16}$in., fastigiate. *Leaves* ovate-lanceolate, obtuse or acute, apiculate, concave. *Margins* entire. *Nerve* excurrent. *Areola, upper* dense, *lower* oblong-quadrate, crisped when dry. *Perichætial* leaves longer than the stem ones, linear-lanceolate, acuminate. *Nerve* excurrent. *Fruitstalk* $\frac{1}{3}$in. long, no longer than the leaves. *Capsule* very oblique. *Operculum* oblique, conico-rostrate, about two-thirds length of capsule. *Calyptra* cucullate.

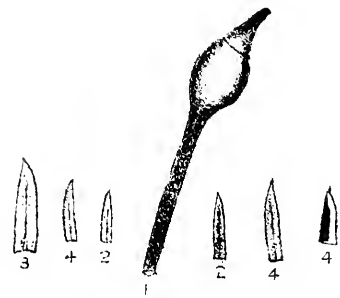
Hab. Damp banks, Broken River, West Coast Road, 1891.

Var. *A.*

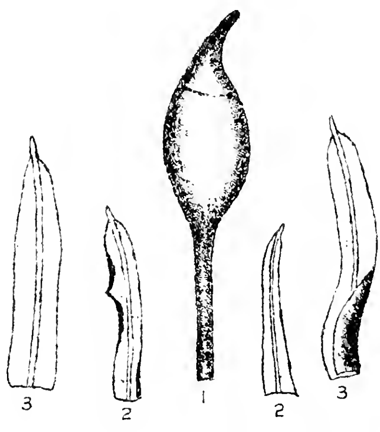
A variety near the River Heathcote, collected by R. B. in 1882. Has a stouter operculum and the leaves longer.



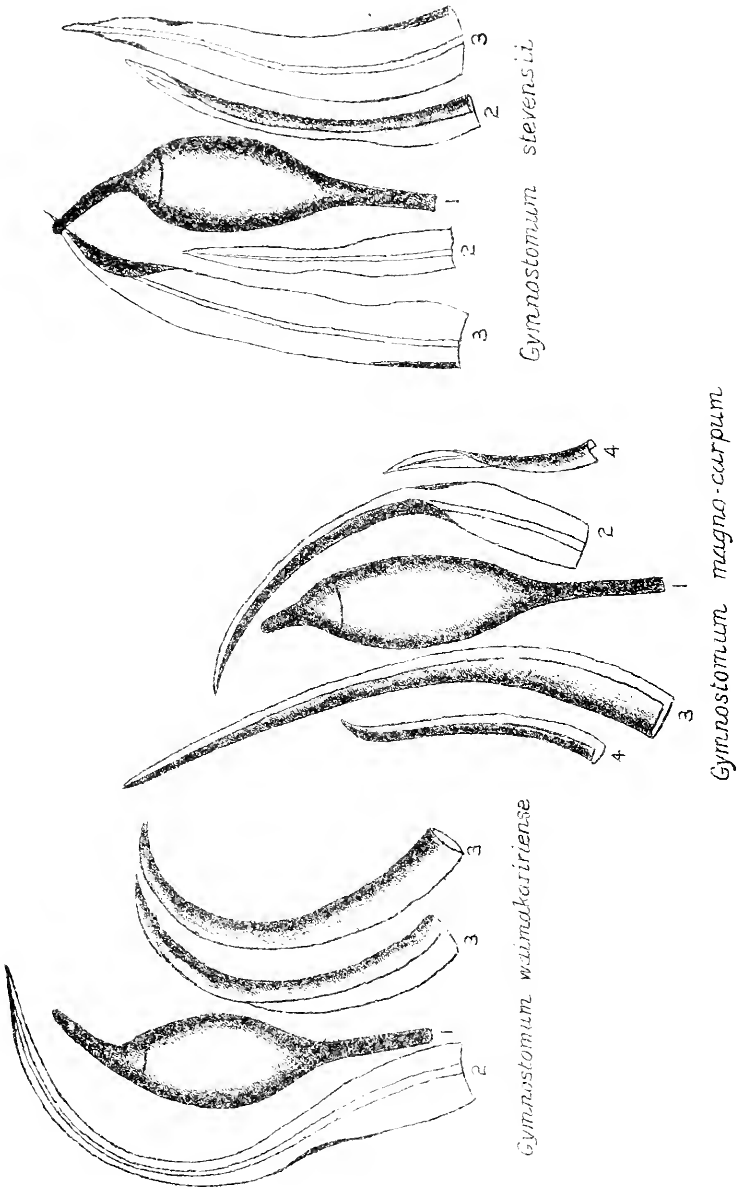
Gymnostomum calcareum

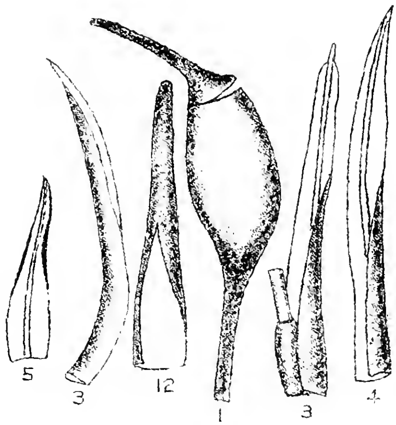


Gymnostomum pygmæum



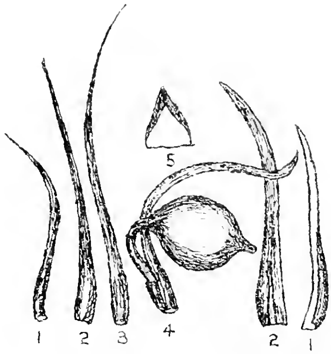
Gymnostomum ligulatum


Gymnostomum stevensii
Gymnostomum magno-carpum
Gymnostomum waimakaririense

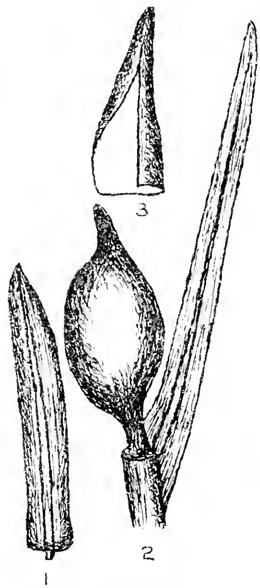


Gymnostomum longirostrum

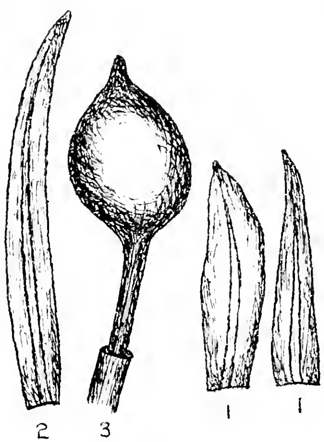
Gymnostomum wrightii



Phascum (Cycnea) arnoldii.



Phascum (Pleuridum) longifolium.



Phascum (Pleuridum) lanceolatum.

(All the figures of these mosses, as well as my previous contributions in this direction, are drawn with the assistance of a camera lucida to one scale, for the purpose of greater facility of comparison.)

EXPLANATION OF PLATES XXXV.–XXXVII.

PLATE XXXV.

Gymnostomum calcareum.

Fig.
1. Capsule.
2. Perichætial leaves.
3. Stem leaf (lower).
4. Stem leaf (upper).

Gymnostomum pygmæum.

1. Capsule.
2. Perichætial leaves.
3. Upper stem leaf.
4. Stem leaves.

Gymnostomum ligulatum.

1. Capsule.
2. Perichætial leaves.
3. Stem leaves.

PLATE XXXVI.

Gymnostomum waimakaririense.

Fig.
1. Capsule.
2. Perichætial leaf.
3. Stem leaves.

Gymnostomum stevensii.

1. Capsule.
2. Perichætial leaves.
3. Stem leaves (upper).

Gymnostomum magnocarpum.

1. Capsule.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaves.

PLATE XXXVII.

Gymnostomum longirostrum.

Fig.
1. Capsule.
2. Calyptra.
3. Perichætial leaves.
4. Stem leaf (upper).
5. Stem leaf (lower).

Gymnostomum wrightii.

1. Capsule.
2. Perichætial leaf (inner).
3. Perichætial leaf (outer).
4. Stem leaves.

Art. XXX.—*Notes on some New Species of New Zealand* Musci: *Genus* Phascum.

By R. Brown.

[*Read before the Philosophical Institute of Canterbury, 2nd August, 1893.*]

Plate XXXVIII.

There do not appear to be very many species of *Phascum* in New Zealand. During the course of a number of years I have carefully searched for plants belonging to this genus in all the localities I have visited, and have only been rewarded by the discovery of five species. Two of these are described in the Handbook of the Flora of New Zealand, the other three are new species. They are all small, tender, and inconspicuous plants, very liable to be overlooked, or taken for young plants belonging to other genera. The capsules of all these three species are immersed among the leaves, and in dry weather are entirely hid by the leaves incurving over and protecting them from the effects of the weather. This is no doubt an explanation of their non-discovery.

In this extremely interesting genus the capsules are indehiscent, there being neither valves nor operculum by which the spores can be shed; these can only be liberated by the decay of the capsule or its rupture through the spores germinating within.

This genus has been divided by botanists into a number of subgenera, only three of which are represented in New Zealand. They are found growing in patches, on damp clay and sandy banks, during the winter and early spring months, and are in fruit from June until November. After this period they are generally dried up by the hot winds prevailing about that time, and are then very difficult to find.

Phascum (Acaulon) apiculatum, Hooker and Wilson, is very common all over the Port Hills, and on the plains in the neighbourhood of Christchurch.

Phascum (Pleuridium) nervosum, Hooker, is also to be found in the same localities, but is not so common as the previous one.

Phascum (Pleuridium) lanceolatum, nov. sp.

Plants perennial, small, growing in dense dark-green patches, monœcious. *Stem* short, $\frac{1}{16}$in., branched. *Branches* fastigiate, $\frac{1}{8}$in. *Leaves* spreading or erecto-patent, oblong, rounded at the apex, apiculate or oblong-lanceolate, acuminate. *Nerve* excurrent, forming an apiculus. *Margins* entire, except at the apex, where they are minutely toothed by the excurrent cells. *Leaves*, when dry, become convolute and incurved over the capsule. *Areolæ* near the base oblong-quadrate; *upper*, round, dense. *Perichætial* leaves nearly one-half longer, erect, acuminate, otherwise very similar to stem-leaves. *Fruitstalk* very short, erect. *Capsule* immersed, subrotund, cuspidate. *Calyptra* cucullate. *Perigonia* gemmaceous, at the base of the branches. *Antheridia* three to four. *Paraphyses* numerous.

Hab. Damp ground, in plantations near the River Avon; in fruit from June to November.

Phascum (Pleuridium) longifolium, nov. sp.

Plants perennial, small, pale-green, growing in small, loose patches. *Stem*, $\frac{3}{16}$in.–$\frac{1}{4}$in., branched. *Branches* fastigiate, about $\frac{1}{16}$in. *Leaves* long, erecto-patent, linear-lanceolate, acute or apiculate. *Margin* entire. *Nerve* continuous, excurrent, forming the point of the leaf. *Areolæ*, *lower* long, narrow, quadrate; *upper* very small and dense; when dry convolute, and incurved over the capsule, completely hiding it. *Perichætial* leaves longer, nearly erect, linear-lanceolate, acute or apiculate. *Nerve* continuous. *Fruitstalk* erect, very short. *Capsule* immersed, oval, unsymmetrical. *Beak* oblique, acute. *Calyptra* cucullate. Monœcious. *Perigonia* gemmaceous at the base of the branches.

Hab. Steep damp clay-banks, in warm situations, on the Port Hills, fruiting a month later than *P. lanceolatum.*

In this plant the leaves very much resemble in outline those of *P. lanceolatum;* they differ in being longer and more numerous, and in the cells at the base of the leaves being also much longer; but the cells at the upper half of this plant are one-half smaller and denser than the corresponding ones of *lanceolatum;* the fruitstalk of *longifolium* is much shorter, and the capsule has a different form.

Phascum (Cycnea) arnoldii.

Plants small, growing in a dense tuft, pale-green. *Stem* very short, branched. *Branches* fastigiate, about $\frac{1}{8}$in. *Leaves* close-set, upper longest, sheathing near the base, subconvolute, straight or slightly falcate, recurving or incurved, nerved. *Perichætial* leaves shorter than the upper ones, otherwise very similar. *Fruitstalk* short, curved. *Capsule* immersed among the leaves, rotund. *Beak* short, straight, and narrow. *Calyptra* small, cucullate.

Hab. Moa Creek (one of the small tributaries of the Wilberforce), growing on rocks together with *Andreas* and dark-brown *Hepaticæ.*

Specimen plant deposited in Christchurch Museum.

EXPLANATION OF PLATE XXXVIII.

Phascum (Pleuridium) lanceolatum.

Fig.
1. Stem leaves.
2. Perichætial leaf.
3. Capsule.

Phascum (Pleuridium) longifolium.

1. Stem leaf.
2. Perichætial leaf and capsule.
3. Calyptra.

Phascum (Cycnæa) arnoldii.

1. Lower stem leaves.
2. Middle stem leaves.
3. Upper stem leaf.
4. Perichætial leaf and capsule.
5. Calyptra.

Art. XXXI.—*On* Lessonia variegata, *J. Ag., Mscr.*

By Robert M. Laing, B.Sc.

[*Read before the Canterbury Philosophical Institute, 1st November, 1893.*]

Plates XXXIX., XL.

In the "Flora Novæ-Zelandiæ," vol. ii., p. 217, *Lessonia fuscescens* (Bory, Voy. Coq., p. 75) is put down as indigenous to New Zealand; and on the authority of Lyall its habitat is given as Lyall's Bay, Cook Strait. In the Handbook, vol. ii., p. 656, it is stated also to occur on the east coast—*i.e.*, of the North Island—Colenso being the authority. Unfortunately I have not access to the original description of the plant in the Voyage of the "Coquille," and no synopsis of the species is given in the "Flora Novæ-Zelandiæ" or in the "Flora Antarctica." In the latter work, however, it is figured, vol. ii., 167, 168, and 171D; and in the "Handbook of the New Zealand Flora" there is a short account of the species. It is more fully described in Agardh's "Species Algarum," vol. i., p. 151.

The specific description in the Handbook, which agrees well with the figures in the "Flora Antarctica," is as follows:—"*L. fuscescens:* Gregarious, forming submarine miniature forests, trunks sometimes 10ft. long, cylindric, as thick as the thigh, bearing towards the top short branches with pendulous foliage. Leaves 2ft. to 3ft. long, 1in. to 2in. broad, linear-lanceolate, toothed, older sinuate."

Now, the only well-defined habitat given for this plant in New Zealand is Cook Strait; and a search along the northern shores of the Strait, in the neighbourhood of Wellington, reveals a *Lessonia* certainly, but one quite different in form from this. It has no massive trunk, but in the older plants from twenty to thirty stems about the thickness of a man's thumb spring from the rhizoid, and the fronds when in the water are not pendulous, but approximately vertical. Moreover, it occurs immediately below low-water mark, and not, as described in the "Flora Antarctica," vol. ii., p. 457, "always far below low-water mark." The leaves, in general shape and external characters, correspond well with those of the South American forms of *L. fuscescens*, as described in the "Flora Antarctica" (*loc. cit.*); but the other characters are certainly sufficient to differentiate it, though in all probability Hooker and Harvey have confused it with *L. fuscescens*. As our New Zealand form is bulky, it is likely that Harvey did not see a complete specimen, but identified the species from the leaves and a few pieces of the stem alone.

J. G. Agardh, on the other hand, in his list of New Zealand seaweeds ("De Algis Novæ-Zealandiæ Marinis," p. 6), includes only one species of *Lessonia*—viz., *L. variegata*, J. Ag., Mscr.—and gives, on the authority of Berggren, Lyall's Bay and Hokianga as its habitats. He adds, as synonyms, *Lessonia nigrescens* (*partim*), Bory, and *Lessonia fuscescens*, Fl. Nov. Zel., p. 217. To the latter synonym he attaches a (?). Unfortunately, however, he gives no synopsis of his new species, but simply shows that it is to be readily distinguished from others of the genus by the structure of the fronds. He states that he has only seen a few specimens, and it is probably on this account that he refrains from giving a specific description. What he says, however, is sufficient to identify his *Lessonia variegata* with the plant so common on the Strait in the neighbourhood of Wellington, and to which Hooker erroneously refers as *L. fuscescens*. Our plant must therefore be regarded as undescribed—at least, as far as New Zealand is concerned. Agardh states (*loc. cit.*) that it is also found on the Chilian coast, but how far it has been confounded with, or is distinct from, the several species of the genus found there, I must leave for others to decide. As we have already seen, it is not *L. fuscescens*, and apparently it can only be partially included, if at all, under any of the remaining species. I therefore propose to give a description of it here that will suffice for systematical purposes, and to refer to one or two points in its structure which will show that it is worthy of a further histological examination.

Lessonia variegata, J. Ag., Mscr.

Hab. Plentiful in rock-pools 6ft. to 10ft. or more in depth in the neighbourhood of Wellington (Cook Strait); Hokianga: *Berggren.* Mr. H. B. Kirk informs me that the plant is also to be seen among the drift-weed on the beaches at Stewart Island.

General Appearance.—A bushy plant, 3ft. to 5ft. high, bearing at the top of its numerous stems a subglobose mass of fronds a foot or two in diameter. It grows below low-water mark, so that the tops of the leaves just reach the surface at low tide. Small specimens may occasionally be obtained which are completely uncovered at ebb.

The Rhizoid.—In the young plant the root consists of a number of short, dichotomous branches, the tips of which are closely appressed to the rock-surface (Pl. XXXIX., fig. 1, *a*). When the plant is torn off it generally brings with it a more or less complete disc of rock-chips, corallines, and other incrustations attached to the root-tips. In the mature plants, owing to the coalescence of adjacent roots, the expansion of the lower branches, and the growth of numerous adventitious rootlets from the lower ends of the stem, the main rhizoid tends to form a ribbed columnar mass (Pl. XL., fig. 1, *a*). This forms a favourite resort for numerous epiphytic and parasitic growths of sponges, zoophytes, sertularians, corallines, florideæ, &c.

The Branch System.—Immediately above the root, even in young plants, a number of branches are given off, which are more or less compressed or oval in transverse section, and from 1in. to 1½in. in width in the direction of the longer diameter. Each branch divides three or four times dichotomously at an acute angle, broadening out a little below each fork, and finally each branchlet terminates in a frond. The pseudo-petioles are twisted several times below each frond, and the twisting is continued for some distance towards the base. The total length of the branching system is from 2ft. to 3ft. New branches are formed thus: A small fissure appears just where the frond joins the top of the stipe. This gradually extends through the lamina until bisection is completed. Occasionally a secondary fission commences before the primary one is completed (Pl. XL., fig. 2).

The Fronds.—These are from 1ft. to 2ft. in length, and 1in. or 2in. in breadth, linear or linear-oblong, sometimes falcate owing to unilateral growth, and with a few teeth scattered along the margin. In the young plant they are generally much longer than in the mature plant, with acuminate apices, as may be seen by a reference to the plates. The probable explanation of this will be given presently. They are olive-yellow in colour, closely covered with linear markings from $\frac{1}{8}$in. to $\frac{1}{4}$in. in length of a darker colour. Hence the specific name.*

Fructification.—The sori are of the usual type, and of irregular size and shape, generally several inches in length, and situated in varying positions on the fronds, more often, perhaps, immediately above the middle than elsewhere. I have, however, found them within an inch of the base. According to Harvey, in the "Flora Antarctica," the sori in *L. fuscescens* are situated beyond the middle of the leaf; and Agardh ("Species, Genera, et Ordines Algarum," vol. i., p. 150) makes their situation at the middle of the frond a generic character. Harvey also states that the cuticle covers the sori. This is certainly not the case in *L. variegata*, in which the sori are on the surface of the frond; and, as Agardh points out in the case of the other species, it is probably also a mistake due to the coherence of the parts in dried specimens.

Growth.—In the youngest specimens seen the plant consists of a single stem surmounted by a leaf, and at this stage is scarcely distinguishable from young plants of *Macrocystis.* In the latter, however, the first fission of the frond is scarcely median, and this character at present serves to distinguish it from *Lessonia*, in which the division passes through the centre of the lamina, and in which all leaves subsequently formed apparently result schizogenetically from the first leaf, so that if the growth were regular the plant ought to consist of a single stem presenting a perfectly dichotomous symmetry in one plane; but, owing to the twisting of the stem already referred to, the branches are thrown out of the original plane; and, owing to the thickening and coalescence of their lower portions, there appears to be a number of stems in place of one arising from the root. This, at any rate, seems to me the most feasible explanation of the large number of stems apparently growing from the rhizoid in the mature plant. As there is no proliferous growth or adventitious branching, it cannot be accounted for by these means; and the only other possible explanation that occurs to me is that the mature plant represents a cluster of plants growing together. Against this idea is the fact that young plants are not seen growing from the rhizoid, and that all the stems are apparently of similar age. In favour of the explanation first given is the great lateral thickening by secondary growth that is clearly shown at the base of the stems, and the fact that sometimes two masses of central tissue are found in one stem, and this

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* If the fronds are steeped in fresh water for an hour or two they blister badly, probably owing to osmosis.

near the base of the plant and not immediately below a fork. (Pl. XXXIX., fig. 2, *a*.)

The growth in length, as in other Laminarians, takes place at the junction of the stipe and the frond, and consequently, the tip of the frond being once worn off by the action of the waves, or eaten by molluscs, it cannot be replaced, and, as all fronds subsequently formed have no apices, a complete leaf is rarely to be found except in young specimens, in which, as has already been stated, they are much longer than in the mature forms. Harvey (*loc. cit.*) explains the absence of the tip in *L. fuscescens* thus: "In the present species the sori are situated beyond the middle of the leaf; they are oblong and nearly as broad as the lamina, of which they carry away the upper part when decaying, causing the apices to be two-horned. In none of the specimens is the point perfect, all the spores we have seen being situated on the sorus, which has itself fallen away from the edge of the frond." I have not noticed that the sorus in *L. variegata* falls away in the manner described. It is certainly frequently attacked by a green filamentous alga which grows on its upper surface, on the tops of the paraphyses, and causes decay; but this green alga, though chiefly found forming a velvety nap on the sorus, grows elsewhere on the surface of the frond.

Notes on the Histology.

The Frond.—A transverse section through the frond shows it to consist of an epidermal and several cortical layers gradually merging into a parenchymatous tissue. In the centre is the hyphal layer, in which, however, the hyphæ preserve a general longitudinal direction. Like the stem, it contains "trumpet hyphæ." Immediately under the epidermis are a number of large lacunæ (Plate XL., fig. 3, *a*). It is on these that Agardh apparently chiefly relies to distinguish this species from others. Under a Browning's platyscopic lens I have counted as many as twenty-five of these in a transverse section of a single frond. They open into ostioles on the surface. The structure of the frond is the same on both sides. I have not seen any "air-cells," as figured by Hooker and Harvey in the centre of the frond.—("Flora Antarctica," vol. ii., pl. 167c.)

The Stem.—Harvey, in speaking of *L. fuscescens*, says ("Flora Ant.," vol. ii., p. 458), "The trunks, which contract to a quarter of their original dimensions when dry, and become deeply furrowed, are perfectly smooth and cartilaginous when fresh. On being cut across, the curious appearance of concentric elliptical rings, in many respects very similar to, though very different from, those of an exogenous trunk, is very evident." Harvey again refers to this appearance in speaking of *L. nigrescens*, in which, no doubt, is partly included *L. variegata*. However, such a series of rings can only with difficulty be made out in our New Zealand specimens. On a stem of one of these being cut across there is to be seen—(1) The thin brown epidermal and cortical layer; (2) a lighter tissue (almost white in spent specimens), which constitutes the great bulk of the stem; (3) a darker tissue, oval in transverse section, and scarcely to be distinguished by the naked eye from (4), a linear more or less central layer, containing brown colouring-matter. It is in No. 2, particularly in dried specimens, that faint concentric rings are to be seen; but I have not been able by microscopical examination to ascertain that they are rings of growth, as Hooker thought they were, or even to differentiate them at all under the microscope. In a hard-dried specimen they remind one of the appearance of the grain in ivory.

Under the microscope the different tissues present the following characteristics: No. 1 is an epidermal and cortical layer of the usual type; under this is No. 2, consisting on the outside of a meristem divided by periclinal walls. By means of this the stem increases in thickness. Owing to unequilateral growth of this layer, tissues (3) and (4) are rarely central. Pitting is common in this part of the stem. The meristem passes into a parenchyma, which constitutes the greater bulk of the stem. Tissue (3) consists of cells which are oblong in transverse section, but in longitudinal section are seen to be many times longer than broad. They anastomose occasionally. This tissue is penetrated by a number of ducts—(?) mucilage-canals—about $\frac{1}{100}$in. in diameter, and perhaps similar to those found in *Macrocystis*. The innermost tissue is hyphal in character, and, like the hyphæ of fungi, it does not stain with iodine and sulphuric acid. (I am not aware if this is a common characteristic amongst seaweeds). It contains "trumpet-hyphæ," which give the usual reactions for callus with chlor-zinc-iodine, Russow's callus reagent, and corallin-soda. The last-mentioned stain, though very distinctive, is, however, transient. With eosin the callus stains rather more deeply than the rest of the tissue, but the result is not very satisfactory. As will be seen, this is only the fourth seaweed in which callus has been found. Oliver says* that "in the *Nereocystis*, as in *Macrocystis*, callus is formed in the true sieve-tubes, as well as in the 'trumpet-hyphæ.' In the 'trumpet-hyphæ' of other *Laminariæ* I have so far (with one exception) been unable to discover any callus." The explanation of the figures illustrating Oliver's

* "On the Obliteration of Sieve-tubes in *Laminariæ*."—"Annals of Botany," vol. i., p. 95.

paper shows that the exception referred to is an unnamed species of *Laminaria* from Vancouver Island. As Oliver mentions that he has found "trumpet-hyphæ" in *Lessonia* (*loc. cit.*), but does not state in what species, it seems probable that in the species he examined callus is wanting, as he is not likely to have overlooked it. He also refers to Grabendörfer as having figured "trumpet-hyphæ" for *L. ovata* in a paper in the Bot. Ztg., 1885, entitled "Beitrage zur Kentniss d. Tange." I regret that I have not access to this magazine, as it would have been interesting to compare the structure of the stem in the two species *ovata* and *variegata*; and Grabendörfer's paper, no doubt, would have assisted me much in the preparation of this.

EXPLANATION OF PLATES XXXIX., XL.

Plate XXXIX.

Fig. 1. Young specimen of *Lessonia variegata*, showing the immature forms of the rhizoid and fronds. (About one-sixth natural size.)

Fig. 2. Group of stems, showing transverse sections. In two of them the central tissue is divided, probably showing coalescence of two separate stems.

Plate XL.

Fig. 1. Fragment of mature specimen of *Lessonia variegata*. (About one-seventh natural size.)

Fig. 2. A perfect frond, showing acuminate apex, and the method of branch-formation by fission. A secondary fission is commencing before the first one is completed. (About one-quarter natural size.)

Fig. 3. Transverse section from the epidermis to the centre of a frond, showing intercellular spaces. (× 200 diam.)

Art. XXXII.—*On the Occurrence of* Xanthium strumarium, *Linn., in New Zealand.*

By T. W. Kirk, F.L.S.

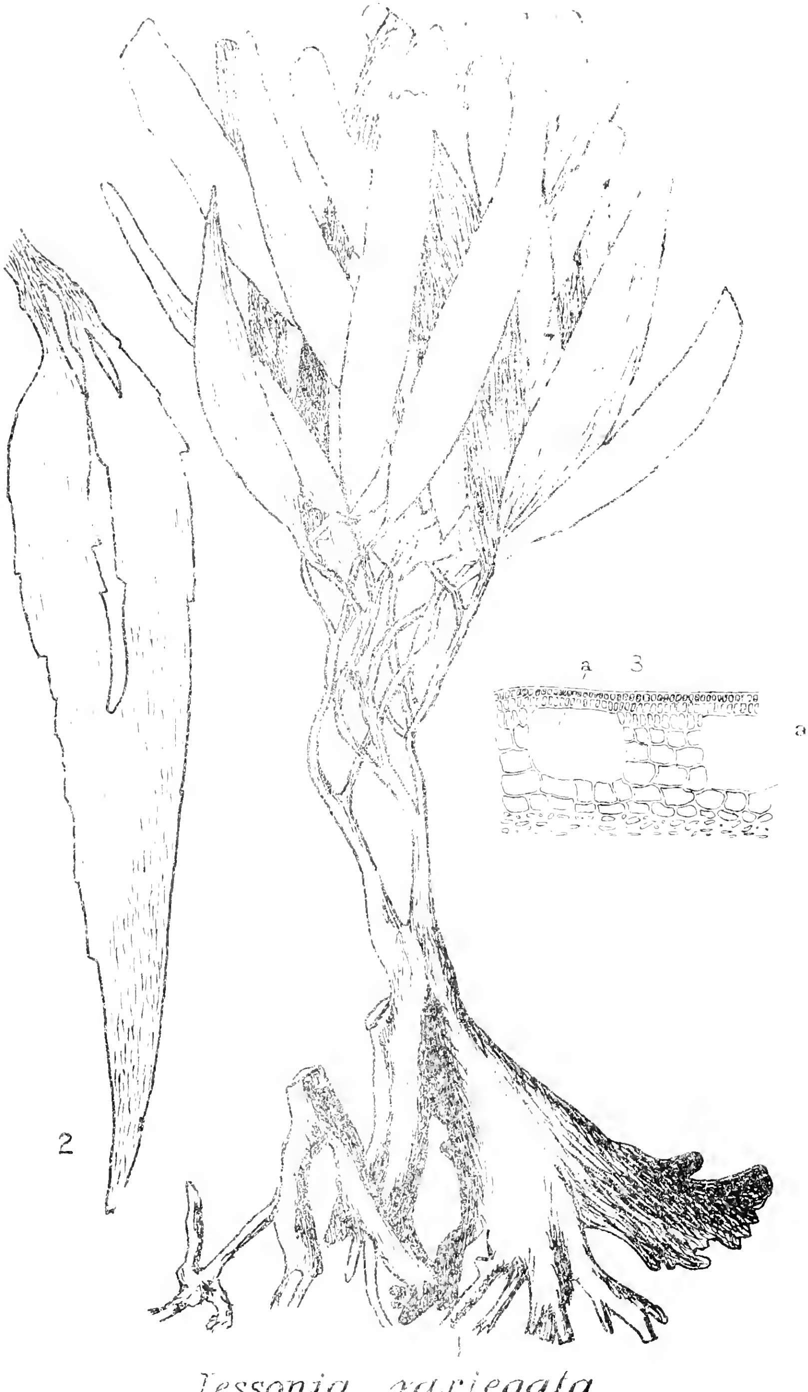
[*Read before the Wellington Philosophical Society, 26th July, 1893.*]

I have on previous occasions drawn the attention of members of this Society, and also of the Field Naturalists' Club, to some very undesirable importations—notably, centipedes and millipedes arriving in bananas, the English mole-cricket, and others.

The most recent of these arrivals is a plant which, if acclimatised, will probably prove harmful to both the cattle- and sheep-farmer.

Lessonia variegata

F.H.T. lith.



Lessonia variegata

F.H.T. lith.

Some time ago the "Silverstream," from Buenos Ayres, discharged a quantity of earth-ballast, which was placed inside the railway-fence on the Bunny Street frontage. A few months later this heap was observed to be covered with a luxuriant growth of weeds, and from it I collected no less than seventeen species—many of them, unfortunately, already too well known in the colony; but two or three have, apparently, not been previously recorded here. Amongst these last was the subject of the present note—viz., *Xanthium strumarium*, known in England as the small burdock, or burr-weed; in America as the clot, or cockle burr; and in Australia as the Noogoora burr, from the locality where it was first observed to be injurious.

The plant belongs to the order *Compositæ*, but the young botanical student would probably at first, on account of the separation of the male and female flowers, have some difficulty in understanding why it should be so classed; a further and careful examination will, however, convince him of its true relationship.

Xanthium, Linn. (From ξανθός, yellow; the plants being formerly used by the Greeks to dye their hair.)

Capitula unisexual, monœcious; staminate globose, in terminal clusters; pistillate 2-flowered, chiefly axillary. Male capitula with few narrow involucral bracts; florets numerous, sheathed by folded hyaline paleæ; corolla 5-toothed; anthers free or nearly so, base obtuse. Female capitula with an ellipsoidal or ovoid closed gamophyllous aculeate involucre, 2-lobellate and 2-rostrate; corolla none; achenes solitary in each cell of the indurated prickly enclosing involucre. Coarse, scabrid, hoary, or glabrate annuals, with alternate petiolate palmately-lobed leaves.

X. strumarium, Linn.—Stem, branches, and leaves puberulous without spines, mottled, spreading, attaining a height of 6ft. or 8ft. Leaves deltoid, 3- to 5-lobed, unequally, often coarsely dentate, often over 6in. broad; base 3-nerved, cordate, sinus wide, cuneate into the petiole of 1in. to 6in. Capitula nearly sessile, clustered; fruit ellipsoidal, about $\frac{3}{4}$in. long, terminating in an erect or somewhat curved beak. (Bailey.)

The female flower-heads are in small axillary clusters of two or three, the male flower-heads being placed above them, at the top of the branchlets. After the pollen has been dispersed, the male flowers soon drop off, and the female flower-heads rapidly develope into oblong burrs, very hard, and thickly studded with hooked spines. On the top of the burr are to be seen two very stout beaks, and within will be found two cells, each with a single seed.

This plant is a rank annual weed, and in Australia grows to a height of 6ft., 8ft., or in some cases 10ft., with wide-spreading branches. The stems of young plants are mottled with purple.

In the earlier stages of development it is readily eaten by cattle. Mr. Gordon, the Chief Inspector of Stock for Queensland, states that its action is to induce paralysis of the heart, causing death without struggle, and apparently without pain. At Mr. Gordon's suggestion, Dr. Bancroft, of Brisbane, undertook experiments which conclusively proved the poisonous nature of the weed. It was introduced into Queensland with cotton from the Southern States of America.

Each plant produces numerous burrs, which, in sheep country, would, from their nature, cause enormous loss to the wool-grower, by injuring the fibre of his chief product.

The fact of so many injurious plants being found in the ballast of a single ship naturally raises the question, What is the best means of dealing with such rubbish?

I am informed that one Harbour Board has decided all ballast except rock shall be taken out to sea by lighters and thrown overboard.

It has been urged in support of this plan that the salt water will rob the seeds of their vitality; but we know that many seeds, especially those with hard covering, retain their vitality after having been carried enormous distances by ocean-currents, so that throwing ballast into the sea, a few miles at most from land, is only providing for the wholesale distribution of noxious weeds all along the coast.

Failing means of calcining, or chemically treating all ballast so as to destroy the plant life therein contained, I would suggest that each Harbour Board set aside a section of ground, securely fenced, that all ballast be deposited there, and its removal from the dépôt allowed only for ballasting vessels, or for reclamation behind well-built retaining-walls, the reason for this last being that, if used for reclamation under any other conditions, the tide would distribute seeds and other light substances far and wide.

With regard to the ballast dépôt, it will be evident that a very small amount of attention would prevent the weeds growing in such an enclosure from bearing seed, and thus a very considerable source of danger be removed.

It may perhaps be some consolation to state that I find our New Zealand slugs are extremely fond of *X. strumarium;* so much so, in fact, that, though I carefully transplanted at different times no less than nine plants from the ballast-heap to my garden, made a special enclosure, and took every care to protect the young plants and to guard against the spread of the burrs when they should be formed, I was yet unable to rear a single specimen; the slugs had evidently no sympathy with scientific experiments, or with my desire to grow plants in order to show settlers what they had to guard against; every plant was ruthlessly eaten off level with the ground. Possibly the slug will yet be proved to be the natural enemy of the Noogoora burr.

ART. XXXIII.—Phænogams: *A Description of a few Newly-discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand.*

By WILLIAM COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 9th October, 1893.*]

CLASS I. DICOTYLEDONS.

Order I. RANUNCULACEÆ.

Genus 3.* **Ranunculus,** Linn.

1. *R. sychnopetala*, mihi.

Having this year received perfect specimens of the flowers of this fine plant, I can now supply what was wanting in the former description of it.† Achenes numerous, roughish, sub 50, styles much produced 1 line long erect and slightly recurved, greenish-yellow; tips minutely penicillate; receptacle elongated, ovoid. The anthers are also placed in 4 rows, the outer 2 rows patent, the inner 2 rows shorter, erect. While, however, the flowers were perfect, and in good condition for examination, they were not advanced enough to enable me to say much of their achenes, the same being unripe.

Hab. (with former-described). Norsewood; *Mr. A. Olsen*: 1893.

Order XXII. LEGUMINOSÆ.

Genus 1. **Carmichælia,** Br.

1. *C. micrantha*, sp. nov.

"A much-branched erect shrub, about 8ft.–9ft. high"; branches terete, tawny-yellow-green, glabrous; my specimen, the top of a large branch about 1ft. long, 2½ lines diameter at base where cut off, the bark curiously (almost symmetrically) closely split-fissured longitudinally; fissures lanceolate sub 1 line long ultimately coalescing, with purple-coloured edges,

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* The numbers of the orders and genera given here are those of them in the "Handbook of the New Zealand Flora."

† *Vide* Trans. N.Z. Inst., vol. xxiv., p. 324.

minutely transversely and regularly nicked; branchlets numerous alternate dichotomous, straight, striate, 8in.–9in. long, slender, terete, the larger ones about 1 line diameter, the youngest wiry, filiform, and pubescent; hairs scattered, weak, white, with many stem-clasping broad obtuse bracts near each other at their tips. Leaves 0. Flowers very numerous, usually in small depressed corymbs of 5, sometimes 2, and sometimes only 1 flower, on the smaller branchlets. Peduncle and pedicels nearly equal in length, short sub 1 line long, pilose, with many fawn-coloured scarious bracteoles, their edges jagged. Calyx dry, semi-scarious, loose, large for flower, half as long as corolla, slightly pilose; margins sinuate and minutely-toothed, finely ciliolate. Corolla less than $\frac{1}{10}$in. long, standard purple with dark veins. Pod (immature) glabrous, small, about 1 line long, narrow-linear-ovoid, acuminate; beak much longer than pod, curved; stigma capitate, roughly penicillate.

Hab. Edges of forest, head of Rangitikei River, County of East Taupo; *Mr. Patrick Stirling McLean:* 1893.

Obs. After close examination I have decided to bring this plant forward as a *species nova* of this curious genus; at the same time I am not wholly satisfied concerning it, through not having seen its ripe fruit. Its whole aspect, however, is peculiar, and apparently differing from its congeners,—in its numerous terete long and filiform yellow-green branchlets with their curiously-fissured bark, and the different disposition of its flowers, with their numerous-coloured bracteoles; unfortunately, its fruit was immature. The one large specimen I received is evidently the upper portion of a large branch, and is about 12in. long.

Order XXVI. Droseraceæ.

Genus 1. **Drosera**, Linn.

1. *D. circinervia*, sp. nov.

Root simple, slender, straight, 1½in. long, broken(?). Leafy stem slender, erect, simple, 8in. high, glabrous. Leaves largely glandular-hairy on upper surface and at margins, their glandular apices small, elliptic, red. Lower leaves at summit of the stock 8, subrosulate spreading, suborbicular not peltate, 1½ lines diameter, decurrent; petioles 6–7 lines long, stoutish; stem-leaves 11, peltate, nearly equidistant throughout stem sub ¾in. apart, lunate, truncate on the straight side, and there 3 lines broad, the 2 angles largely produced and bearing at their tips 4–5 very long flexuous cilia: the curvilinear margin much narrowly laciniate-fringed; the two principal nerves biorbicular from the insertion of the petiole; petioles filiform sub 1in. long. Flowers (immature) small(?) at top of stem, in a small branched sub-corymb; pedicels about 1 line long. Sepals glabrous, smooth, black.

Hab. Open lands; Taupo: 1885.

Obs. I. This plant is nearly allied to *D. auriculata*, Backh., and also to *D. peltata*, Sm., differing, however, from the former in its lower leaves being not peltate with long petioles, and from the latter in its lower leaves being decurrent on longer and narrower petioles, and from both in the largely laciniate margins of its leaves, their greatly extended angles, and their peculiar orbicular venation. Its flowers are also differently disposed, not being racemose and with smooth sepals.

II. I received this plant several years ago, with others, from Taupo; and from its being immature I refrained from describing it, as I had been led to expect more complete specimens. It stains the drying-papers red, like others of its genus; and I believe, from its long slender simple and broken tap-root, that, like some of them, it also arises from a bulb. Having but a single specimen, which, though not fully developed, is entire, allowance must be made for not giving any description of its floral parts.

Order XXIX. ONAGRARIEÆ.

Genus 2. **Epilobium**, Linn.

1. *E. nanum*, sp. nov.

Plant very small, glabrous, erect, $2\frac{1}{2}$in. high; stem simple red slender, minutely bifariously puberulent on the basal portion; leaves few, opposite, distant $2\frac{1}{2}$ lines apart on stem, linear-lanceolate, sub 2 lines long, subacute, with 1 (rarely 2) very small blunt teeth at lateral margins, thickish, green, subpruinose, tapering, the basal half of midrib below red prominent; petiole very short, stout. Flower solitary, axillary near top less than 1 line long; corolla perfect but unexpanded, white; calyx shorter than corolla, grey, lobes subacute with red margins, and a red central line; capsule $\frac{2}{10}$in. long, slender, glabrous, green, scarcely tetragonal; peduncle $\frac{6}{10}$in. long, thickly puberulent with short white curved hairs.

Hab. Among other low herbage (as *Nertera*, *Utricularia*, *Hydrocotyle*, &c.); marshy spots, high land base of Mount Tongariro, Taupo district; January, 1893: *Mr. H. Hill.* (Received in living tufts, as dug up.)

Obs. Of this little plant I have only obtained two specimens, both alike in size, &c., but one only bearing a flower. The regular shape of their small narrow leaves, and their strictly-erect growth, the simple stem without any basal branches, or root-stock buds, serve to mark it as being distinct from the other small indigenous species of this genus, which are creeping plants with round leaves. The puberulous lines on their lower stems are excessively minute, and can only be detected with a strong lens. The curved close hairs on the peduncle are a curious and pleasing object. More specimens are a desideratum.

Order XXXIX. Compositæ.

Genus 17. **Senecio,** Linn.

1. *S. dimorphocarpos*, sp. nov.

Plant perennial, herbaceous, glabrous (*primâ facie*), but with a few slightly-scattered weak woolly hairs. Main stems stout, erect, 2ft.–3ft. high, 3–4 lines diameter, striate, purple. Leaves basal (root-stock), subrosulate, spreading, obovate-spathulate, 5½in. long (including petiole), 1¼in. broad, deeply pinnatifid, lobes cut bluntly laciniate and crisped adnate (*sursum currens*), the lowermost very small, almost pinnate; petiole 1½in.–2in. long, narrowed, deeply sulcate, succulent; cauline, on main stems, numerous, alternate 6–12 lines distant, thin, obovate, much tapering, tip broad, 12in. long, 3in.–4in. wide near top, sub-lyrate-pinnate; segments large and close above on rhachis, small and very distant below, irregularly and deeply laciniate-lobed (subpinnatifid), lobes distantly and bluntly toothed, decreasing rapidly in size downwards and very small near base, dark-green above paler beneath, slightly hairy; hairs short, weak, and scattered, woolly on veins; veins few filiform and prominent; the young immature leaves densely woolly; scurfy on undersurface; midrib (or rhachis) narrow; petiole (or lowest rhachis) 1in.–2in. long, slender, slightly expanding and subamplexicaul at base; leaves on branches, distant, oblong, elliptic, much more narrowly cut, laciniate, flaccid, spreading, 3in.–5in. long, 2in.–2½in. broad, decreasing in size upwards and extending to bases of panicle branches. Flower-heads rather large, 10–11 lines diameter, numerous in a loose terminal irregular many-branched subcorymbose panicle 4in. wide; branchlets long, dichotomous, and very slender; peduncles about 1in. long, slender, striate, single and two together, finely and slightly downy, each having 4–6 scattered long linear bracteoles. Involucre cup-shaped or suburceolate, glossy within, the bracts 13 cut to base, 1½ lines long and ½ line wide, imbricate, suboblong-ovate, acuminate, green with wide membranous white margins, prominently 2-nerved; nerves dark-green; tips acute, dark-brown-purple, very hairy and ciliolate with a few (5–8) scattered linear (almost filiform) bracteoles at base, their tips very acute and coloured like those of involucre. *Ray*-florets generally 13, ligula (without the tube) 3½ lines long, linear-lanceolate obtuse with a single notch at tip, bright-yellow, spreading (but revolute in age), 4-veined; the tube exceedingly slender, roughish subscaberulous. *Disk*-florets numerous, darker yellow, scarcely exceeding the involucre, the tube infundibuliform subangular, 5-nerved; nerves dark-coloured; style long, hairy, lobes large, stout, much arched, tips truncate and finely penicillate; anthers tailed, obtuse, slightly and sparingly roughish subtuberculate, enlarged (tumid) at base. Achenes pale linear subterete—of *ray* glabrous, truncate at both ends, slightly curved and more cylindrical than those of disk; of *disk*, hairy, striate, slightly tapering, thickest at top. Pappus white—of *disk* numerous, straight, barbed, acute, shorter than floret; of *ray* few (4–6) smaller flexuous and weaker. Receptacle subhemispherical, alveolate, the ridges minutely toothed.

Hab. In gullies, Kaweka Mountain-range, County of Hawke's Bay; 1892: *Mr. F. W. C. Sturm.*

Obs. I. A fine-looking plant, having affinity with *S. latifolius*, Hook. fil., though differing in several important characters; and in its two forms of achenes, &c., with *S. jacobæa*, Linn., a British and European species, which evidently belongs to the same natural section.

II. I have received some large and good specimens of this plant from its kind discoverer, but not a complete plant, so I do not know its root-stock, neither if it is much branched at the root; I have, however, a fine young plant in my garden.

2. *S. areolatus*, sp. nov.

Plant herbaceous, erect 15in.–18in. high (?), glandular, hairy, with more or less of white scurf. Main stems 12in.–14in. long, slender, striate, having 4–5 distant branches at top, each with a long leaf at base. Leaves (cauline) few, distant about 2in. apart on main stems, membranous, dark-green, 2in.–3in. long, subobovate in outline, irregularly and deeply pinnatifid, narrowed into a petiole, sessile and stem-clasping, base much dilated and lobed, auricles toothed, lobes few long narrow acuminate, margins thickened and distantly toothed; teeth indurated, black; veinlets numerous, closely and compoundly anastomosing. Flower-heads rather small, in a loose, spreading, subcorymbose panicle; subpanicles 3in.–4in. long, very slender, dichotomous, with a single long leaf at bases; peduncles about 2in. long, filiform, each bearing 6–10 heads on capillary pedicels 3–4 lines long. Involucre cylindrical 4-lines long, a little shorter than florets and pappus, green, scabrid, about 15 linear acuminate bracts, tips acute, irregular in width, with white membranous margins, 1–2 nerved; nerves pale, prominent, with a few long, narrow, scattered bracteoles below. Florets very slender, tubes capillary—of *ray*, few, sub 12, ligula yellow, very small, much revolute, 4-nerved; of *disk*, numerous, about 60, bell-mouthed, 5-cleft, segments erect, subacute. Receptacle pitted, alveolar ridges somewhat regularly and acutely toothed. Pappus numerous, white, soft, slightly scabrid. Achene narrowly oblong, striate, contracted under pappus, edges strigillose-pubescent; tip obtuse, with a central capillary point. Arms of style long and much arched, tips terete, thickened.

Hab. High hills, eastern slopes of Ruahine Mountain-range, west of Woodville, County of Waipawa; 1893: *Mr. H. Hill.*

Obs. I have received only flowering-stems (three) of this plant, roughly and hastily gathered; their cauline leaves, being tender, bruised and much broken, so that allowance must be made for their description: their thickly anastomosing veins, together with the peculiar strigillose pubescence of the achenia and the general glandular pubescence of the plant, afford good characters. It has much the appearance of an *Erechtites*, and at first sight I had supposed it to belong to that small genus.

Order XL. Stylidieæ.

Genus 2. **Helophyllum**, Hook. f.

1. *H. muscoides*, sp. nov.

Plant low cæspitose compact, spreading, forming pretty large mat-like patches. Branches 1½in. long, each bearing 2–3–4 small branchlets about ½in. long at top, their tops being nearly equal. Leaves closely imbricated all round stems, glabrous, linear, semi-terete, thick, 1½ lines long, $\frac{1}{25}$in. broad, wider and flatter at base, which is also white and glossy; apex obtuse, slightly spathulate and knobbed, brownish-yellow and orange, the young leaves bright-green. Flower solitary on tip of branchlet, white, star-like; calyx 6 linear lobes, obtuse, length of tube, glabrous; corolla 6-parted, segments oblong, obtuse, distant, each 1 line long, equal, spreading flat on leaves; style erect, much exserted, white; stigma penicillate, with 2 small pale-coloured anthers underneath, adpressed.

Hab. Tongariro Mountain, Taupo; 1893: *Mr. H. Hill.*

Obs. A species near to *H. colensoi*, Hook. f., but with very much smaller and differently-shaped leaves. All the flowers I have seen (nearly a dozen) were 6-lobed and regular.

Order LV. Lentibularieæ.

Genus 1. **Utricularia**, Linn.

1. *U. vulcanica*, sp. nov.

Scape simple, erect, filiform, 1½in.–2in. high; 1-flowered (one specimen 2-flowered), purplish-brown, glabrous, 4 simple bracteoles sublinear obtuse, narrowest at tips adpressed in a semi-whorl 1 line below flower; capillary rootlets very fine. Leaves 2 (or 3) at base, narrow linear-spathulate, obtuse, $\frac{1}{2}$in.–1in. long, $\frac{1}{25}$in. (or less) wide, 1-nerved, weak, spreading; petiole long and very narrow. Calyx sepals unequal, cut to base, suborbicular concave, purplish-green, shining, veined; veins simple; margins undulate, whitish; the tip of the smaller segment emarginate. Corolla yellowish(?) with purple veins 3 lines diameter, upper lip subovate obtuse; the lower lip sub-3-lobed spreading; spur ascending transversely obtuse; anthers large, suborbicular, purple; style short, stout; stigma linear, brown. Capsule globose, $\frac{1}{10}$in. diameter, very membranous, shining. Seed small, pale, oblong, shining, tips rounded, base narrower truncate, sides straight.

Obs. This little plant is allied to *U. subsimilis*, mihi* (also detected in similar situations in the interior Taupo country at a lower altitude), but differing in size, in form and colour of corolla, &c.; better specimens are, however, much wanted. I received from Mr. Hill a large number of specimens, but they were all more or less damaged through having been closely packed, as they were collected in little wet turfy tufts with other small plants. One character, however, was common to them all—that of size and height.

Class II. MONOCOTYLEDONS.

Order I. Orchideæ.

Genus 3. **Bolbophyllum**, Thouars.

1. *B. ichthyostomum*, sp. nov.

Plant small, epiphytal, prostrate, creeping, densely matted. Stems slender, 3in.–5in. long, tortuous, dry, whitish, longitudinally striate, emitting many thickish terete succulent white rootlets, their tips obtuse. Pseudo-bulbs on upper side of stems $\frac{1}{3}$in.–$\frac{1}{2}$in. apart, sessile, ovoid, $\frac{1}{6}$in. long and subglobular, $\frac{1}{10}$in. diameter, wrinkled, glabrous, shining, pale-green. Leaves, 1 to each bulb at top, with a narrow circular sheath at base, oblong and oblong-ovate (sometimes oblong-lanceolate), tip obtuse, sometimes slightly retuse, $1\frac{1}{2}$–2 lines long, deeply sulcate, thickish, slightly recurved, minutely and regularly rough-dotted-hairy above, and with minute microscopical circular dots below, obsoletely parallel-nerved, 3 nerves on each side of midrib visible between the eye and light; margins closely ciliolate with coarse, stiff, patent, obtuse hairs, petiolate; petioles short, $\frac{1}{20}$in. long, stout, glabrous. Flowers very small, few, solitary, scattered, white; peduncle arising from under bulb, stout, erect, 2 lines long, with a simple sheathing scarious bract near the top; perianth (*post*

* Trans. N.Z. Inst., vol. xvi., p. 334.

anthesin) adhering to tip of upper valve of ovary (marcescent), expanded about 1 line diameter; sepals and petals ovate-deltoid obtuse, silvery-shining, very membranous; ovary large, subobovoid, gibbous, 2 lines long, yellow, thickly glandular-echinate (as, also, top of peduncle above bract), bivalved; valves gaping, but not to base largely concave, dissimilar, broad, $\frac{1}{10}$in. diameter, obtuse; margins undulate uneven, thickened; the upper and larger valve with 2 lateral nerves; the lower 1 central one. Seeds very minute, subfusiform, thin, white, scarious.

Hab. On trunks of trees, forest near Kumeroa, River Manawatu, County of Waipawa; May, 1893: *Mr. H. Hill.*

Obs. I. This interesting little plant is allied to *B. pygmæum*, Lind., which *primâ facie* it closely resembles, differing largely, however, on close examination, particularly in its glandular-echinate ovary and leaf. It is also a still smaller species. The ripe capsule gaping so curiously at its sutures, somewhat resembling the open mouth of a fish, is the cause of its specific name.

II. Although I received a large patch, or mat, of the plant (about 4in.–5in. each way), I only detected 6–7 pale-yellow capsules, all alike in size and form, and broadly gaping, and each bearing its minute withered flower, the plant being long past flowering, so that all allowance must be made for the imperfect description of the perianth. The microscopic seeds were also plentifully shed, scattered like dust over the neighbouring plants. Perfect flowers are much desired.

Art. XXXIV.—*A List of* Fungi *recently collected in the Bush District, County of Waipawa; being a Further Contribution to the Indigenous Flora of New Zealand.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 9th October, 1893.*]

Again, in January last, I despatched to the Director of the Royal Botanic Gardens, Kew, London, another lot of *Fungi* that I had gathered at various times during the preceding winter and spring in the forest country near to Dannevirke. This parcel contained 175 separate packets. I have lately received from Kew the list of the same examined and named, from which it appears that several of them were fresh duplicates of specimens formerly sent; others were in triplicate (some of them being perennial, and, being also in different stages of growth, presented various forms and appearances);

while not a few, obtained in winter, were merely in a state of mycelium, and others imperfect or sterile, of which better specimens are wanted. Those that have been determined and are new to our New Zealand flora are here given (some of them I know belong to the Australian and Tasmanian floras), and only one specimen out of the whole lot is a true *species nova*.

FUNGI.

§ I. FOREIGN FUNGI ALREADY DESCRIBED, BUT NOT BEFORE FOUND IN NEW ZEALAND.

Of Genera known to inhabit New Zealand.

Genus 1.* AGARICUS, *Linn.*

1. A. (Clitocybe) velutipes, *Fr.*
2. A. (Mycena) filipes, *Fr.*
3. A. (Pleurotus) mitis, *Fr.*
4. A. (Pleurotus) porrigens, *Fr.*
5. A. (Pleurotus) depluens, *Fr.*
6. A. (Pholiota) squarrosus, *Müll.*
7. A. (Flammula) inopus, *Fr.*
8. A. (Flammula) marginatus, *Fr.*
9. A. (Naucoria) sideroides, *Fr.*
10. A. (Tubaria) furfuraceus, *Fr.*

Genus 4. MARASMIUS, *Fries.*

1. M. insititius, *Fr.*

Genus 10.† POLYPORUS, *Fries.*

FOMES, *Fries.*

1. F. microporus, *Fr.*

POLYSTICTUS, *Fries.*

1. P. vulgaris, *Fr.*

Genus 12. FAVOLUS, *Fries.*

1. F. squamiger, *B.*

Genus 13. HYDNUM, *Linn.*

1. H. molluscum, *Fr.*

Genus 16. STEREUM, *Fries.*

1. S. spadiceum, *Fr.*

Genus 17. CORTICIUM, *Fries.*

1. C. sebaceum, *Fr.*
2. C. violaceo-lividum, *Fr.*
3. C. molle, *Fr.*
4. C. ceraceum, *Fr.*

* The numbers attached to the genera are those of the same in the "Handbook of the New Zealand Flora."

† This genus is now separated into four genera—*Polyporus*, *Fomes*, *Polystictus*, and *Poria*—but in Hooker's work all are included under *Polyporus*.

Genus 19. GUEPINIA, *Fries.*

1. G. flabellata, *Fr.*

Genus 30. LYCOPERDON, *Tournefort.*

1. L. colensoi, *C. and M.*

Genus 68. HYPOCREA, *Fries.*

1. H. carnea, *B. and C.*
2. H. sulphurella, *K. and C.*

* DACRYOMYCES, *Nees.*

1. D. stillatus, *Fr.*

LACHNEA, *Fries.*

1. L. scutellata, *Fr.*
2. L. erinacea, *Sw.*

LAMPRODERMA, *B.*

1. L. echinulata, *Rost.*

TRICHIA, *Hall.*

1. T. chrysosperma, *Rost.*

Of Genera new to New Zealand.

BADHAMIA, *Berk.*

1. B. hyalina, *Fr.*

AURICULARIA, *Bull.*

1. A. lobata, *Fr.*

TORULA, *Pers.*

1. T. velutina, *Preuss.*

§ II. SPECIES WHOLLY NEW TO SCIENCE.

HYMENOBOLUS.

1. H. atro-fuscus, *Masse, n. sp.*

And here I think I may again remark on the two striking facts further indicated by this list:—

1. The large number of *Fungi* here in New Zealand that are identical as to both genera and species with those of European and other countries; as shown also by the list originally published by Sir J. D. Hooker in his "Handbook of the New Zealand Flora," as well as in my former lists of *species novæ*, and of known species since detected in New Zealand, given in several of the later volumes of the "Transactions of the New Zealand Institute."†

2. The small number of truly indigenous (endemic) *species novæ*.

* This genus, with the three following ones, are not in Hooker's "Handbook of the New Zealand Flora," but are in Trans. N.Z. Inst., vols. xix., xxii., and xxiii.

† Trans. N.Z. Inst., vol. xvii., p. 266; and also vol. xix., p. 311.

At the same time I should state that nearly all that I have been able to collect during several years were obtained from almost the same localities repeatedly gleaned, comprised within a wooded area of, say, twenty miles, between Norsewood and Tahoraiti. My own belief, founded on practical experience, is that the number of *Fungi* will be yet greatly increased in years to come, while at the same time, I fear, many species (besides numerous others, *species novæ*, of the more graceful and symmetrical cryptogamic orders—*Musci*, *Hepaticæ*, and *Lichenes*) will become irrecoverably lost to science through the persistent clearing and destroying of the virgin forests, their peculiar habitats.

ART. XXXV.—*Notes, Remarks, and Reminiscences of Two Peculiar Introduced and Naturalised South American Plants.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 10th July, 1893.*]

> Extremes in Nature equal good produce;
> Extremes in man concur to general use.
> POPE: *Moral Essays.*
>
> —find
> A tale in everything.
> WORDSWORTH: *Simon Lee.*

1. The AMERICAN ALOE = *Agave americana*, Linn.

IN passing lately through the Town of Waipawa, my attention was drawn towards an American aloe that had flowered during the past summer in a garden there; the tall withered flowering-stem was still standing erect, and the parent plant had its usual large number of young ones (suckers, offshoots) nestling around it; but these, amounting to nearly twenty, presented the uncommon and peculiar appearance of all bearing flowering-stems about 3ft. high, each having many flowers (several dozen) similar in size, colour, disposition, and show to those of the parent plant. As I had never before noticed this phenomenon, and had frequently seen and closely watched several specimens of these plants in flower, in my own gardens and in those of others, both at the warmer climate of the north (Bay of Islands) and here in Napier, I have deemed this event worthy of recording. And as the real value of this huge and striking plant is, very likely, but little known—especially to our rising generation—perhaps, also, to some of my audience, who may have seen it after flowering, here in Napier, chopped up and cast out and carted away, a few words concerning its uses may not be out of place.

Its native home (as its specific name imports) is America; there in equinoctial America the plant is very common, from the plains even to 9,000ft. altitude, where it is useful as impenetrable hedges with its hard, big, and spiny leaves. In Mexico it has also been cultivated from time immemorial, under the names of *Maguey* or *Metl*, in order to obtain a kind of wine, called *pulque* by the Spaniards, made from the inner leaves just before its flowering-stem is developed. Humboldt has given a full account of its culture. The juice is said to be of a very agreeable sour taste; it easily ferments, on account of the mucilage and sugar it contains. This beverage, which somewhat resembles cider, has, however, an odour of putrid meat, extremely disagreeable. But the Europeans who have been able to get over the aversion which the fetid odour inspires prefer the *pulque* to every other liquor. A very intoxicating brandy is formed from the *pulque*, which is called *mexical*, or *aguardiente de maguey*. The Government drew from the *Agave* juice a nett revenue of £166,497 in three cities (*Royle*).*

Its fibre, and that of some allied species, especially the *Pita* (thread) plant, is extremely tough, and forms excellent cordage; this is separated by bruising and steeping in water and afterwards beating, and is obtained from the roots as well as the leaves. The ancient Mexicans also made their paper of *Agave* leaves laid in layers.† Its root is diuretic and anti-

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* "Before the Revolution, the duties on the *pulque* formed so important a branch of revenue that the cities of Mexico, Puebla, and Toluca alone paid $817,739 to Government."—(Humboldt: "Essai Politique," tom. ii., p. 47).

† "Their manuscripts were made of different materials—of cotton-cloth, or of skins nicely prepared; of a composition of silk and gum; but for the most part of a fine fabric from the leaves of the aloe (*Agave americana*), which grows luxuriantly over the tablelands of Mexico. A sort of paper was made from it resembling somewhat the Egyptian *papyrus*, which, when properly dressed and polished, is said to have been more soft and beautiful than parchment. Some of the specimens still existing exhibit their original freshness, and the paintings on them retain their brilliancy of colours."—(Prescott, Hist. Conquest of Mexico, b. i., ch. 4.)

Again, he says: "The miracle of nature was the great Mexican aloe, or *maguey*. As already noticed, its bruised leaves afforded a paste from which paper was manufactured; its juice was fermented into an intoxicating beverage (*pulque*), of which the natives to this day are excessively fond. Its leaves further supplied an impenetrable thatch for the more humble dwellings. Thread, of which coarse stuffs were made, and strong cords, were drawn from its tough and twisted fibres. Pins and needles were made of the thorns at the extremity of its leaves; and the root, when properly cooked, was converted into a palatable and nutritious food. The *Agave*, in short, was meat, drink, clothing, and writing materials for the Aztec. Surely never did nature enclose in so compact a form so many of the elements of human comfort and civilisation."—(*Loc. cit.*, ch. 5.)

syphilitic, and is even brought to Europe mixed with sarsaparilla. It is also stated by Long, in his "History of Jamaica," that the expressed juice of the leaves evaporated is useful as a substitute for soap; and Lindley says, "*Agave saponaria* is a powerful detergent: its roots are employed in Mexico as a substitute for soap." It was early introduced into Jamaica, Antigua, Dominica, and Cuba, and also into the countries bordering on the Mediterranean, where it is become very common.

I have known its thick fleshy juicy leaves to be successfully used for rheumatism, particularly lumbago: their rind taken off, and the large fresh wet slab rubbed on the parts affected. It seemed to possess a similar power on the skin to that of hartshorn or turpentine liniments. In one instance the fresh leaf was used (as above) with beneficial effects in lumbago here in my own house, by my manservant.

I remember, several years ago, the flowering of a plant in the Botanic Gardens at Kew caused some excitement, from the gardeners' fable respecting it—that "it flowered only once in a hundred years;" and from it being the *first* that had flowered in England; and, as it was under glass, a proportionately high turret had to be built up for its tall flowering-stem, which grew rapidly, and caused the turret to be several times enlarged to keep pace with it.

The plant, however, flourished well in the open air in the West of England, where I have seen several. I remember two old and very large plants in my maternal grandfather's gardens in Penzance (A.D. 1814–1819), but they had not flowered when I last saw them, and were shortly after dug up and destroyed, the ground being required for other purposes.

It was an interesting and unique sight to observe on a calm summer's evening, in my garden in the Bay of Islands, the large moths (*Protoparce distans*) in great numbers flying around the flowers of the *Agave americana*, extracting their honey with their long proboscces, as, the flowers being situated high up on their tall pole-like flowering-stem, the operations of the moths were seen to advantage against the clear sky; the plant itself also being an exotic, and its large flowers never before known to them, made it the more interesting. Moreover, what further served to increase the pleasure of observing this winged army of big moths diligently at work was their peculiar manner of carrying it on, never, like bees, and other smaller *Lepidoptera*, lighting on a flower, but while on the wing rapidly uncoiling their slender proboscces, and thrusting them deep into the *Agave* flowers, their wings at the same time quickly vibrating and causing a low humming noise that was not unpleasant.* I have watched them steadily for half an hour, and longer, and have never found one of them to light on the flower, or the plant itself, to rest.

2. The Prickly Pear = *Opuntia ficus-indica*, or Indian Fig.

This fleshy plant of the *Cactus* family, which produces the fruit known in the south of Europe as the Indian fig, has no connections with the fig-tree, nor has the fruit with the fig. Its origin is not Indian, but American; everything is erroneous and absurd in this common name. (Just as in the case with the former plant, *Agave*, which is no true aloe, neither does it belong to the same order with the aloes.) However, since Linneus took his botanical name from it = *Cactus ficus-indica*, afterwards connected with the genus *Opuntia*, it was necessary to retain the specific name to avoid changes which are a source of confusion, and to recall the popular denomination.

This plant is well known in Napier, as well as in other places in New Zealand, it having been early introduced (long before this country became a British colony). It does not, however, perfect its fruit here with us, although it does plentifully at the north (Bay of Islands, &c.), the climate there being warmer, and more suited to it.† My chief reason, however, for bringing it forward in this paper is to show the extraordinary uses made of it, and of other closely-allied species‡ in their native homes in South America; and that

* I had also often observed them dexterously performing the same kind of feat with the flowers of the common honeysuckle (*Lonicera periclymenum*, L.), only in this latter case the tube of the honeysuckle is much more slender. At such times, too, I should be quietly seated on a low chair, with the woodbine spreading thickly around me, while of my presence the moths seemed to take no notice, in their eagerness to collect their food.

† I may here give a little anecdote concerning the edible use of its fruit here in New Zealand. It was in the winter season of 1842 when the Antarctic Expedition ("Erebus" and "Terror"), under Sir James Ross, was at anchor (wintering) in the Bay of Islands. One fine day Dr. (now Sir J. D.) Hooker was on shore at Paihia, the Church Mission station, where Dr. Andrew Sinclair, R.N. (afterwards Colonial Secretary), was then residing, and I joined them. We soon concluded to go across to Waitangi (where the treaty had been signed), about a mile and a half distant, in my boat. On arriving there we strolled into the garden of the owner and late occupier (Mr. Busby), and there on its raised boundary were several large plants of the prickly pear, growing profusely and bearing much ripe fruit. Dr. Sinclair, who had been in South America, was delighted at the sight (fruit being scarce at that season in the Bay), and soon commenced gathering and eating the "figs," to our (or, at least, to *my*) great astonishment, as I had never seen them eaten before. I scarcely need add that we two speedily joined him.

‡ Upwards of forty species have been described, though with some botanists several of them are deemed to be merely varieties.

too as valuable forage-plants for both sheep and large cattle. And this use (as I take it) will be the more interesting to our sheep- and cattle-breeders here in Hawke's Bay and elsewhere when it is remembered by them what a prodigious outcry was raised some twenty-five years ago when the large and common thistle (*Cnicus* sp.), then lately introduced, was becoming exceedingly plentiful, causing some of our early settlers to view its rapidly overrunning the country with dismay, fearing the certain starvation of their flocks and herds. Our Provincial Council (of which I was a member) was literally besieged with urgent applications to pass immediate stringent laws for the suppression of "vicious thistles"; but, fortunately for Hawke's Bay, the majority in the said Provincial Council, after much debating, determined *not* to do so. And afterwards, in not a few instances, in times of drought, those very doomed and maligned thistles *saved their flocks.* All Provincial Councils in the colony, however, did not act so prudently, and therefore much of bitterness and grief and lawsuits, and consequent "costs," followed. In many places where the thistles once completely covered the ground there is not one now to be seen.

This plant (the *Opuntia*) existed both wild and cultivated in Mexico before the arrival of the Spaniards (A.D. 1518). Fernandez described nine varieties of it, which shows the antiquity of its cultivation. The famous cochineal insect feeds on one of them especially, and it has been transported with the plant to the Canary Islands and elsewhere. It was one of the first plants which the Spaniards introduced to the Old World, both in Europe and Asia ; and the plant soon became naturalised in the South of Europe and in Africa. In Spain it bore its American name of *tuna ;* while the Moors, who took it into Barbary when they were expelled from the peninsula, called it "fig of the Christians." The custom of using the plant for living fences,* and the nourishing property of the fruits, which contain a large proportion of sugar, have determined its extension round the Mediterannean. The fruit is very similar in its properties to that of currants, in some being refreshing and agreeable to the taste, in others mucilaginous and insipid. Many are valued as palliatives of intermittent and bilious fevers, in consequence of their refreshing sub-acid juice. The fruit of *O. tuna* is of the richest carmine, and forms a valuable pigment, employed at Naples as a water-colour.

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* Of *Opuntia tuna* it is recorded: "This kind of Indian fig makes strong living fences. When the Island of St. Christopher (West Indies) was to be divided between the English and the French three rows of the *tuna* were planted by common consent between the boundaries."—(*Sloane.*)

In this country, as in England, we scarcely know the Indian fig except as succulent ugly sprawling shrubs without leaves; but some species have leaves of an ordinary description, and when old the columnar species form wood of considerable strength. Humboldt speaks of a forest of such plants, not mere herbaceous species, but tall trees, with stems yielding wood suitable for domestic purposes. And Darwin states that in Central Chili "the cactuses, or, rather, *Opuntias*, were very numerous. I measured one," he says, "of a spherical figure, which, including the spines, was 6ft. 4in. in circumference. The height of the common branching kind is from 12ft. to 15ft., and the girth with spines of the branches between 3ft. and 4ft." ("Naturalist's Voyage"). Further on in his admirable book he says, "A species of large tree *Cactus* was one of the principal kinds of food of the great land-tortoise in the Gallapagos." His account of both—the huge reptile, and the plant, its food—is exceedingly interesting.

There is no reason for supposing that the modern *Opuntia* is described by Theophrastus, as the German botanist Sprengel asserted. The account given by the former writer, as far as we know, rather suits some tree like *Ficus religiosa*. Hot dry exposed places are the favourite homes of the Indian figs, for which they are naturally adapted in consequence of the imperfect evaporating pores of their skin, a circumstance which, as De Candolle has shown, accounts for the excessively succulent state of their tissue.

In some recent valuable publications by the Department of Agriculture of the United States Government, "On the Grasses and the Forage-plants for Cultivation in the South," I find several practical statements both important and curious respecting this plant and its allied species and their uses for forage, in letters and communications from extensive and practical cattle-breeders in several of the Southern States—viz., Texas, Mobile, New Mexico, and California—and, as they are also very extraordinary, I shall quote a few of them verbatim. These, however, are prefaced by some humane and able remarks from the Department of Agriculture, U.S., which I also extract:—

"A number of species of *Cactus*, mainly of the genus *Opuntia*, and commonly called nopal, or prickly pear, are used as food for cattle and sheep in the dry regions of Texas, and westward, where the ordinary forage-plants fail. In the natural state cattle do not often touch it, unless driven by hunger, except while the new growth is young and tender. Sheep eat it without preparation more readily than cattle, and for them the plants are sometimes merely cut down so as to be within reach. More often the herder passes along and clips off a portion of each flat joint, so that the sheep can enter their noses without coming in contact with the spines. For cattle it is customary to singe off the spines over a brisk blaze.

"Considering the extent to which these plants are eaten by stock, even in their natural state, it is remarkable that so few evil effects have been observed. A large majority of those who have mentioned their use state that no injurious results have come to their notice.

"A sufficient number of instances of injury are reported, however, to show that compelling stock to eat them unprepared is cruel, if not unprofitable, and to render it probable that the suffering and loss on this account have not been fully observed. A number of instances are reported of cattle having died from the accumulation of the spines in the mouth and stomach. The jaws and neck sometimes become swollen and inflamed from the presence of the spines. The tongue has been known to become so filled with them as to be rendered unfit for food. How this amount of injury can occur and not affect the growth of the animal it is difficult to see. The injury to sheep is mostly confined to the nose and lips, and is not considered very serious, 'as the needles soon fester and come out.'

"The succulent nature of the plant in the growing-season sometimes has too great a laxative effect, but if other fodder is fed with it this tendency is rather beneficial than otherwise. Notwithstanding these difficulties, however, the *Cactus*, when properly prepared, is a valuable fodder-plant, and is destined to come into more general use in the warm, arid parts of the country."—(*Bulletin*, No. 3, p. 50.)

J. A. Avent, Bexar County, Southern Texas :—

"I have been feeding prickly pear for thirty years. It is an excellent food for cattle if fed with fodder or hay of any kind. When not too full of sap it may be fed alone. There is nothing that cattle like better than prickly pear when accustomed to it. The old stumps, with a little corn, will fatten cattle very fast. We burn off the thorns in feeding it, but most stock-raisers do not. The apples ripen about the 1st July, and are eaten by almost everything. Hogs get fat enough upon them to render into lard when the crop is good, and it seldom fails."

A. J. Spencer, Uvalde, Texas :—

"It is eaten by cattle, sheep, goats, and hogs. They eat it mainly as found in the range, though sometimes the thorns are scorched off. It is considered one of the best native forage-plants. It is a partial substitute for water for all stock that eat it. The only injury I have known to result from eating it has been to sheep, and then only when eaten while frozen."

Professor George W. Curtis, College Station, Texas :—

"It is used quite extensively for cattle and sheep. The prickles are singed off, or the whole plant is boiled and fed mixed with bran.

"Has your attention been called to the use of the prickly pear as a lubricant?—Certain of the western railroads have used it with excellent results. It is gathered in Texas, shipped to Saint Louis, ground up coarsely, and pine tar added to keep the albuminoids from decomposition (I do not know whether anything else is added or not), after which it is barrelled and returned. The total cost is 2½ cents per pound, and it is said to do the work of 5 or 6 cents' worth of grease and rags formerly used. It is especially useful in preventing and cooling hot boxes. If this comes into general use it will open a new field of production."

Dr. A. E. Carothers, Cotulla, La Salle :—

"I have fed 400 beeves, and am now feeding 800 more on this food. From the analysis furnished by Mr. Richardson, of your [Government] department, I found that the *Cactus* was deficient in albuminoids, and, from the well-known richness of the cotton-seed oil-cakes in those elements, I selected it to supply the deficiency, which it did very well. . . . I feed per head about 60lb. of the *Cactus* and an average of about 6lb. of the meal per day for ninety days. A train-load of 330 head of these cattle sold last week in Chicago at 4½ cents. The meat is singularly juicy and tender, the fat well distributed among the muscles. I have sold it at 1 cent per pound gross over grass-cattle in San Antonio."

Edward Beaumont, Jemes, New Mexico :—

"The *Cactus* is not used here to any great extent, but it makes good food for horned cattle, especially cows. The thorns are scorched off over a blaze of brush or straw. When cattle get used to eating it they come running as soon as they see a smoke."

O. F. Wright, Temescal, San Bernadine County, California :—

"Many kinds of *Cactus* grow here. The flat kind, or prickly pear, is abundant in places. Cattle, goats, and sheep eat it sometimes without any preparation when very hungry; but it looks as though needles and pins would be a pleasanter and safer diet. I have never known, however, any bad results to come from eating it. After boiling to soften the thorns it makes good food for milch cows, and is much relished. The trouble of boiling prevents its extensive use."

I may also mention another introduced plant (a common British weed here in Napier) as being extensively used and valued as a forage-plant in some of those Southern States, and this relation will also, I think, surprise many of our settlers.

3. ERODIUM CICUTARIUM = *Alfilaria* (in America), Hemlock-leaved Heron's-bill (commonly called a Geranium).

This plant is one of the commonest of our British introduced weeds, being found everywhere, even in the streets and roads of Napier, and, being perennial and a quick grower, lining the kerbs and the bases of houses. No doubt it is well known.

It shows itself of very different sizes. Sometimes its leaves are only 2in. or so long, and sometimes 8in.–9in., but all alike; at first radiate and symmetrical from its root-stock, flat on the ground, it often presents a very neat and striking appearance.

In my own grass-paddocks and pathways it has long been very common; and at first, while I could not but admire its graceful form, I feared it would prove to be another unwelcome imported weed; but I have found horses to feed well on it, intermixed with grasses and clovers. So that from observation I have concluded that not only this but other foreign plants (commonly called "weeds" by us) are really of more service to stock generally than we are aware of, when growing together with grasses and clovers; and, indeed, are naturally better adapted to keep them in health than when fed on rye-grass and clovers alone. Notwithstanding, I was surprised to find this plant (*Erodium cicutarium*) so highly valued as a forage-plant in the Southern States of America. As before, I give a few quotations respecting it:—

"It occurs abundantly, and is of much value for pasture, over a large extent of territory in Northern California and adjoining regions. A few have begun its artificial propagation, and it is undoubtedly worthy of introduction into other regions in the south and west having prolonged droughts. — (*Loc. cit.*, p. 34.)

Professor E. W. Hilgard, in the report of the Department of Agriculture of California, says,—

"Two species of crane's-bill (*Erodium cicutarium* and *moschatum*) are even more common here than in Southern Europe, and the first-named is esteemed as one of the most important natural pasture-plants, being about the only green thing available to stock throughout the dry season, and eagerly cropped by them at all times. Its Spanish name of *Alfilerilla* (signifying a pin, and now frequently translated into 'pin-weed') shows that it is an old citizen, even if possibly a naturalised one."

O. F. Thornton, Phœnix, Maricopa County, Arizona :—

"It is not cultivated, but is rapidly spreading on the dry ranges—*i.e.*, valleys and mountain-sides—and is one of the very best wild grasses, either green or dry."

J. C. Tiffany, San Marcial, Socorro County, New Mexico :—

"There is very little in this county; what there is has been brought in the wool of sheep from California. It grows well in uplands or low, and is spreading rapidly. It is excellent feed—one of the very best. I am trying to get a large quantity of the seed to sow on my ranges. Can you inform me how it may be obtained? I would scatter it in localities over 20,000 acres if I could get the seed at a reasonable cost."

And now let us hear a few words from the opposite side—again exemplifying the wide difference between practical knowledge and theoretical fireside speculation :—

Dr. A. Gattinger, Nashville, Tenn. :—

"It is not known here, but I have seen it in Germany. It is a vile weed, and ought not to be introduced into cultivation. I cannot understand how such a thing can be seriously spoken of when so many really good native plants are totally ignored."—(*Loc. cit.*, p. 36.)

In conclusion, I would observe that I had several objects in view in writing this paper; particularly,—

1. To bring to notice the remarkable abnormal early flowering of the young offshoots of *Agave*.

2. To show the many great and beneficial uses made of that plant, and of another equally strange-looking one, by ancient as well as by modern races of men.

3. To call particular attention to the interesting and well-established fact of the ancient Mexicans having long cultivated several varieties of those two wild endemic plants (*Agave* and *Opuntia*), together with others, as banana and vanilla, as an additional reason for believing in the great antiquity of that nation; and so, *pari passu*, for reasonably concluding the same of the Maori people, from their having cultivated for ages many varieties of their flax (*Phormium*) and "sweet potatoes"—kumara (*Ipomœa chrysorhiza*).

4. To acquaint our sheep- and cattle-breeders (several being members of our society) how badly off for grass those of their calling are in those Southern States of America, and what very strange plants are consequently largely and successfully used by them for forage.

5. To place on record my (old) belief that not a few of those plants which we have long considered as mere weeds, and worthless, may yet become of great value for beneficial uses.

Art. XXXVI.—*On Four Notable Foreign Plants.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 9th October, 1893.*]

At our July meeting I had the honour of reading to you my paper on two peculiar yet useful foreign plants that are acclimatised with us here in New Zealand—viz., *Agave americana* and *Opuntia ficus-indica*. A chief reason for my bringing them to your notice (as I mentioned at the time) was their having been well known to and cultivated by the Aztecs, or ancient Mexican nation, long before their ruthless invasion by the Spaniards in 1519; and, in continuing my researches in that same direction, I found other noted plants that were also assiduously cultivated by that ill-used race, which have since become of the highest esteem among ourselves, and are commmonly used by us and by nearly all civilised peoples.

And here I may (*in limine*) call your attention to two matters respecting those useful plants that have been so very long in cultivation, or rather, perhaps, I should say, to the ancient races by whom they were cultivated.

1. That such kind or class of labour—that of the husbandman—is always a sure proof of the antiquity of the civilisation of the people successfully practising it; for, leaving out the so-called barbaric or Stone Age of man, nothing can be more certain than this: that the proper cultivation of food-crops, wherever found, with all their attendant and necessary labour, must have been handed down from olden times; *pari passu*, I may truly say, with that of building good houses, and vessels for navigation, and all the many useful arts, &c., of life. For such works are not attended to by savage peoples, who live on the wild uncultivated vegetables and fruits of the earth, the spontaneous production of nature, equally with the flesh of the wild animals common to their countries. Indeed, here in New Zealand we have notable instances of this in two races that *lived* near us—the Tasmanians and the Australians. (I am, I regret to say, obliged to speak of one of these distinct peoples, the Tasmanians, in the *past tense*, as not one of them now lives, though once numerous; and all destroyed by civilised "Christian" man! and that, too, during my own time.) Especially when we also consider with them the very superior position of the Maoris of this country, whose extensive root-

crops* were only annually raised and preserved through an immense amount of close attention and labour, and all done without the use of iron or any other metal. It is only when man has outgrown, or abandoned, the roaming, ever-changing life of a hunter, and has defined and settled his habitation, that he can become a real and loving cultivator of the soil.

2. That the beginnings of all such cultivation of food-crops, especially when the plants themselves are not indigenous to the countries in which they were anciently cultivated, is lost, far back in the night of history; hence, too, all particular mention of their introduction is always surrounded by marvellous legendary and mythical lore—a further proof, I may, I think, rightly consider of their high antiquity. And this is eminently seen in the ancient traditions among the Aztecs and other original American races, of how they first received some of their prized cultivated plants; in those also of the ancient Greeks respecting their first receiving wheat from Ceres, Isis, and Triptolemus; and those still more romantically mythical ones of the Maoris concerning their prized *kumara;* while those of the origins of their *taro* and *hue* and *aute* plants† are utterly unknown.

As on the former occasion (above mentioned by me), so now, two of the plants I purpose bringing before you this evening were cultivated by those ancient Mexicans; these are the *banana,* so well known here among us as an esteemed and wholesome article of food, and the *vanilla,* almost equally well known for its sweet scent and flavouring uses, though neither of them are grown in this colony. And I think I shall be able to give you some very interesting, if not astonishing, particulars respecting both plants.

1. Of the Banana, or Plantain (*Musa sapientium* et *M. paradisiaca,* Linn.; *Musa sapientium,* Br.).

This plant is peculiar in many respects:—

1. From having been found in both the Old and New World.

2. From its antiquity, being mentioned in our oldest books; as by Pliny, who relates it having been found by Alexander in his Indian expedition in the greatest abundance in the country of the Sydraci, and that it was remarkable for the size and sweetness of its fruit, upon which the sages‡ of India live.

* Cook says, "These plantations were of different extent, from 1 or 2 acres to 10; taken together, from 150 to 200 acres in cultivation in the whole bay"—Tolaga Bay—"though we never saw there an hundred people. Each lot was fenced in—so closely done that there was scarcely room for a mouse to creep between."—"Voyages," vol. ii., p. 313.

† Kumara = *Ipomœa chrysorhiza,* Forst.; taro = *Colocasia antiquorum,* Schott.; hue = *Cucurbita* sp.; aute = *Broussonetia papyrifera,* Vent.

‡ Gymnosophists or Brahmins.—Hist., lib. xii., cap. 12 (6).

Hence the botanical name of *Musa sapientium*. *Musa* (generic) is from the Arabic *mouz* or *mauwz*, which we find was given to it as early as the thirteenth century; the second specific name of *paradisiaca* comes from the ridiculous hypothesis which made the banana figure in the story of Adam and Eve. It is, however, a curious fact that the Hebrews and the ancient Egyptians did not know this Indian plant.

3. From its many varieties or sorts—upwards of sixty—all forming but a single species. The celebrated botanist De Candolle says: "There is an immense number of varieties of the banana in the south of Asia, both on the islands and on the continent. The cultivation of these varieties dates in India, in China, and in the Archipelago from an epoch impossible to realise. It even spread formerly into the islands of the Pacific, and to the west coast of Africa. Lastly, the varieties bore distinct names in the most separate Asiatic languages, such as Chinese, Sanskrit, and Malay. All this indicates great antiquity of culture, consequently a primitive existence in Asia, and a diffusion contemporary with, or even anterior to, that of the human races." Cook found it largely cultivated at Tahiti. The accurate and observing Parkinson (Sir Joseph Banks's botanical draughtsman), who was with Cook on his first voyage, says of it: "The well-known tropical fruit called plantains and bananas, of which there is a great variety in these islands; they reckon more than twenty sorts, which differ in shape and taste. Some of these are for eating raw, and others best boiled, and will serve instead of bread. They plant them in a rich soil, and take great pains in their cultivation. They call them *meiya*" (now *meia*). The celebrated Peruvian author Garcilasso de la Vega* says distinctly, "At the time of the Incas, maize, quinoa,† the potato, and bananas formed the staple food of the natives." He describes the *Musa* of the valleys in the Andes, distinguishing the rarer species with a small fruit and a sweet aromatic flavour (the *dominico*) from the common banana, or *arton*. The botanist Desvaux, in a remarkable work published in 1814, studied the specific question. He gives it as his opinion that all the bananas cultivated for their fruit are of the same species. In this species he distinguishes forty-four varieties, which he arranges in two groups—the large-fruited bananas (7in. to 15in. long) and the small-fruited bananas (1in. to 6in.), commonly called fig-bananas.‡ R.

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* Descendant of the Incas, who lived from 1530 to 1568. A copy of his scarce work is in our Institute library.

† *Quinoa*, a small, insignificant plant, a species of *Chenopodium* (*C. quinoa*, Willd.). The leaves are dressed as spinach, and the small seeds are still esteemed at Lima.

‡ To a wild fertile species found in Asia, Desvaux gave the name of *paradisiaca*.

Brown, in 1818, maintains the same as all belonging to one species, and so brought back Desvaux's second species (*M. paradisiaca*) to the one earlier-named one (*M. sapientium*).

We, however, here in New Zealand only know the banana as an imported dessert fruit, and, as such, scarcely ever in perfection as fully ripe, seeing what we receive from the tropical isles of the Pacific are always obliged to be sent to us in a green or unripe state; and, then, of its many varieties we obtain (I believe) but *one*. It is far more extensively used as a vegetable (as well as a fruit) in the countries where it is grown as an introduced plant, particularly in the West Indies, for instance, where, while unripe, it is said to be excellent boiled as a vegetable, or sliced and fried as fritters for breakfast. Roasted and flavoured with the juice of oranges, or lemons and sugar, and made into a kind of *compôte*, it is very choice; in some countries the fruit is dried, in which state it can be preserved for months, or, if spices and sugar are added, it is formed into a paste quite capable of keeping good for years. The mealier ones, by being oven- or sun-dried, and then pounded, can be readily converted into a nutritious flour, which contains not only starch, but protein, or flesh-forming material. Finally, the "merissa" beer, which is drunk in prodigious quantities all over the Upper Nile and Lake Country in Africa, is the fermented juice of the banana. Even the Mahdi has had to wink at its consumption; while a recent traveller doubts whether he ever saw so many tipsy people as in a certain district of Africa. The banana will even yield medicine, for the juice of the stem—the spongy pith of which is also highly nutritious—is a useful astringent and diaphoretic. Taken internally, the leaves are said to be valuable against dropsy, and are often used externally in scalds and ulcers. The stems are in Tonquin burned, and the ashes employed for purifying sugar; while all parts of the plant abound in a fibre which has never been systematically used except in small quantities. In Dacca the country people make from it the string of the bow with which they tease cotton; and in some of the Indian islands a cloth is woven from the banana-thread which is not much inferior to that made from the *abaca*, a kind of banana that yields the well-known Manila hemp; and the large fronds are employed not only for packing, and as plates for holding food, but in roofing native huts.

The banana, we learn from a United States official report, is so popular a fruit in that country that during August and September 78,000 tons were imported, while, on the other hand, its culture is extending with such rapidity that before long the entire home demand will be met by Florida, Mississippi, and other suitable areas of the Republic. It is, however, doubtful whether the warmest portions of the United

States will ever be able to compete with the West Indies in rearing a fruit which flourishes in such perfection all over Jamaica and the Antilles generally. Central Africa, too, is becoming one vast banana plantation. For miles and miles nothing else is seen; even the Indians of Central and South America have not taken more kindly to it. Captain Lugard describes the fruit as the national meat and drink.

In all these lands the plants grow with great ease, in spite of the fact that in many of them they receive the least amount of care. To set out a new plantation is the simplest of operations. The stems, formed by the base of the leaves, are annual, and usually die down after the exhaustive process of fruiting has been completed, new ones being produced from buds or suckers in the root-stock, which is perennial. It is by planting these buds that the banana is propagated, and fresh plantations made; and so exceedingly simple is this form of agriculture that the plant generally bears ripe fruit within ten months of the offsets being put into the ground. Emin Pasha tells us that, though the plantations in Africa are well kept, the only manure they receive is bunches of grass allowed to rot around the base of each plant.

In conclusion, I may briefly observe that I have often been struck with admiration when considering the banana-plant, and noticing (here in New Zealand) the great size and heavy weight of its bunch of fruit, not unfrequently from 40lb. to 50lb. (while in the West Indies such attains to even 70lb., and I have been credibly informed that in South America some sorts bear a bunch of fruit weighing over 100lb.)—this, too, growing high up on the single columnar reed-like stem of the plant, and projecting far from it in a drooping form when the fruit is formed. There is such a wonderful provision of nature to sustain such a heavy mass when extended hanging by its simple annual stem, coupled with the bounteous gift of such a wholesome, ever-plentiful, and easily-grown fruit to the natives of the tropics. I have sometimes compared (mentally) the banana, as to its fruit being that of an *annual* plant, and produced in large quantities, with that of the pumpkin, another annual, whose fruits are often of a large size and weight; but the fruits of the weak pumpkin-vines are supported on the ground, and the plant itself is only raised with much care and attention from seed annually sown.

While staying a few days last month in the bush (at Dannevirke), I saw an express-waggon bringing away from the railway-station a compact load of green bananas in large bunches, each bunch set upon its end in the conveyance, filling it, and coming along slowly. On inquiry, I found there were twenty bunches of bananas. It was a remarkable sight, there in that place so far inland.

Addendum.—In order to make my memoir the more complete I have endeavoured to get, from official sources, the amount in weight of bananas imported annually into this colony, but have failed, owing to no distinction having been made in the sorts of fruits imported, all being classed together, but only in the countries producing them. I may, however, give the following official amounts of fruits imported from two principal places within the tropics in the South Sea, which includes (at least) four kinds of fruits commonly used—viz., bananas, pine-apples, cocoanuts, and oranges—omitting the Australian Colonies:—

		Lb.	£
1891.	From Fiji	3,901,264	15,584
	From South Sea Islands ...	4,554,629	17,136
1892.	From Fiji	4,797,936	17,336
	From South Sea Islands ...	2,688,831	9,434

2. Of Vanilla planifolia, Andrews.

This plant—a species of orchid, anciently cultivated by the Aztecs (and, curiously enough, for one of the very same purposes for which it is now so extensively used all over the world —viz., to flavour their drinks, one of which was cocoa), is also an indigenous plant of Mexico, and is still cultivated by them. Vanilla was formerly confined to a very limited area, and being an orchid, and a dainty tropical product, was scarce, and long considered difficult of cultivation, but of late years, and through the practical application of scientific knowledge, its production has wonderfully increased, so that it has become a large and pretty general article of commerce.

Few, perhaps, of my audience this evening know much respecting this plant save in connection with ice-creams and superior chocolate. The scented vanilla of commerce is merely the seed-pod of the plant, and, seeing it is now so well known by name, and so commonly used, a few interesting items respecting it and its early history and introduction into Europe, and the triumph of science combined with skilled persevering labour in bringing it on to a proper consummation, may not be considered out of place.

There is an excellent paper on the early history of vanilla in Europe by Professor Morren, of the University of Liége, from which I take several quotations. Professor Morren was one of the first (if not the very first) who succeeded in obtaining ripe fruits from the vanilla in Europe. He says,—

"Having been fortunate enough to obtain two years since, and at two different times, an abundant crop of this interesting fruit, I believe I may assert that henceforth we may produce in Europe vanilla of as good a quality, if not better, as that which is exported from Mexico. . . . My experiments may afford the most convincing proof that in our own climate, but in our hothouses, the same circumstances of atmosphere as those which exist under a Mexican sky produce in the vanilla plant all the phenomena of a good and perfect maturation of the fruit. . . . The *Vanilla aromatica* of Swartz, introduced into Europe in 1739 by Miller, is not to be found at the present time in England. This species was long believed to be the true vanilla of commerce. But the *Vanilla planifolia* of Andrews* is the same plant which is generally cultivated on the Continent, and has produced at Liége an abundant crop of odorous and delicious fruit. This interesting species was at first cultivated in the Hon. Charles Greville's choice collection of plants at Paddington, near London, where it flowered for the first time; but then, no artificial fecundation having been performed, no fruit was produced. In 1812 this plant was carried from the gardens of Mr. Greville into those of Belgium, whence it was introduced at Antwerp. The plant grew rapidly there in the Botanic Garden, and slips were sent to all the towns in Belgium and France, but they very rarely flowered, and fruit was never obtained, so that this culture was despaired of. Nevertheless, in 1819 Dr. Sommé (the director of the Botanic Garden at Antwerp) sent two plants of vanilla to the curator at Brussels that he might send them to the Dutch colonies of Java, where it was said the plant might become valuable by its produce. The history of this migration of the vanilla-plant from America to the East Indies is too interesting not to be made known. Only one of the two roots stood the long passage from Belgium to the East Indies. There at Java, in the Botanic Garden, it prospered well, and flowered, but its flowers bore no fruit. The observations on the necessity of an artificial fecundation in the greater part of the orchideous plants were not known at that time; and I attribute the flowers of the vanilla not bearing fruit in the East Indies to the absence of the species of insect which nature has doubtless given to the climate of Mexico to effect there a fecundation which man alone, by a study of the organs, is able to perfect in other countries. It was long after—in 1836—that, by a peculiar horticultural treatment, we had at Liége, upon one vanilla plant, fifty-four flowers, which, having been fecundated by me, produced the same number of pods; and in 1837 a fresh crop of about a hundred pods was obtained upon another plant by the same methods; so that now there is not the least doubt of the complete success of this new cultivation.

"From the works of the illustrious Alexander von Humboldt we learn that the Mexicans were already in the habit of

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* *Repository*, vol. viii., pl. 538.

perfuming their chocolate when the Spaniards discovered this part of America. Chocolate was brought from Mexico into Europe in 1520, but it appears that vanilla was brought to the Continent as a perfume about the year 1510, at the same time as indigo, cochineal, and cacao itself—that is to say, ten years before the arrival of tobacco. . . . I find that the *Vanilla planifolia* is as common in the gardens of the British Islands as in those of the Continent; but the complaint there generally is that it very rarely flowers. . . . The vanilla-plant in order to flower should be at least five or six years old. The older and larger it is, and the more branches it has, the better and more abundantly it will flower. . . . The culture consists in twining the long branches, cutting, and burning them at their extremity with a hot iron; everything that contributes to stop the sap serves to bring it into a flowering state. . . . The flower of vanilla has this peculiarity: that the *retinaculum* is highly developed, so that this organ forms a curtain suspended before and above the stigmatic surface, thus separating it completely from the anther, which in its turn incloses in two cavities, naturally shut, the pulverulent masses of pollen. From this structure it results that all approximation of the sexes in this orchideous plant is naturally impossible. It is thus necessary either to raise the *velamen* or to cut it when the plant is to be fecundated, and to place in direct contact the pollen and the stigmatic surface. . . . The direct results of this memoir, therefore, go to prove that in all the intertropical colonies vanilla might be cultivated, and a great abundance of fruit obtained, by the process of artificial fecundation. . . . It is a subject which well deserves attention in a commercial point of view, and is, moreover, a proof of the importance of science in improving every branch of industry."

I have gone to some length in these extracts, because (as I shall be able to show you) much of what Professor Morren has so clearly stated, and almost foretold, has already come to pass.

Not very long ago some 5cwt. or 6cwt. was the total of vanilla imported into England from Mexico. At present the United States alone take about 136,000lb. from Mexico, and a proportionate amount from other sources. The Mexican form, we are told, still holds its own in the market, but several other varieties are now cultivated. Numerous other regions have of late years competed with Mexico for the custom of the vanilla buyer. The latest of these is our colony of Fiji, from which some choice samples have been sent to England. Java now harvests enough for the Dutch consumption, none of it being offered to the outside world; and Bourbon, from which in 1849 only 7lb. or 8lb. were exported, has now 3,000 acres under cultivation, and a crop which seldom falls below 200,000lb., while the quality has been so greatly improved by careful cultivation and preparation that Mexico is beginning to feel uneasy. What is known in commerce as "inferior Bourbon" is actually the product of our colonies of Mauritius and the Seychelles. Brazil, Peru, and other parts of South America are also in the market with their vanillas, while the Pacific coast is well supplied from Tahiti and the Sandwich Islands; and, as the market does not appear to be glutted—the perfumer and the confectioner finding a use for all that is raised—it is likely that West Africa and all the West Indies will before long enter the field; for, notwithstanding that the *planifolia* of Mexico is still the best of the vanilla species, it is quite capable of being transplanted, and it is notorious that several of the other varieties are wonderfully improved by being grown a little less at haphazard than in their native woods. But every sky will not suit the vanilla orchid. The soil is of slight moment, since the plant, clinging for support to trees or to trellis-work, derives a large portion of its nourishment from aërial roots, as is the case with some of our indigenous epiphytal orchids, only these do not arise from the ground. The climate seems to be all-important, for the plant requires a mean temperature of between 75° and 80°, and a damp, steaming atmosphere. Its long, fleshy pods take some six months, or more, to arrive at perfection, and constitute the portion of the plant in which lie its peculiar virtues. A clearing is made in some damp part of the forest, a few trees being left to serve as supports for the vanilla-plants, which are then planted out in the shape of cuttings, and left to the kindly action of the equatorial sun. In three years they are ready for harvesting, and for thirty more will yield pods enough to pay for the gathering. Nor is much care required, except to aid the fertilisation of the flowers by artificial means. But in Mexico this is not needed, and the process of fertilisation (which in no orchid, as Darwin has taught us, can be effected by itself) is accomplished by means of native insects. Yet it is known from experience that even artificial fertilisation has to be performed with judicious care; for, were all the flowers to be fertilised, the result would be an overflowing crop one season, but almost certain death to the plants through exhaustion before another season arrived. Then comes the plucking, each pod being detached as it ripens, a crackling sound as it is passed between the fingers being the criterion as to its ripeness. After being dried in the sun the pods are slightly fermented, to develope their peculiar odour, and, in some places,—for the *modus operandi* differs in different countries,—rubbed over with oil before they are sent to market. Long experience is required, not so much for the cultivation of the vanilla as for preparing and assorting it for sale. The presence of the *givre*, or "frost," is regarded as the test of the best pods. The "frost" consists of needle-shaped crystals, which begin to form at the ends, and gradually spread in a white powder over the whole pod. This efflorescence is composed of the substance known as "vanillin," and to it the peculiar fragrance of the pods is due. Vanillin is, however, not confined to the orchid from which it derives its name. Considerable quantities of it have been extracted from Siam benzoin and raw sugar, from the sapwood of fir trees, from the oil of cloves, and, of all sources, from assafœtida! Ices flavoured with vanilla have not infrequently been found to be poisonous. It is, nevertheless, affirmed that the vanilla has no evil effect on the human system, as much as 15gr. having been swallowed without the patient suffering. On the contrary, it is an aromatic stimulant, exhilarating the mental powers and increasing greatly the energy of the animal system. It is depressing to think that, just when this fragrant orchid looks like becoming one of the good angels of the tropics, the German chemists are manufacturing vanilla artificially, though, happily, they are not likely ever to produce the exquisite balsam of the ripe pods, which is so seldom to be met with in Europe.

In fine, seeing that the vanilla was, at last, successfully cultivated in the hothouses in Liége and in other places in Europe, and is also become a new and an increasing article of commerce from our Polynesian neighbours—Fiji, Tahiti, and the Sandwich Islands—such may also, in years to come, be raised here in our Colony of New Zealand, at the more northern parts, and under glass. *Tempus revelat.*

3. Of the Edelweiss=*Leontopodium alpinum*, Cass., and its two New Zealand relations.

For my third plant I must take you to the Alps, to the mountains of Europe, particularly to those of Switzerland and Austria; and also to those nearer us—the Alps of the South Island, and our own Ruahine. From the small, very local, and peculiar herbaceous plants of the Swiss mountains I select the famed edelweiss (*Leontopodium alpinum*, Cass.), and this for at least three reasons:—

1. Because it is also considered to be a great and valuable rarity, and has become of late years an increasing article of commerce, so that laws have been obliged to be made by the Swiss and by the Austrian Governments, to prevent their little plant of world-wide celebrity becoming extinct.

2. Because the Swiss mountain flora is very peculiar, possessing more than 120 alpine plants not found anywhere else; these are believed to be involuntary migrants from the arctic

regions, survivors of the flora driven south before the advancing ice-sheet of the glacial period.

3. Because we have here in New Zealand on our mountains two closely-allied plants resembling the Swiss one, which are usually known as the New Zealand edelweiss—viz., *Gnaphalium* (*Helichrysum*) *colensoi*, and *Gnaphalium* (*Helichrysum*) *grandiceps*, both plants first described by Sir J. D. Hooker in his "Handbook of the Flora of New Zealand," the former of these two from Mount Hikurangi, near the East Cape, and also from the Ruahine Mountain-range, where I first met with it in 1845; and the latter from the Southern Alps, where it was first detected in several localities by Dr. Sinclair, by Professor Von Haast, and by Dr. Hector. There is not much difference between them apparent, however, on close comparison and examination, and they strongly resemble their European relative.

Several years ago the Swiss cantons were obliged to pass a law prohibiting the common reckless collecting, and consequent rapid destruction, of their alpine plant *Leontopodium alpinum*, for the havoc among the patches of edelweiss had become so great that, in order to protect it from the ravages of climbing tourists, the Government of Valais was compelled, in 1887, to make enclosures for the undisturbed cultivation of the plant, and at the same time to issue an order that the edelweiss was no longer to be plucked. This was soon followed by Austria; and I find more recently that the Diet of Tyrol have been obliged to do the same. Here is a notice of it from a late London paper: "The Diet of the Tyrol last week passed a Bill imposing heavy fines upon persons found selling any samples of the beautiful but rare alpine flower called edelweiss, which has been pulled up by the roots on the mountains. A similar Act was passed seven years ago by the Diet of Salzburg, with a view to the preservation of the edelweiss plant, which is threatened with extinction in the Austrian Alps. In the Salzburg district the success of this legislation is not encouraging."*

Its destruction was one of the many unpleasant results of the alpine mania. The little plant, with its protective covering of woolly hair, is no doubt a curious and pretty one; but there are many more attractive flowers on the mountains. The edelweiss is, however, rather difficult to obtain, and, not being found much below an altitude of 5,000ft. or 6,000ft., the wearing of a sprig in the tourist's hat, after the guides' style, is supposed to infer a moderate acquaintance with the mountains a little way from the hotel-doors, if not some experience in that "climbing" which, for two or three months in the

* London *Standard*, 21st April, 1893.

year, forms the staple of conversation at the local *tables d'hôte*.

I remember reading some time back of a London *belle* (of whom it may be said she possessed "more money than wit") spending no less a sum than £300 in the making of a dress-cloak or mantle for her use at a grand ball completely overlaid with edelweiss.

I can show you specimens of the southern plant,—*Gnaphalium (Helichrysum) grandiceps*—and of the Swiss plant—*Leontopodium alpinum*—the true edelweiss; but for our northern (or Ruahine) plant I must refer you to the coloured drawing of it in Hooker's "Flora Novæ-Zelandiæ," made from my Ruahine specimen. I never met with this plant but once in all my visits to that mountain region, and that was on the edge of their western summits, at above 5,000ft. elevation. It was profusely growing on the outer edge of a steep cliffy fall of broken shingle, through which it was a difficult matter to force one's way up to it, as the small dry *débris* from the high cliff formed such a loose slope (or *talus*) on which there was no standing, and carried everything down before it. I often sought this plant on subsequent visits, but without success. Dr. Sinclair, however, detected it growing in a similar situation in the South Island, at "Tarndale Mountains, 5,000ft. altitude, in shingle"; and it is worthy of remark that in both Islands it keeps at about the same elevation as the allied Swiss plant.

Between the two genera of *Gnaphalium (Helichrysum)* and *Leontopodium* there is but very little difference. The small genus of *Leontopodium*, containing only three species, established by Brown, has been merged into *Gnaphalium* by both Hooker and Bentham.

4. Of the Rose of Jericho = *Anastatica hierochuntica*, Linn.

Another highly curious, little-known, and local plant, commonly known as "the rose of Jericho," and also "holy rose," I now bring to your notice. I have lately obtained the loan of a perfect plant of this singular vegetable for exhibition here, thinking it would prove as great a curiosity to you as it was to me, for, although I knew it from drawings and from description, I had never before seen a specimen. Strange to say, this plant is not only no rose, nor even distantly allied to that delightful flowering family, but is a species of the more common Cruciferous or *Brassica* order, to which our cabbage, turnip, radish, and watercress belong. It is, moreover, an annual very local in its *habitat*, growing wild in the sandy arid deserts of Egypt and of Syria, and on the coasts of the Red Sea, and is the only species of its genus;

and further it has only one other allied genus, *Morettia* (and this too, like that, containing only a single species), in the fifth tribe of the extensive order of Crucifers, or *Brassicaceæ.*

As this plant is a very great singularity, and famed for its strongly-marked hygrometrical properties, and as I have a specimen to show you, I may also tell you a little about it—both natural, and legendary and mythical.

1. *Natural.*—It is a small, annual, dwarf, shabby-looking plant, only a few inches high; it has one stout tap-root, and its stem, also stout, is short and very much dichotomously branched from the neck, and expanding while young; leaves small, oblong; flowers minute, white; pods also small, ventricose; seeds few. After flowering the leaves fall off, and the branches and branchlets become dry, hard, and woody, and are soon contracted into a globular form. In this state the little plant is easily withdrawn from the sand by the wind, hurried from place to place, and blown from the desert into the sea, or into any water, and as soon as it is wetted the branches relax and expand as if its life was renewed; the valves of the pod open, and the tiny seeds cast on the shores are scattered with the sand by the winds until they are settled, when they spring into life and take root. If this plant is taken up before it is withered, and kept entire in a dry room, it may be long preserved, and after being many years in this situation, if the root is placed in a glass of water a few hours, the buds of flowers will swell, open, and appear as if newly taken out of the ground, or it will recover its original form in the same manner if wholly immersed in water.

I may here mention that I have been sometimes reminded of this little natural globose vegetable ball, drifted about by the winds over the sandy deserts of Arabia, on seeing the globular heads of the female flowers of the large indigenous sea-side grass, *Spinifex hirsutus*, similarly blown about by the winds over the flat sandy shores of our own coasts in my old travelling-days. Indeed, there have been times—at low water, and the sandy flats dry, and wind fair (behind us)—when my Maori companions, carrying heavy loads, in order to relieve the tedium of their long journeys, would gather a few of those round, dry heads, and set them a-going before them, they keeping up a kind of short run after them. From this ancient Maori circumstance and juvenile custom, and the natural rolling of the ball before the winds when ripe and dry, they call those heads *turikakoa* = joyous, or nimble, knees.

The monks of Palestine gave it the name of "the rose of Jericho,"* and also "holy rose," and of it they make a little

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*From, I suppose, "Ecclesiasticus," xxiv., 14—"A rose plant in Jericho."

money. They dry it, and sell to travellers and pilgrims as possessing miraculous powers.

2. *Legendary and Mythical.*—Some superstitious tales are told of it, among which it is said "to have first bloomed on Christmas Eve, to salute the birth of the Redeemer, and also paid homage to His resurrection by remaining expanded till Easter."* The common people in Palestine believe that if you put this plant in water at the time when a woman first experiences the pains of childbirth it will expand at the precise moment when the infant is brought into the world. The plant is called *Kaf Maryam*, or *Mary's Flower*, in Palestine, because it is supposed that the flower opened at the instant Jesus was born.

We have in England many plants bearing similar names, connected with ancient legendary lore, or such may have been originally intended as reminiscences or *souvenirs* of holy things — as, lady's mantle, lady's tresses, lady's slipper, lady's bedstraw, lady's looking-glass, lady's comb, &c. Such colloquial names of plants abound in all European countries; and here, too, in New Zealand, the ancient Maoris called several plants, their flowers and fruits, after their old mythical personages, by way of commemoration.

Here, too, in conclusion, a remark by way of explanation may be made respecting the somewhat strange and long scientific name given by Linnæus to this little plant, which may also be termed a hard one, but yet (like many of the plants of the olden times, named by him and other thoughtful botanists) full of meaning. (1.) Its generic name, *Anastatica*, is from the Greek ἀνάστασις = rising again, resurrection, or, rather, revivication, and is highly suitable. (2.) Its specific name, being a compound of two Greek words, is more difficult, yet also proper, meaning (as I take it) audaciously, impudently, or shamefully, holy! carrying with it a kind of double rebuke — (*a*) at the poor little insignificant desert annual of no floral beauty being called a *rose*; and (*b*) at the further daring assumption of *holy* to that pleasing name of the queen of flowers.†

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* "Gardeners' Chronicle," 1842, p. 363.

† In our English botanical works I find this specific name differently spelled as to its termination: *hierochuntina*, Lindley and others; *hierochunta;* and by Mueller, in his recent "Index Perfectus," Linn., *hierochuntica*. This last I have here adopted.

III.—GEOLOGY.

Art. XXXVII.—*The Nelson Earthquake of the 12th of February, 1893.*

By George Hogben.

[Read before the Philosophical Institute of Canterbury, 5th July, 1893.]

Plate XLI.

The earthquake was felt more strongly at Nelson than anywhere else. Considerable damage was done in the town and neighbourhood, and it was estimated that the total loss would not fall far short of £4,000. Many chimneys were brought down, others were twisted out of position, and, according to the *Colonist* of the 13th February, over one hundred were injured. In several buildings ceilings and plaster were shaken down, and walls were cracked. The spire of the Cathedral was estimated by the City Surveyor to have been 3ft. out of plumb after the earthquake. Clocks were stopped, water overflowed in jugs north and south, a large amount of crockery and some statuary were broken in private houses and in shops, and in one or two instances plate-glass windows were broken. Careful observations of the direction with compass bearings seem to have been taken, and these appear to show that the chief line of movement was from south by west to north by east. In connection with this, we may note one fact recorded—viz., that the north wall of a massive stone malt-kiln was thrown away from the ends of the east and west walls, and from the floor of the upper story, to such an extent that the malt poured down upon the lower floor through the aperture caused.

The time given by the officers of the Post and Telegraph Department was 8.2 (checked by New Zealand Mean Time); another good observation was 8.1. I have therefore taken 8.1½ as the actual time of the beginning of the shock at Nelson.

The report of the *Colonist* newspaper, to which I am indebted for most of the above details, concludes that the shock was more severe than that of the 19th October, 1868: this is almost certainly correct—indeed, it is the most considerable earthquake felt in New Zealand since the 23rd January, 1855.

The effects noted at Wellington were well marked in character, but far less in degree of intensity than at Nelson. The most important from the point of view of the present investigation were the stopping of clocks, the ringing of bells, the cracking, and in some instances the fall, of plaster, the overthrow of movable objects, the cracking of some walls, and the fall of a few chimneys, probably already out of repair.

In the Post Office buildings pendulum-clocks at right angles to the line of shock (E. and W.) were stopped, and all the western walls where the plaster of the ceiling joins the wall were cracked, and chips of plaster deposited on the dado moulding. It is interesting to remark that the seismometer at the Museum showed a large displacement, and registered movements both from east to west and from north to south—that is, it showed both the longitudinal and transverse vibrations.

As will be seen from what follows, the velocity of propagation was much greater than the average velocity of New Zealand earthquakes; and this, coupled with the undoubted fact that the shock was a compound one, made the determination of the origin more than usually difficult. A small error in time is of far more importance with a large than with a small velocity; and when two shocks follow closely on one another, and one of them only is felt at many of the places, it becomes a matter of some difficulty to determine which shock it was that was observed at any particular place. There is, in addition, the usual amount of uncertainty as to whether the same phase of a long earthquake is referred to by different observers—all being asked to give the time of the beginning of the shock. The time put down for the apparent duration is of some service in resolving this uncertainty. Using this and the other means of checking the times given, I have set down the times at the first five places in the list (*a*) as of greater weight than the others. The times in this list and in the second list are stated to have been all checked by New Zealand Mean Time by the Telegraph officers, who filled up the forms supplied to them. The times in the third list (*c*) were not so verified.

Place.	Time of Beginning of Shock, N.Z. M.T.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale.
(*a*) Nelson ..	A.M. 8.2,* *or* 8.1	N.E. to S.W., *or* S. by W. to N. by E.	about 1 min.	For remarks see p. 347	viii. +
Wellington ..	8.3*	E. to W.	30 secs.	For remarks see p. 348	vii. +
Kaikoura ..	8.3*	N.E. to S.W.	15–20 secs.	"Moderately severe." Rumbling preceding. Crockery rattled	iv.
Opunake ..	8.4*	E. to W. N. to S. E. to W.	73 secs.	Very sharp: three shocks — sharpest for years. A few articles thrown from shelves	iv. to v.
Christchurch	8.4½*	E. to W.	more than 1 min.	Maximum between 8.5 and 8.5¼. Commenced with slight tremors; increased slowly to maximum; then decreased more rapidly. Crockery set in motion. One account says three distinct shocks	iv.
(*b*) Wanganui ..	8.5,* *or* 8.3*	N. to S., *or* S.W. to N.E.	90 secs., *or* 4 or 5 min.	"Severe." Broke battery-jar in officer's house. Water spilt out of washstand jugs. Mr. Field says began at 8.3 and lasted (gyratory motion) 4 or 5 minutes. Slackened and increased again three times. Began with slight rumble	v. (?)
Timaru ..	8.4½*	N. to S.	15–20 secs.	No previous rumbling. Succession of small shocks, with rolling movement. Followed by a slighter shock	ii. to iii.
Westport ..	8.3*	S.E. to N.W.	1 min.	"Severe." Loud rumble preceding	iii. +
Cambridge ..	8.2¾*	S.E. to N.W.	20 secs.	"Slight." No damage	iii.
Hawera ..	8.2*	N.W. to S.E.	80 secs.	"Severe." Milk spilt out of pans	iv. to v.
Helensville ..	8.4*	S.E. to N.W.	15 secs.	Slight, then sharp	iii.
Blenheim ..	8.5½*	E. to W. (n'rly) then heavy upheavals at right angles	50–60 secs.	Clocks stopped, bells rung, crockery thrown down; several chimneys thrown down, others cracked and twisted. Time given for middle of shock	vii. to viii.
Manaia ..	8.3*	N.E. to S.W.	90 secs.	"Severe"	iii. +
Otaki ..	8.2½*	N.E. to S.W.	20 secs.	"Severe." Clocks stopped. Preceded by loud rumbling ..	vi.
Marton ..	8.1*	N.E. to S.W.	35 secs.	"Sharp." Shook buildings; rattled crockery. Accompanied by loud rumbling	iv. +

Place.	Time of Beginning of Shock, N.Z. M.T.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale.
Greymouth ..	A.M. 8.1*	E. to W. S.E. to N.W. N. to S.	15 secs.	Three movements. No rumbling. Heavy undulating motion	iii. +
Hokitika ..	8.4*	N.E. to S.W.	50 secs.	"Slight, then severe." One long shock, not two as reported. Newspaper states two smart shocks, with interval of 2 mins.; second one lasted 45 secs.	iii. +
Ashburton ..	8.3*	N.E. to S.W.	ab't 10 secs.	"Sharp." Double shock	iii.
(*c*) Picton ..	8.2	N. to S.	40 secs.	One chimney thrown down; houses shaken violently ..	vii. +
Takaka ..	8.4	W. to E. (n'rly)	ab't 1 min.	Buildings swayed; crockery fell; milk spilt to eastward ..	vii.
Collingwood ..	8.0 (?)	W. to E., *or* from slightly N. of W.	70 secs.	"Sharp, followed immediately by severe." Clocks stopped. A number of bricks shaken out of top of chimney at E. side. One outside chimney shifted 2in. Preceded by slight rumbling. Cattle frightened	vii.
Karamea ..	8.0 (?)	N.W. to S.E.	ab't 100 secs.	Clocks stopped	vi.
Otira Gorge ..	8.3	E. to W.	..	..	iii. to iv.
Waitara ..	8.5	S.W. to N.E.	2 shocks 30 secs. each	Each shock very sharp, followed by rumbling. Water spilt. Lamp-glasses thrown off shelf; clocks stopped	vi. +
Auckland ..	7.55 (?)	S.E. to N.W.	15 secs.	Slight. Two shocks in quick succession. Windows rattled	iv.
Manukau Hds.	8.4 and 8.6	S.E. to N.W.	..	Two slight shocks, faint rumblings accompanying ..	iii.
Woodville ..	8.2	N. to S.	80 secs.	..	iii.
Reefton ..	8.3	..	..	"Sharp." Preceded and followed by tremors lasting ½ min. Some damage to crockery	iii. to vi.
Palmerston N.	8 (soon after)	..	10 secs.	"Smart"	iii.
Oamaru ..	..	..	..	Shock felt. No details	ii.
Kaipara ..	..	..	..	Shock felt. No details	ii.
Waikato Dist.	..	..	..	Shock felt. No details	ii.
Patea ..	..	..	..	Shock felt. No details	ii.
Hanmer Plains	..	..	..	Shock felt. No details	ii.
Rakaia ..	..	..	..	Shock felt. No details	ii.
Amberley ..	8.6	N.N.W.	some secs.	..	iii.
Malvern ..	8.10	..	..	Not severe. Preceded by long rumble	..
Akaroa ..	8.3	N. to S.	..	..	iii.

THE ORIGIN OF THE SHOCK OR SHOCKS.

To ascertain this I employed, as usual, the methods depending on the direction, time of beginning of shock, and intensity —the time-methods being, as a rule, by far the most reliable.

1. *By the Method of Directions.*—Drawing lines through all the places where the apparent direction was noted, we find that a circle with centre B and a radius of 10 miles can be drawn to cut or touch the direction-lines for Nelson (N.E. to S.W.), Wellington, Picton, Blenheim, Christchurch, Greymouth, Hokitika, Wanganui; and a circle with centre A and radius 26 miles would agree with these, and with Takaka, Westport, Karamea, Marton, Kaikoura, and nearly with Collingwood, Hawera, Opunake, Otaki. These form most of the places. We should therefore expect the epicentrum to be within or near the circle (B), and almost certainly within the larger circle (A).

(The direction-lines must be drawn in the direction noted for each place and at right angles thereto—to include cases where the direction of only the transverse vibrations is given. One of the two direction-lines will then be the direction of the line of propagation, unless there has been reflexion, or some other cause of deviation of the waves.)

2. *By Time-methods.*—(α) *Straight lines,* (β) *circles,* (γ) *co-ordinates.* (See Milne's "Earthquakes.")

(α) The method of *straight lines* is available when we have several pairs of places at which the shock was simultaneous; the epicentrum must be equally distant from each of the pair. I have used four such pairs: Wellington–Westport, Kaikoura–Wellington, Westport–Kaikoura, Opunake–Hokitika (an independent pair). All the positions given by the intersections of the equidistant lines are near together, and E_3, the mean position, would thus be the epicentrum. This corresponds to a velocity (superficial) of about 58 miles per minute. E_3 is near the circle (B) and within the larger circle (A).

(The limits of the velocity for E_3 are 46 miles and 61 miles per minute.)

(β) The method of *circles:* From the times at Opunake, Wellington, Christchurch, Hokitika, with an assumed velocity of 40 miles per minute, we get the epicentrum E_1. To suit this, the Nelson time should have been 8h. 1min. 8sec.; we can hardly allow it to have been quite so early, hence the velocity is probably too small (*i.e.*, if the other times are good). Using Wellington, Opunake, Christchurch, and Nelson (origin deep), with an assumed velocity of 55 miles per minute, we obtain E_2 for our epicentrum.

The point F is found from the times at Nelson, Wellington, Christchurch, Kaikoura, Opunake. The velocity of propagation assumed is 50 miles per minute, and this solution agrees also with Wanganui (8.4), and Westport (8.3) nearly, and is only $\frac{1}{4}$min. out for Picton (8.2).

(γ) The method of *co-ordinates:* The times in the list (a)—all verified by New Zealand Mean Time, and apparently good times, referring to the same phase of the same shock—were employed. Christchurch was taken as the origin of co-ordinates, the line Christchurch–Hokitika as the axis of y, and the axis of x at right angles (north-easterly).

The reduced equations are—

$$\begin{array}{ll} \text{Opunake}), & 544x + 196y + \frac{1}{4}u - \frac{1}{2}w = 83{,}588 \\ \text{Kaikoura}), & 186x - 8y + \frac{9}{4}u - \frac{3}{2}w = 8{,}665 \\ \text{Wellington}), & 384x - 16y + \frac{9}{4}u - \frac{3}{2}w = 36{,}928 \\ \text{Nelson}), & 300x + 110y + 9u - 3w = 25{,}525 \end{array}$$

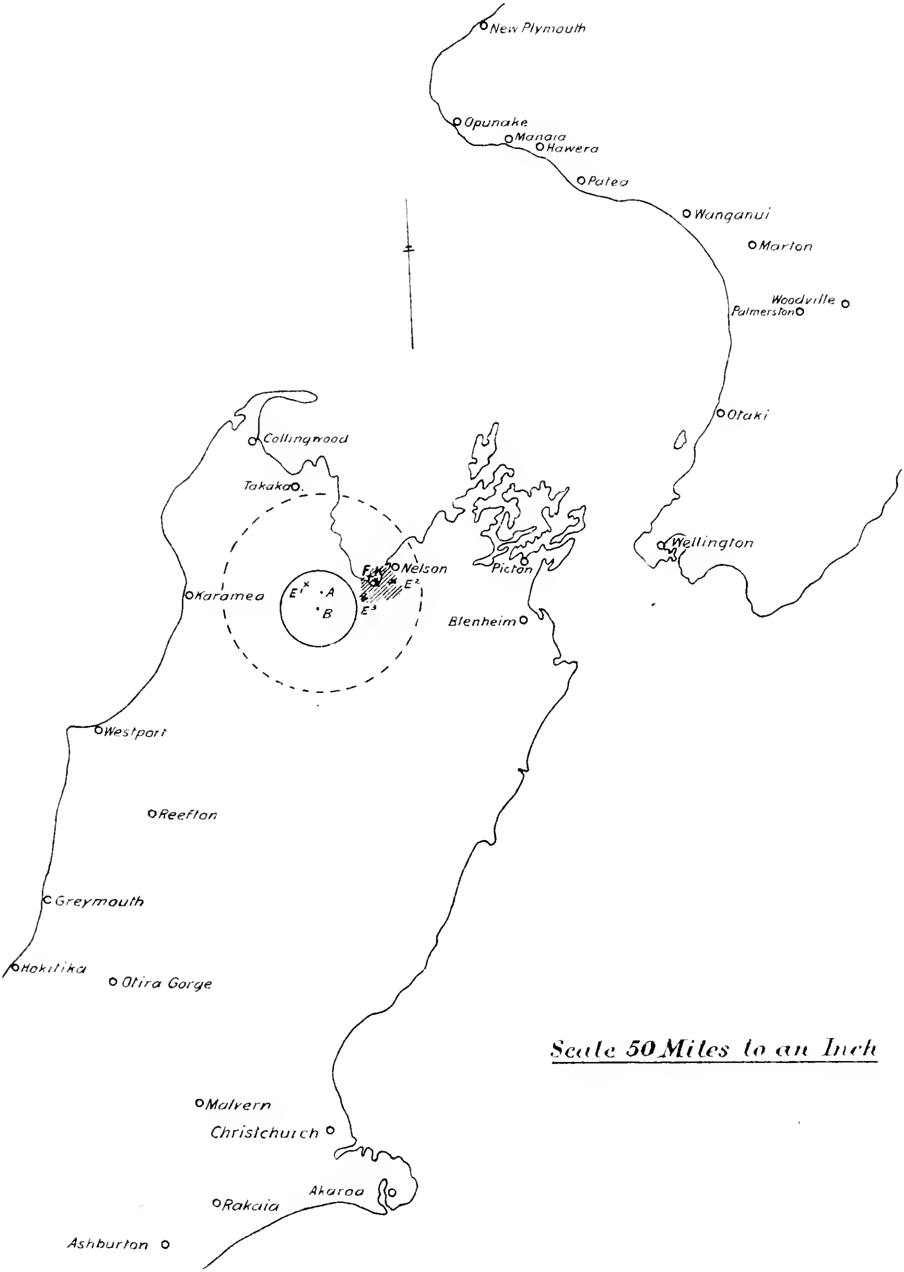
Hence $x = 145{\cdot}15$ miles, $y = 59{\cdot}6$ miles, $v = 49\frac{3}{4}$ miles per minute = 4,378ft. per second (velocity of propagation), and the time at the origin = 8h. 1min. 20sec. A.M. The point K near F, five miles and a half W.S.W. of Nelson, is the point thus found for the epicentrum. By trial we find that a depth of about 5 miles for the centrum best suits the data.

This agrees within the limits of errors of observation with Westport, and also with Wanganui, if we take the mean of the two observations (both by good observers).

The degree of agreement is shown by the time at the origin as calculated back from each place; it should be the same, of course, from whatever place we reckon.

—	Time at Place of Observation.	Time at Origin below K, in Minutes and Decimals.
Christchurch	8.4½	1·35min. past 8.
Kaikoura	8.3	1·32 "
Wellington	8.3	1·32 "
Nelson	8.1½	1·33 "
Opunake	8.4	1·33 "
Westport	8.3	1·21min. past 8.
Wanganui	8.4	1·20 "
Picton	8.2 (not checked)	0·88 "

The other places do not give a time at the origin agreeing with this; but the errors are all (or very nearly all) of one sign, and vary from $-$*1min.* to $-$ *3·96min.*, occurring in groups. Examination of the several groups leads us to suppose that there were several shocks, all nearly below K, the first deep, about 25 miles down, the second higher up, and the third about 5 miles below the surface. At some of the more distant



Nelson Earthquake of 12th Feby. 1893

F.H.T. lith.

places only the deep-seated shocks were felt. At Wanganui Mr. Field noted vibrations for 4 or 5 minutes with several distinct shocks (but possibly several maxima of the same shock). At Timaru the first shock, and a later one (about $1\frac{1}{2}$ or 2 minutes later), were observed. Of all these positions found for the epicentrum, E_2 best corresponds with the Nelson observations of direction; but it is possible that, if these observations were those of the transverse vibrations, K, or a place a little to the north of it, would agree equally with them.

It is, of course, most likely that the epicentrum would be an area large enough to include all the places, K, F, E_2, E_3 (epicentric area on map, Pl. XLI.). The amount of damage done at Nelson was greater—far greater—than that reported from any other place. It is probable, therefore, that the angle of emergence there was nearly that of the maximum intensity —*i.e.*, between 56° and 45°. This would agree with either K or E_2, with a depth of 5 miles for the origin.

The origin might be guessed at with a tolerable degree of probability by the use of isoseismals. Looking at the last column in the table given above, we see that the isoseismal of intensity, vii. on the Rossi-Forel scale, would be drawn outside Picton, Takaka, Collingwood, Wellington, Blenheim; but would have all the other places outside it. An ellipse might be so drawn with a focus not far from the epicentric area (K, F, E_3, E_2).

3. *Intensity.*—The maximum intensity of this earthquake was as far above the average of our ordinary mild New Zealand shocks as its velocity of propagation was. The intensity at Nelson was evidently viii. (Rossi-Forel scale), or a little above it.

If a = amplitude of the largest vibration in the motion of any earth-particle, and T = the period of the largest wave, then $\frac{4\pi^2 a}{T^2}$ = intensity of shock defined mechanically = destructive effect = maximum acceleration due to the impulse.

Now, Dr. Holden, Director of the Lick Observatory, has given equivalents of the degrees of earthquake-shocks on the Rossi-Forel scale in terms of the acceleration due to the velocity of the shock itself (American Journ. Sci., 1888, No. 210).

Thus a shock of intensity viii. corresponds to 500mm. per second. We should not probably be far wrong if we gave 600mm.–800mm. per second as the measure of the intensity of our present earthquake—or, in other words, from $\frac{1}{16}$ to $\frac{1}{12}$ of the acceleration due to gravity.

Summary.—The earthquake of the 12th February, 1893, originated below an area within 5 or 6 miles of Nelson, to the south and west. The principal shock took place at 1min. 20sec. past 8 a.m., or thereabouts, at a depth of 5 miles approximately. The velocity of propagation was 4,378ft. per second; the intensity of the shock, measured by the velocity of the earth-particle, about 2ft. per second, or rather more than viii. on the Rossi-Forel scale.

Theory suggested.—The principal shock was preceded by others at a much greater depth, and we may, if we please, imagine a succession of rock-falls (or slidings or crushings) to have taken place in the interior of that portion of the earth's crust underneath the epicentric area K, F, E_3, E_2.

Art. XXXVIII.—*On a New Plesiosaur from the Waipara River.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Plate XLII.

There is in the Canterbury Museum a remarkably fine specimen of a sauropterygian, which was collected by Mr. A. McKay in June, 1872,* from the Cretaceous rocks of Bobby's Creek, Waipara. It is mentioned by Sir James Hector in his descriptions of the fossil reptiles of New Zealand in the Wellington Museum, but no description or figure of the present specimen has as yet been published.

The skeleton is imbedded in a hard, grey, argillo-calcareous concretion, like all the others from the same locality. This portion of the concretion is nearly 6ft. long, and has been split longitudinally, showing the ventral aspect of the animal. Originally it was in several pieces, but they have been placed together and set in plaster. As at present seen, the head and neck are absent. The pectoral arch is represented by the coracoids—that of the right side being nearly perfect—and a fragment of the right scapula. The proximal half of the right humerus is also seen. Between the coracoids, and stretching out behind them, is a series of eleven dorso-lumbar vertebræ with only their hæmal surfaces exposed. On either side, lying almost in their original positions, are some abdominal ribs—eight on the right and ten on the left side—four of which on

* Geol. Canterbury and Westland, p. 169.

the left side have been turned round so as to expose their inner surfaces. Portions of four pectoral ribs are seen near the right coracoid. Behind these vertebræ are the pubes and ischia, which have been but little displaced. Those on the left side are nearly perfect, but those on the right side have lost their outer margins. Behind the pelvic arch is the tail, the fourteen vertebræ of which have been split longitudinally in section, so that no surface is seen. Anteriorly these vertebræ present an indistinct mass, but the last seven on the slab show distinct outlines. Here the specimen ends abruptly, but it is evident that the tail must have been continued much further, as it tapers but little. The transverse breadth of the last vertebral centrum is 55mm., while the largest lumbar centrum has a transverse breadth of only 65mm. These caudal vertebræ, being in section, show that the articular surfaces of the centra are more deeply concave than in most of the plesiosaurs; and the same can be ascertained for the trunk vertebræ by removing a portion of two of the centra.

In the abdominal region, just in front of the pubes, there are a number of rounded pebbles of quartz—about seventy-five can be seen—varying in size up to 20mm. in diameter. As similar pebbles are not found elsewhere in the rock containing the saurian remains, it is evident that these have been swallowed by the animal, probably to adjust the specific gravity of its body with that of the water.

The total length of the specimen is 5ft. 2½in., of which the tail occupies 1ft. 8in. The distance from the post-axial margin of the coracoid to the pre-axial margin of the pubis is 1ft. 8in., and the greatest antero-posterior length of the pelvic arch, from the pre-axial margin of the pubis to the post-axial margin of the ischium, is 1ft. 1in. The animal was about the size of *Plesiosaurus australis*, to which it was referred by Sir Julius von Haast; but Sir James Hector pointed out that it does not agree with that species either in the shape of the ribs or in the form of the vertebral centra, and he considers that "it must have been a very different animal."* The pelvic bones also differ much from those figured by Sir James Hector. In the distinctly but moderately cupped articular surfaces of the vertebral centra this specimen resembles *P. crassicostatus* and *P. hoodii* alone of the described New Zealand sauropterygians; but in both those species there is a tubercle in the centre of the cup, which does not appear here, and they both have the centra proportionately shorter than in the present specimen. The proportions of length to breadth of the vertebral centra resemble those of *P. mackayi* and

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* "On the Fossil Reptilia of New Zealand," Trans. N.Z. Inst., vol. vi., p. 341.

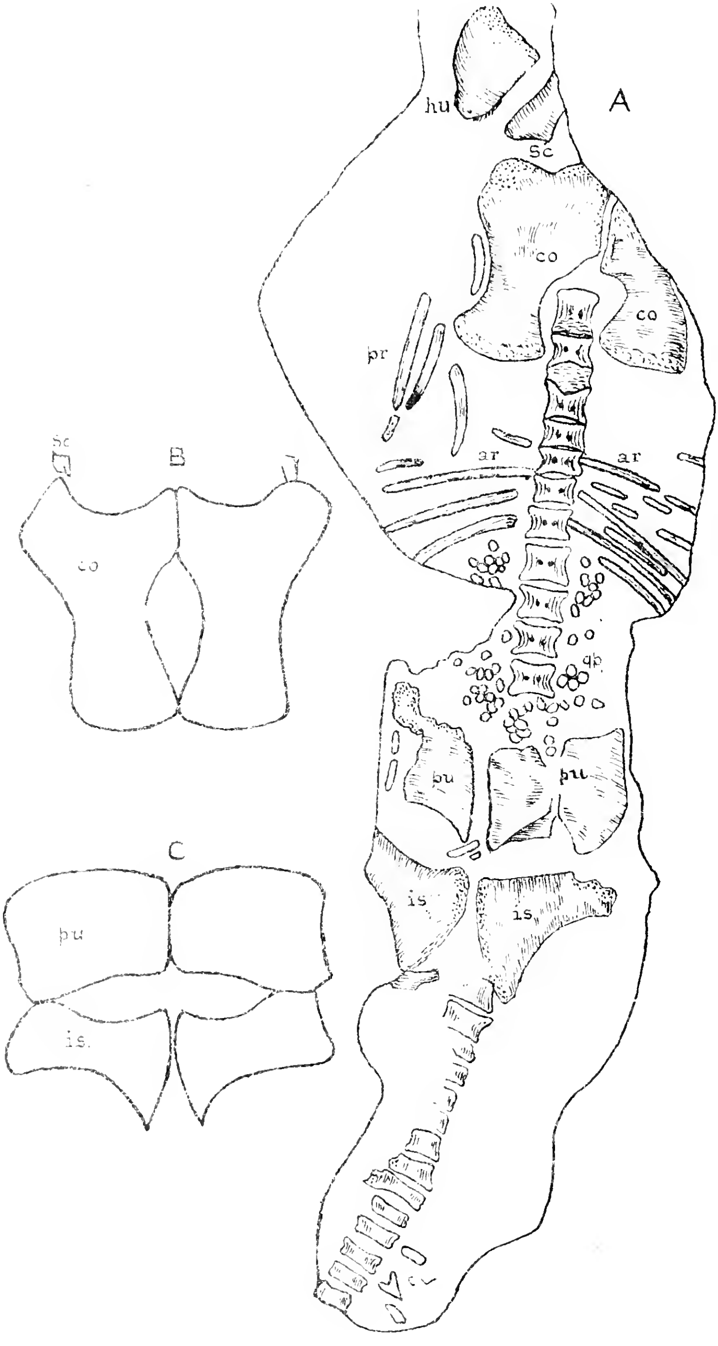
Mauisaurus haastii; but both of these have the articular surfaces flat, while in *P. mackayi* they are said by Sir James Hector to be "quadrate, not circular,"* which is quite different from the present specimen. Lastly, *M. haastii* has a very different coracoid and humerus, while *M. latibrachialis* is only known by its humerus, which appears to differ much from our animal. It is therefore necessary to make a distinct species of the present specimen, and I have given it the name of *caudalis*, in allusion to its long and powerful tail. Mr. R. Lydekker has referred all the New Zealand Cretaceous sauropterygians with which he is acquainted to Leidy's genus *Cimoliosaurus*,† because the vertebræ seem to resemble closely those of *C. constrictus* and *C. planus*. *Cimoliosaurus* is also a genus which ranges from Middle Jurassic to Upper Cretaceous, while *Plesiosaurus*, as now restricted, is found in Europe only in the Rhætic and Lower Jurassic. The principal generic character of *Cimoliosaurus* is the shape of the scapula, and, although this is not yet known in any of the New Zealand species, I think it most prudent, for the present, to follow Mr. Lydekker, and I therefore call this saurian *Cimoliosaurus caudalis*.

Description.

Vertebræ.—The neck is entirely missing. A row of eleven dorso-lumbar vertebræ exhibit their ventral sides only; the transverse processes, zygapophyses, and neural arches being buried in the matrix. However, a fragment can be removed which enables the centrum of the eighth of the series to be accurately measured. These measurements are as follows: Antero-posterior length, 48mm. (1·9in.); length at middle of cups, 39mm. (1·5in.); transverse breadth of articulating surface, 65mm. (2·6in.); height of articulating surface to bottom of neural canal, 55mm. (2·2in.). The transverse breadth at the middle of the centrum is 56mm. (2·2in.). There are two pairs of venous foramina on the ventral surface of each vertebra. The outer pair, which are the larger, are about 33mm. or 34mm. apart, and the inner about 20mm. apart. They are not situated in any cavity, nor are they bounded by any mark, but the ventral surface of the vertebræ is smooth and rounded. The tail probably exceeded the body in length. As at present displayed there appear to be fourteen vertebræ, but it is only the last seven which can be accurately measured. Of these the antero-posterior length is 34mm. in the most anterior, and 28mm. in the most posterior; while the length at the centre of the cups is 25mm. and 22mm. respectively. The transverse diameter of the articular surface is 61mm. in the most anterior

* *Loc. cit.*, p. 345.

† Catalogue of the Fossil Reptilia in the British Museum, vol. ii.



Cimoliosaurus caudalis.

and 55mm. in the most posterior. The cups are simply concave, without any flattening or tubercle in the middle. The chevron bones were not anchylosed to the centra. One of these (Pl. XLII., fig. A, *c.v.*), lying on the surface alongside the vertebra which is the last but two in the series, is 40mm. in length, and the two limbs are 28mm. apart at their ends. Two others are seen lying on their sides, each being 43mm. in length and 14mm. in breadth. As the ventral surfaces of all the caudal vertebræ are missing, it is impossible to say whether these chevron bones were or were not attached to the centra by longitudinal ridges.

Ribs.—The shafts of four displaced pectoral ribs (*p.r.*) are partially exposed on the right side of the animal at and just below the coracoid. They are thick and strong, and slightly compressed, their diameters being about 20mm. and 16mm. Several abdominal ribs (*a.r.*) show on each side, and these are but little displaced. They are more slender than the pectoral ribs, their diameter being only 13mm. The external surface is rounded and longitudinally striated, while the internal surface is flattened, and has a deep and broad longitudinal groove.

Pectoral Arch.—The coracoids (*co.*) are but slightly displaced, and the two still touch each other anteriorly. They are longer than broad, deeply notched in front, concave on the outer margin, and convex on the posterior margin. The inner margin is also apparently concave. I am aware that in the plesiosaurs the coracoids are often thin and broken in the middle, but that is not the case with this specimen. In it the inner margins are smooth and rounded, and that of each coracoid is symmetrical with that of the other, which could not be the case if they were broken. Consequently the coracoids must have been separated by a large fontanelle in the middle, and have touched anteriorly and posteriorly only, as represented in the diagram (Pl. XLII., fig. B). At the anterior symphysis the bone curves ventrally so as to make a longitudinal keel with its fellow. The inner anterior corner is broken, and we cannot say how far it projected forward, or whether it articulated with a pro-coracoid. The antero-posterior length of the coracoid is 10·5in. Its anterior breadth, from the posterior end of the glenoid cavity, is 6·5in., its posterior breadth is 5in., and the breadth in the middle is 2·5in. Only the post-axial extremity of the scapula remains, and it is too fragmentary to afford any reliable characters. The proximal end of the humerus is 2·5in. in diameter, and at a length of 3·5in. from the end it has expanded to a breadth of 4·5in. This end of the humerus is not well preserved, and it cannot be ascertained whether it bore any trochanterial ridges.

Pelvic Arch.—This is but slightly displaced, and better preserved than the pectoral arch. The *pubes* have been crushed notwithstanding that they are strong—about 8mm. in thickness, and with a thickened symphysial margin. The shape is somewhat quadrate, broader than long, slightly concave on its post-axial and slightly convex on its pre-axial margins; the shape of the external margin is doubtful. The antero-posterior length of the symphysis pubis is 5·5in., and the greatest transverse width of each bone is 7·5in. The *ischium* is strong, and thick in the centre. It is elongated transversely, with concave anterior and posterior margins. The posterior margin projects post-axially at its inner corner. Its antero-posterior length at the inner margin is 6·5in., and in the middle 2·5in. The greatest transverse width is 7·5in. I have attempted a restoration of these bones in Pl. XLII., fig. C.

No ilium is seen, nor any of the bones of the hind limb.

EXPLANATION OF PLATE XLII.

Fig. A. *Cimoliosaurus caudalis*, ventral aspect, reduced to $\frac{1}{10}$: *hu.*, humerus; *sc.*, scapula; *co.*, coracoid; *p.r.*, pectoral ribs; *a.r.*, abdominal ribs; *q.p.*, quartz pebbles; *pu.*, pubis; *is.*, ischium; *c.v.*, chevron bones. About one-tenth of natural size.

Fig. B. Restoration of coracoids.

Fig. C. Restoration of pubes and ischia.

Art. XXXIX.—*On* Conchothyra parasitica.

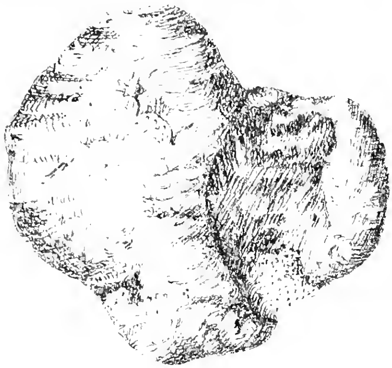
By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd August, 1893.*]

Plate XLIII.

Conchothyra parasitica is a fossil gasteropod mollusc highly characteristic of the reptilian beds at the Waipara River, but it has also been found at the Clarence River, at the Malvern Hills, at Broken River, and on the Canterbury Plains near the gorge of the Waimakariri River. It is from this last place that the figured specimens come.

The name appears first in the Catalogue of the Colonial Museum, Wellington, 1870 (p. 193), and again in Dr. Von Haast's report on the geology of the Waipara district, in



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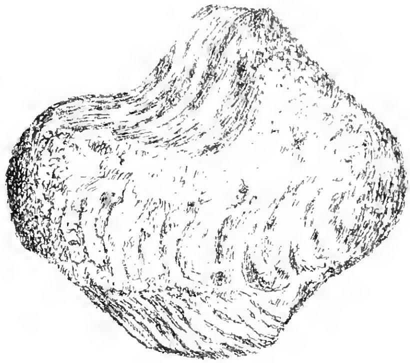

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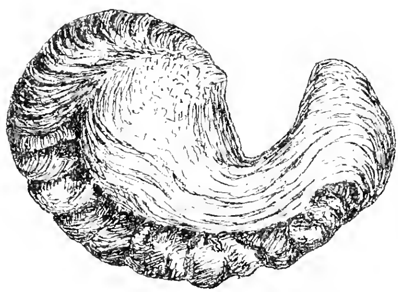

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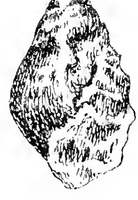

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Conchothyra parasitica

J.G.R. del. F.H.T. lith.

Reports of Geological Explorations, 1870–71, p. 10, as *Conchothyra parasitica*, McCoy. But, as no description of it has yet appeared—further than in a footnote by myself in the Reports of Geological Explorations, 1873–74, p. 35—I presume that it is a manuscript name sent by Sir F. McCoy to Sir J. von Haast. This omission I propose now to supply, with the help of some figures drawn for me by Miss Gordon Rich.

Genus CONCHOTHYRA.

Shell in the young fusiform, the spire acute and about one-third the length of the whole shell. The columella nearly straight. In the adult the shell is globose; the inner lip with a strong callosity which extends over the anterior end of the aperture, and, in old individuals, covers the whole shell. Columella curved to the right. Aperture rather narrow; the outer lip developed into a massive lobe, slightly notched above and below.

Perhaps identical with *Pugnellus*, Conrad, but differs in the adult in the columella being curved, and the anterior canal not being produced. Also, the incrustation is much thicker.

C. parasitica. Pl. XLIII., figs. 1–5.

Spire acute, of four whorls, shorter than the body whorl, apparently smooth. Incrustation smooth on the aperture, but rough with growth-lines on the exterior. Lobe of outer lip with nearly parallel sides, rounded at the end, and reaching nearly to the anterior end of the shell. Length, 47mm.; breadth, 50mm. Aperture—length 26mm., breadth 14mm.

EXPLANATION OF PLATE XLIII.

Conchothyra parasitica.

Fig. 1. Adult shell, natural size, ventral aspect.
Fig. 2. " " dorsal aspect.
Fig. 3. " " basal aspect.
Fig. 4. " " partly decorticated.
Fig. 5. Young shell (cast), natural size, ventral aspect.

Art. XL.—*Notes on the Geology of Kuaotunu Goldfield.*

By James Park, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 19th June, 1893.*]

It has often been asserted that the Hauraki Peninsula is a goldfield from one end to the other, and the numerous discoveries of the last few years would certainly seem to justify this conclusion. The wide gaps which at one time existed between the older-established goldfields are being gradually filled up, while the boundaries of all the fields are being continually extended.

Perhaps the most important find of late years was the discovery of payable gold at Kuaotunu, a little over three years ago. Since that date a large amount of money has been expended in the preliminary work of prospecting and opening the mines, erection of batteries, and other necessary works, and as a result this field has now taken its place as a steady gold-producer.

Kuaotunu is situated on the east-coast side of the peninsula, on the neck of the short peninsula lying between Mercury Bay and Whangapoua Harbour. It is connected with Coromandel by a bridle-track, and there is regular communication with Auckland by a steamer-service twice a week. The port suffers the disadvantage of being an open roadstead; and this is a difficulty which it will be very costly to remedy. The water-way has, nevertheless, been an inestimable boon to the place, and it is doubtful if without this it would have been able to survive the troubles which beset the early stages of its existence.

General Geological Features.

When first I examined this goldfield I was led, from the surface indications, to the belief that its geology would be found to present but little to distinguish it from the geology of the Thames, Coromandel, and other well-known goldfields in the Hauraki Peninsula. A detailed examination on a subsequent occasion showed that, including the Matarangi district, two distinct geological formations are represented on this goldfield. Both contain gold-bearing quartz veins. The younger formation consists of decomposed andesitic tuffs and breccias, which do not occur within the drainage-area of the Kuaotunu River, but are largely developed at Matarangi, whence they extend almost continuously to Coromandel to the west, and Mercury Bay and Makarau to the south.

At Kuaotunu proper the older rocks—of probably Palæozoic age—consist of an upper series of highly-indurated sandstones and greywackes, and a lower gold-bearing series of clay-shales, diabase-ash and breccia beds. The former occupy the low spurs and ridges which form the western boundary of the Kuaotunu basin, while the latter descend northwards from the sources of the river, and form the high bush-covered ranges on the east side of the river-valley.

CLASSIFICATION OF FORMATIONS.

Recent.—Sand-dunes, alluvial flats, and swamps.
Lower Tertiary.—Andesite tuffs and breccias.
Palæozoic.—(*a.*) Sandstones, greywackes, &c.
(*b.*) Clay-shales, diabase-ash and breccia beds.

Recent.

The sand-dunes extend along the coast from Maori Point to the mouth of the Kuaotunu River, a distance of over a mile. They seldom rise to a height exceeding 25ft. On their inland side they are bounded by a wide extent of low-lying flat and swamp land, which follows the course of the river for over a mile and a half. In places the swamp possesses a width of almost half a mile, but in general it is widest at the lower end of the valley, and gradually narrows in the upper part until it ends a little above the Try Fluke battery.

Lower Tertiary.—Andesite Tuffs.

When travelling from Coromandel to Kuaotunu this formation is first met with near the summit of the main range, on the slopes looking towards Whangapoua Harbour. From there it extends eastwards to Owera and Matarangi, near Kuaotunu. The tuffs decompose readily into yellow and yellowish-brown clays, but in general physical characters they are undoubtedly closely related to the gold-bearing tuffs at Coromandel and the Thames. Their finely-stratified appearance in places would tend to the belief that they were of pyroclastic origin, the materials of which they are composed having probably been derived from submarine or maritime volcanic eruptions of a widespread and violent character.

The coarse andesitic breccias which are everywhere associated with the finer tuffs consist of large angular and rounded masses of hornblende-andesite, enclosed in a matrix of grey or yellowish coloured ash or tuff-like material. No solid flows of andesite were observed in this district associated with the gold-bearing tuffs and breccias.

This district affords no evidence as to the age of these gold-bearing rocks. They rest unconformably on a highly-denuded surface of the Palæozoic sandstones and greywackes, while no elastic rocks of younger date are found overlying them.

The scarcity of evidence relating to the age of these tuffs is a noticeable feature of the geology of the Hauraki Peninsula, and this circumstance is solely due to the almost entire absence of members of the numerous fossiliferous formations which in other parts of New Zealand render the geological structure so varied, and very frequently so involved and complicated.

The only evidence bearing directly on the age of these rocks, so far as known at present, is found at Waitete, situated on the coast-line a few miles south of Cabbage Bay. Two years ago, when making a reconnaissance geological survey of that part of the coast, I discovered a small patch of the New Zealand brown-coal measures, occupying an area not many square chains in extent. They consisted of the following strata, reading the section downwards:—

1. Hard shelly limestone.
2. Calcareous and marly sandstones.
3. Ferruginous conglomerates.

The conglomerates were about 200ft. thick, and rested directly on the basement rocks, which at this point consisted of blue- and red-banded slaty shales. The shelly limestone, which was the highest and closing number of the series, dipped away to the north-east, and a few chains back from the beach disappeared below a great accumulation of volcanic tuffs, breccias, and solid lava-flows of an andesitic character. These rocks, so far as could be judged from physical characters and general appearance, were in every respect similar to the gold-bearing tuffs and associated rocks in other parts of the peninsula.

On a subsequent occasion I traced these tuffs and breccias without a break as far as Paparoa and Paul's Creek, and thence southwards to the Tokatea Range near Coromandel. Another circumstance which tends to prove their identity with the tuffs and andesites of the Thames and Coromandel is the discovery in them of gold-bearing veins of quartz in the neighbourhood of the limestone deposit.

The Palæozoic rocks on which the coal-measures rest are in several places in the vicinity of Waitete intruded by massive dykes of igneous rock. It is a noteworthy fact that I was unable to find, after a most careful examination, a single fragment of igneous rock included among the materials composing the conglomerates. This negative evidence is of great value as tending to prove that these igneous intrusions took place after the deposition of the Cretaceo-tertiary coal-beds. The whole of the stratigraphical evidence obtainable at Waitete points to the Post-eocene age of the Thames and Kuaotunu tuffs, which can be traced almost continuously to Coromandel on the west and Te Aroha on the south.

In connection with their economic importance, it is interesting to note that they are the youngest gold-bearing rocks in the Southern Hemisphere, being younger than the gold-bearing rocks of Otago, Reefton, and the different goldfields of Australia, by the whole of the Secondary epoch and the upper part of the Palæozoic. Even in composition and origin they stand unique, and their homologues are found only in two countries in the Northern Hemisphere—namely, Transylvania, in Hungary, and the Pacific States of America; and in these countries the similarity extends also to their gold and silver contents, which are frequently as refractory and difficult to treat as ours, while their free-milling bullion is alloyed with silver to the extent of about 30 per cent., as it is throughout the Hauraki Peninsula.

Palæozoic Rocks.

(*a.*) *Greywackes and Slaty Breccias.*—These rocks occupy the wooded spurs and ridges on the west side of the Kuaotunu River, and form the broken rocky headlands and islets between Kuaotunu and Matarangi, and the steep precipitous sea-cliffs north of the mouth of the river.

They consist of hard siliceous greenish and grey-coloured sandstones, interbedded with hard blue slaty breccias and occasional bands of slaty shale. They are always much jointed and shattered, and often streaked with thread-like veins of quartz or hæmatite. Up to the present time no vein containing payable gold has been found in them.

(*b.*) *Clay-shales, Diabase-ash and Breccia Beds.*—The clay-shales occupy the lower slopes of the spurs on the east side of the valley, and are well exposed in many of the road-cuttings. Their strike varies from north to north-east, and their dip is always, so far as can be made out, to the eastward. They are soft and crumbling, and form red, yellow, and brown clays. In many places on the spurs behind the township they contain large irregular segregated masses of grey chalcedonic quartz, often streaked or brecciated. On the range between Kuaotunu and Otama there are several very large deposits of this kind of quartz cropping out and forming conspicuous objects in the landscape.

At Otama and Opito the clay-shales are intruded by large masses or dykes of black hornblende-andesite, forming high isolated hills with rounded outlines and steep black sides.

Besides chalcedonic quartz, the clay-shales also contain veins or reefs of crystalline quartz which in many places have been proved to contain payable gold. Among these may be mentioned the Waitai, Otama, Maori Dream, and Black Jack Mines.

Immediately overlying the clay-shales come a series of diabase-ash and breccia beds. These are principally developed in the high, conspicuous, abruptly-ending ridge which lies between the two main branches of the Kuaotunu River. This ridge extends from the "Junction" at the Red Mercury battery to the sources of the river.

As seen in the low-level drives of the Red Mercury and Great Mercury Mines, these rocks consist of a series of greenish-grey diabase-ash and breccia beds, interstratified with smaller beds of a dark-grey slaty shale and slaty breccia. The ash and breccia beds decompose most readily into red and brown clays, and in the shallower parts of the mines their true nature cannot be determined. In the solid they are intensely hard and tough, and their presence has added greatly to the cost of the development of the reefs in the Red and Great Mercury Mines at the low levels. They are traversed by the Try Fluke, Red Mercury, and other parallel reefs, which follow their course and underlie.

These diabasic rocks are not found on any other part of the peninsula, and their presence here as gold-bearing strata may indicate a greater persistence of the reefs than has been the case in the other goldfields of the Hauraki district. The well-known Try Fluke reef, enclosed in these rocks, has been traced through the leases of the Kapai, Try Fluke, Carbine, Red Mercury, Great Mercury, and Irene. It possesses well-defined walls, and varies in width from 2ft. to 20ft. Its average width is probably about 6ft. Its course is N.N.E.–S.S.W., and its dip easterly at angles seldom under 60°, and more often over 65°. It has been proved to continue downwards in the deepest workings so far undertaken upon it.

The nature of the quartz varies in different parts of the lode. In some places it is hard, cavernous, and stained black and brown with manganese-oxides; in others it is mullocky, friable, and crumbling, and stained rusty-brown with iron-peroxide. At the outcrop, near the Red Mercury low-level drive, the lode-matter possesses a pure white colour, and occurs in peculiar tabular bundles made up of thin layers or laminæ of friable quartz, which look like pseudomorphs after some of the heavy earths.

The gold is alloyed with about 35 per cent. of silver, and it exists principally in an extremely finely-divided state. The patches of rich quartz which are so characteristic of the reefs at the Thames and Coromandel are not known in this reef or in any other reef in this district.

ART. XLI.—*On the Occurrence of some Rare Minerals in New Zealand.*

By JAMES PARK, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 23rd October, 1893.*]

AT the meeting of the Australasian Association for the Advancement of Science, held at Christchurch, in 1891, I read a paper describing a number of new and rare minerals found in New Zealand.* Since that date a number of other minerals have come under my notice, some of them new to this country, and some of them, although previously known here, yet interesting from the exceptional character of their occurrence.

CERVANTITE (Yellow Oxide of Antimony).

In the month of January, 1892, Mr. George Wilson, Inspector of Mines for the Hauraki Goldfields, forwarded a collection of ores from the antimony-lode at Waikari, in the Bay of Islands district, to the Thames School of Mines for examination, and the determination of their value. The principal ore in this collection was antimonite, the commonly-occurring grey sesquisulphide of antimony. In several specimens the sulphide was incrusted with a layer of the yellow oxide (SbO_4) several inches thick. Its hardness was about 5, and specific gravity 4, while its colour varied from yellowish-white to sulphur-yellow. The purest example contained 76 per cent. of antimony.

Cervantite is a most valuable ore of antimony, but is seldom found in large quantities. It generally results from the alteration of the sulphide, and is most frequently found at the outcrop, or shallower parts of antimony-lodes. It is well known at Hillgrove in New South Wales, Oporto in Portugal, and many other foreign localities; but so far as I can ascertain it has not been previously described from New Zealand.

SENARMONTITE (the Grey Oxide of Antimony).

This mineral was also identified in the collection from Waikari. It frequently accompanies antimonite, but is even less abundant than cervantite.

In the Colonial Museum and Laboratory report for 1892,

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* "Transactions Australasian Association for Advancement of Science," vol. iii., pp. 150–153.

Mr. Skey, the Government Analyst, describes a mixture of this mineral and stibnite from Waikari containing 78·9 per cent. of antimony.

Pyromorphite (Phosphate and Chloride of Lead).

A small specimen of this mineral was forwarded to me from the Champion Mine, Tui Creek, Te Aroha, towards the end of 1891. It occurred as an incrusting layer of small, irregular, yellowish-green crystals, on a yellowish-brown crypto-crystalline quartz, which is found associated with the galena-lode in that mine. It has not been identified in any other part of New Zealand.

Anglesite (Sulphate of Lead).

In 1889 I collected several examples of this mineral at the Champion Mine, Te Aroha, where it occurred in thin veins and small threads in the galena-lode, especially near the out-crop. Its colour was greyish-white, and it occurred in a massive form.

In a paper read before the Auckland Institute in October, 1885, Mr. J. A. Pond, F.C.S., stated that the ore-body cut in the low-level tunnel at the Surprise Mine, Te Aroha, was a sulphate of lead, containing a few enclosed grains of galena. This appears to be the first record of this mineral from this colony.

Cerussite (Carbonate of Lead).

During a visit to Te Aroha, in 1889, I collected this mineral at the Champion Mine, where it occurred in a quartz lode in large lenticular-shaped shoots. In the paper referred to above Mr. Pond described the lode in the Surprise Mine, which, near the surface, he stated was composed principally of carbonate of lead.

The lustre of the Tui Creek cerussite which I possess is vitreous or resinous, and the colour greyish-white to dark-brown. It occurs in a compact, granular or massive form, and crystals are rare.

The rocks at Te Aroha, in which the last three minerals are found, consist principally of indurated tuffs and ash-beds, with which are associated flows of solid hornblende-andesite and dacite.

Genthite (Hydrated Silicate of Nickel and Magnesia).

During the operation of clearing away a slip on the Tapu Road, in the month of September, 1891, the roadmen discovered a small vein of this rare and interesting mineral. I subsequently examined the locality, and found it situated about a mile south of Tapu. The vein was very irregular, and less than ½in. in thickness. The matrix was rusty-coloured quartz. The strike of the vein was N.N.E. to S.S.W., and it was contained in highly-decomposed brown-coloured tuffs, which are probably of pyroclastic origin, judging from the occurrence in them of a thin seam of coaly shale a few chains distant from this point.

MELANTERITE (Ferrous Sulphate).

This mineral results from the alteration of iron-pyrites. It is found in large quantities in many of the old workings in the Kurunui Hill and Old Caledonia Mine, where it occurs in thick layers incrusting the floors and sides of the drives, and as stalactitic masses which frequently reach to the floor, and thus block up the passages. The exposed surfaces are always invested with a layer of greyish-white ferrous sulphate, which occurs in the form of fine acicular filaments possessing a beautiful silky lustre. The solid mineral possesses a bluish-green colour and a coarsely crystalline structure.

This mineral is found in metal mines in all parts of the world, but its vast development at the Thames is of an exceptional character.

VIVIANITE (Hydrated Phosphate of Iron).

Early in 1892 Mr. James Macky, jun., manager of the Norfolk Battery, presented the School of Mines with a large specimen of this mineral from what was described as an extensive deposit which had been discovered during the operation of sinking a well on the property of Mr. Matthew Hunter, situated near Mercer Railway-station. This vivianite occurs in the earthy form. It is soft and friable, and possesses a deep-blue colour. It is a very pure variety, and contains about 26 per cent. of phosphoric acid. I have not been able to visit, and personally examine, this deposit, but, judging from the details supplied by Mr. Macky, it would appear to be by far the largest known in New Zealand.

Art. XLII.—*Tridymite-Trachyte of Lyttelton.*

By P. Marshall, M.A., B.Sc., Lecturer on Natural Science, Lincoln Agricultural College.

[*Read before the Philosophical Institute of Canterbury, 6th September, 1893.*]

Plates XLIV.-XLVIII.

The volcanic system of Banks Peninsula presents to geologists an exceedingly interesting if somewhat complicated problem. Since the earliest days of colonisation it has been the subject of elaborate investigations by the officers of the Geological Survey of Canterbury, but no one has done more able and lasting work in this district than the late Sir Julius von Haast, formerly Provincial Geologist of Canterbury.

According to this observer—and his views have been accepted throughout the colony—the peninsula is composed of the ejecta and lava of a few large volcanic foci, the boundaries of which were determined by him, and laid down in the official geological map of Canterbury. Of these vents, the one situated in the depression now known as Lyttelton Harbour was, according to him, the largest and most important.

The harbour itself is about eight miles long by two broad, and is too large, according to Sir J. von Haast, to have been at any time the actual crater of a volcano, and he accounted for its dimensions in the following way:—

A large volcano, perhaps several thousand feet higher than the remaining caldera walls, occupied the site of the harbour, its eruptions being spasmodic and explosive. Between each two eruptions the vent is supposed to have been more or less choked up by congealed lava and agglomeratic accumulations. As, owing to the gradual diminution of the volcanic forces, the eruptions became less frequent the agglomeratic matter accumulated to a greater extent between two successive eruptions, and this, reacting again, caused the intervals to be still longer but the eruptions more energetic. After a long period of quiescence he supposes that the crater resembled that of Vesuvius before the eruption of 1813—a rocky plain, over which small ash-cones were built up—and that, as in the case of Vesuvius, the gases and steam generated in the volcanic laboratory beneath at length reached such a bulk, and had so great a tension, that they were able to overcome the resistance of the superincumbent matter, and a terrific eruption took place, blowing out a large quantity of rock, and leaving the hollow that now forms Lyttelton Harbour. Although it may

Fig. 2

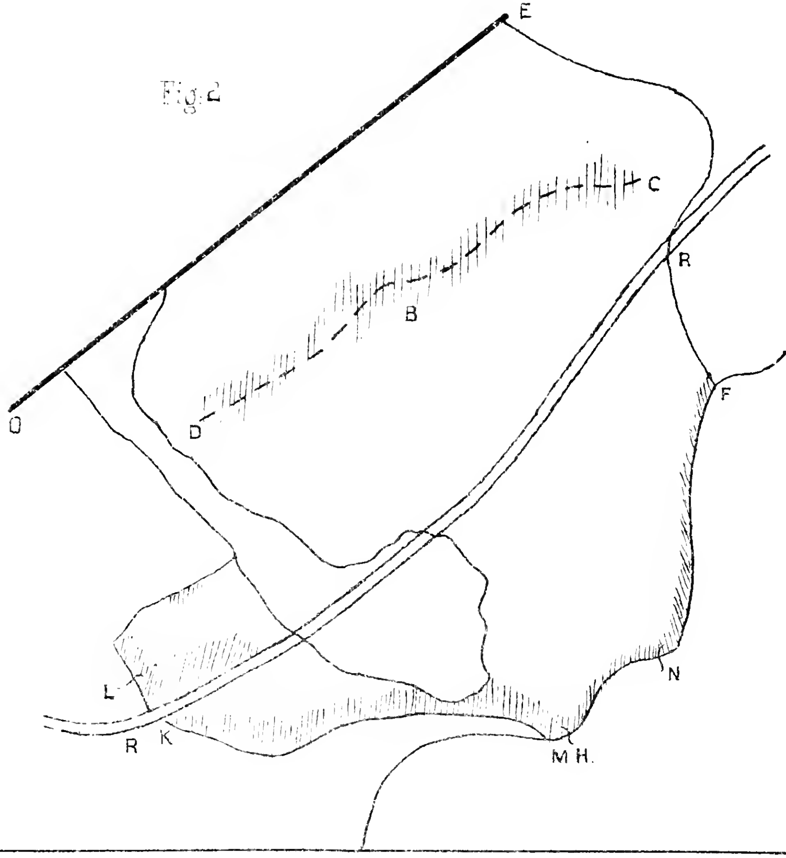
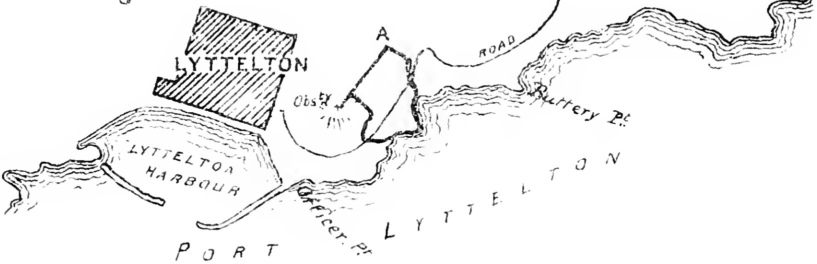


Fig. 1



To illustrate Mr P. Marshall's paper on
Tridymite Rocks.

F.H.T. del.

seem bold to invoke the aid of such a vast explosion, we must remember that even in recent times there have been cataclysms that have equalled in intensity and magnitude that required for the formation of Lyttelton Harbour. The force expended at the Krakatoa eruption was quite as great as that required by hypothesis in the present case. Even in New Zealand we have had an illustration of the immense power exerted by imprisoned steam in the destruction of the terraces at Rotomahana, where a gigantic chasm was formed almost as large as Lyttelton Harbour.

Since this great spasmodic effort two other eruptions or periods of activity have been witnessed in this system. The first resulted in the formation of Mount Herbert in the former caldera wall, where the lavas which flowed down the sides of this secondary vent interfere with the symmetrical appearance of the walls.

By the last eruption Quail Island was formed. This eruption is unimportant; it does not seem to have been attended by any explosive action, and to have attained to only extremely small dimensions.

As would be expected from the spasmodic character of the earlier eruptions, a large number of radiating cracks were torn open in the surrounding crater-walls, and into these the magma was injected, giving rise to a well-defined system of dykes, which preserve an astonishingly constant direction, width, and composition over large horizontal and vertical distances. From a careful examination of these dykes it was ascertained that, with a few exceptions, they can be classed in two systems. Of these the most important radiates from a spot situated a little to the south of Quail Island, while the other proceeds from the centre of a shallow bay to the south-east of the former one.

The rocks of the Lyttelton system are, with a few exceptions, members of the basic series of igneous rocks, the commonest species being one that is best named olivine-andesite. Andesites without olivine have also been found, while basalts, especially in the later eruptions, are frequent, being, as a rule, very finely grained. Trachytes also occur, particularly in dykes, and from the prevalence of dykes of trachyte Sir Julius von Haast drew an important induction in support of Durocher's theory of volcanic action and the origin of the eruptive rocks. Rhyolites are also found as members of the very earliest eruptions, and still crop out at Governor's Bay, on the shore of the harbour.

The most anomalous of all the rocks occurs on the Lyttelton–Sumner Road, about half a mile from Lyttelton. This rock was discovered by Sir J. von Haast, and was called by him a domite. A chemical analysis was made by Professor Bickerton, which is quoted on page 300 of Haast's "Geology of Westland and Canterbury." Subsequently the rock was examined by Professor Ulrich, and he discovered the rare mineral tridymite in it. Specimens were also sent to Professor Von Rath, but no detailed description of the rock has yet been published, though a collection of volcanic rocks was described in Germany.

Professor Von Haast, in the "Geology of Canterbury and Westland," describes this rock as "a remarkable trachyte rock, interstratified between two others of a basic character." He thus evidently considers that it comes from the same source and has the same origin as the other rocks of the Lyttelton system. After a careful examination of the rock itself and the surrounding lavas, the writer has been forced to form an opinion directly opposed to the expressed and written ideas of the professor.

As it would be impossible to give an intelligible description without the aid of a diagram, part of an official chart of the harbour and an enlarged rough sketch-map of the area examined are added (Pl. XLIV.). In the chart it will be found at the point A. The chart has a scale of 1⅗in. to the mile. The sketch-map is intended to show only that part of the district that has been actually examined.

About half a mile from Lyttelton the Lyttelton–Sumner Road passes an abrupt wall of a whitish rock, K, about 30ft. high, extending about 70 yards up the face of the hill and a few yards below the road, the wall being nearly at right-angles to the direction of the road. As it is followed up the hill this wall gradually decreases in height, and is ultimately on a level with the surrounding ground. Higher than this the outcrop cannot be traced at this point, but it turns sharply to the right, and runs for some distance parallel with the road. The highest point of this outcrop is about 490ft. above sea-level. Between this height and 690ft. the slopes are thickly covered with grass, except in one or two places where basic lava that apparently overlies the trachyte crops out. At a level of 690ft. above sea-level there is another wall-like outcrop, which runs almost parallel to the direction of the road, and is fairly constant in elevation. To the right it gradually gets smaller, and disappears at C. On the left it ends somewhat abruptly at D. From this point to the top of the hill, 770ft., all the rock seems to be trachyte of the same character as the first outcrop, and its resemblance is borne out on microscopical examination. At E, along the crest of the hill, the trachyte seems to disappear, and a little further on a wall-like buttress of basic rock stretches across at right-angles to the axis of the hill. Descending the hill from E to F, the ground is strewn with boulders of the same rock; and at F, on the shore of the harbour, there is a small cliff of the same rock, with several small sea-worn caves. The cliffs continue to bound the shore to the point H, whence it slopes up the hill to K, which was our starting-point.

There are four well-defined dykes in this rock, three of which, M and N, on the shore, are of small size, while the fourth, which cuts into the outcrop K, is 6ft. to 7ft. wide.

At the top of the hill there is clear evidence of a large dyke, which runs parallel to the length of the hill, along its summit. In breadth the dyke measures about 20ft., and in length about 200 or 300 yards, its bearing being E. 41° N.

It is evident that the trachyte lava issued from this dyke, as outcrops are found the whole way from the top to the bottom, and are generally of a vesicular character. If, as Sir J. von Haast suggests, it flowed from a central crater, situated near Quail Island, it would necessarily, like the other rocks of the harbour, present a single face of moderate breadth, and of a tolerably constant altitude above the sea-level.

It is possible that the lava flowed from a crater that occupied the position where the Town of Lyttelton now stands. This, however, is highly improbable, as no independent evidence exists of the activity of a vent situated there. No system of dykes has been discovered; none of the other hills enclosing the depression afford evidence of such a vent, while on one side all traces of crater-walls, if they ever existed, have been removed.

The very appearance, too, of the hill under consideration gives one the idea that its origin is not the same as that of the others, for, while its surface is, generally speaking, smooth and rounded, and resembles the slopes of Mount Herbert, the others, almost without exception, present that series of sharp, steep walls rising tier above tier that so plainly indicates to the geologist that they are formed of lava-flows lying one over the top of another with a moderate angle of inclination. These considerations, and the fact that a well-defined dyke exists at the summit, must remove all doubt as to whether an independent origin should be assigned to this small system of volcanic products.

As the age of the whole system of Banks Peninsula is not yet settled with any exactitude, it would be idle to attempt to ascertain the precise geological age at which this minor eruption took place. There is, however, little difficulty in ascertaining its age relatively to the other eruptions of this volcanic system.

It is stated by Sir J. von Haast that the original crater was the only one whose eruptions were of a sufficiently spasmodic character to rend fissures in the surrounding rocks, which, on being filled with igneous matter, form dykes.

Now, it is evident that this large dyke must have been formed during or preceding such a paroxysmal eruption. Its age, then, must be assigned to some period during which these eruptions were still in full force. Again, it is evident that the caldera of Lyttelton had already been formed when this eruption took place, for the lavas that were emitted from this dyke flowed down the face of the harbour-walls when they were approximately of their present shape and form, otherwise during the formation of the caldera this small accumulation would have been blown out of existence. Thus its age can be assigned as not earlier than the latest phase of eruption.

Lastly, the presence of other dykes piercing this rock proves that the convulsion by which the large dyke was formed was not the last effort of the declining volcano, but force still resided in it sufficient to crack the surrounding rock, and volcanic magma was still present in sufficient quantity and under sufficient pressure to fill these cracks up to the level of the surface, and thus form dykes.

The age, then, of the system must be stated as younger than the most violent paroxysms of the central volcano, but in all probability older than the Mount Herbert system, for these lavas are in no place seen to be pierced by dykes, and the eruption was therefore subsequent to the convulsions of the central crater.

The presence of sea-worn caves even near the top of the hill does not help us much, as it has been shown by Professor Hutton and others that within the Pliocene period great oscillations of level have taken place.

In macroscopic appearance the trachyte previously mentioned resembles a rhyolite in its very light colour, but no quartz crystals can be seen.

The colour is almost white in places, but generally iron-oxide has segregated in cracks owing to weathering, thus giving it a banded and sometimes almost spherulitic appearance.

Large crystals of plagioclase can be distinguished, the striation often being visible with a simple lens. The rock is generally vesicular, and it is in these vesicles that glass-clear tridymite crystals are seen, and frequently appear to have a hexagonal outline.

The texture is porphyritic, the phenocysts being invariably feldspars.

There are two well-developed divisional planes in the rock, one being parallel to its surface and the other parallel to the direction of flow, showing that the cooling proceeded from the surface as well as from the sides.

No macroscopical difference can be seen between the rock on the summit of the hill and that on the sea-level, except that the former is, if anything, the more vesicular of the two.

The mineralogical structure of this rock presents many peculiarities, both in the nature of the minerals themselves and in their association with one another.

Tridymite occurs in considerable abundance, for, although thirty-six sections of the rock were cut, some crystals of the mineral occur in every section. The feldspars, both orthoclastic and plagioclastic, frequently occur in large porphyritic crystals, and present the peculiar feature of a central core of plagioclase surrounded with a mantle of orthoclase or sanidine. Ferro-magnesian constituents are rare, or entirely absent, but magnetite occurs in considerable quantity, while needles of apatite penetrate the ground-mass and feldspars. As an accessory of somewhat doubtful occurrence, zircon may be mentioned.

Tridymite, although often present in the ground-mass, is generally found attached to the sides of vesicular spaces, and sometimes completely fills the smaller vesicles. The crystalline groups are, as a rule, of irregular shape, but in some a fairly regular hexagonal boundary may be observed. They are quite transparent, and possess a vitreous lustre.

In sections they appear generally as rounded aggregates, quite clear and transparent, with numerous cracks that resemble cleavage. With polarised light, however, they break up into a number of irregularly-shaped areas of extremely minute dimensions, but all possessing different optical orientation. To see the structure distinctly, a magnifying-power of 70 diameters or more should be employed, and it will then be noticed that, although irregular, there is an approach to the hexagonal boundary in the majority of the plates. Each of these areas undoubtedly represents a distinct individual, but, owing to their extremely small dimensions, it was found impossible to isolate any one of them and submit it to optical examination with the hope of forming any ideas as to the system of crystallization. The peculiar irregular structure of the aggregates is well shown by altering the focus of the microscope by means of the fine adjustment, when it will be seen that, even in the thinnest sections, there are several layers of crystalline plates.

The aggregates are frequently traversed by cracks which seem to bear no definite relation to the outline of the individual grains of the aggregates themselves. A peculiar feature of many of these grains is a radial structure (shown in Pl. XLVIII., fig. viii.). Although not universal, this structure occurs in the majority of the grains. Figs. vii. and viii. were both drawn from a section beneath a magnifying-power of 70.

Fig. vii. shows the normal structure of tridymite with polarised light, except that the different areas are not shaded as they appear beneath the microscope. The interference colours are always low, but it was found impossible to give the general effect by shading the different areas.

Feldspars.—These are perhaps the most interesting of all the minerals in this rock, for the sections serve to show that the isomorphism of orthoclase and the more acidic plagioclases (andesine) is almost exact—so nearly so that crystallization of sanidine can proceed with as great energy round a core of plagioclase as round one of sanidine.

Sanidine occurs in beautiful glassy porphyritic idiomorphic crystals, as well as in granular aggregates with irregular outlines. The porphyritic crystals are generally of small dimensions, and often give square sections, which shows that the crystals are not generally elongated in the direction of the chief axis. Cleavage is plainly seen in most of the sections, and a faint zonal structure can generally be observed. Between crossed nicols the interference colours are low, greys and bluish-grey of a low order being general, and affording a marked contrast with the brilliant interference colours of plagioclase in the same section.

Twinning is exceedingly common, and, though well-developed examples of the Carlsbad type are frequent, the majority of the twins are irregularly penetrating, frequently without the slightest indication of any regular law; but at other times twins resembling those formed on the Baveno and Manebacher law have been observed.

The Carlsbad twins—composition plane $\infty \grave{P} \infty$ (010), twinning plane $\infty \bar{P} \infty$ (100)—are numerous, occurring in crystals of all sizes, even the microlites in the base sometimes showing this type of structure. Some examples of these twins are given in the figures.

A twinned crystal that bears some resemblance to a Baveno twin is shown in Pl. XLVIII., fig. ix. Unfortunately, this crystal seems to have been considerably corroded before the rock cooled, and the margin has therefore become somewhat rounded. Supposing this to be a Baveno twin, it would consist of four individuals such as those figured in Dana's "Text-book of Mineralogy" (page 100, fig. 325, and page 325, fig. 587). The composition and twinning-plane are the clinodome $2 \grave{P} \infty$ (021). Although the traces of the twinning-planes are not exact diagonals, they do not show more irregularity than many of those of the Carlsbad twins. A very similar crystal has been found in another section; while in a third there is another, consisting of two individuals, the twinning trace being more nearly a diagonal.

Irregular penetrating twins are frequent, and some are drawn in the annexed figures. They do not call for any special description.

In order to show clearly that the supposed sanidine is not plagioclastic feldspar cut in the direction of a plane parallel to the brachypinacoid ∝ P ∝ (010), Pl. XLVII., fig. v., may be mentioned. In the large crystal drawn in this section the traces of the faces which appear longest have cleavage-cracks parallel to them, and must therefore be the traces of the base O P (001) and the clinopinacoid ∝ P ∝ (010).

As these traces are almost exactly at right-angles to one another, and extinction takes place when the cross-wires are parallel to these traces, the section must be cut in the zone of the orthopinacoid and base. If, now, the mineral were plagioclase, twinning parallel to the brachypinacoid (corresponding to the clinopinacoid of sanidine, as shown below) would be observed in such a section—that is, supposing the usual isomorphic relations to hold good, as they will be shown to do when the plagioclases are considered. The fact that the mineral extinguishes parallel would in itself generally be considered sufficient to show that it is sanidine and not plagioclase. The truncations of the angles are, of course, due to the development of a clinodome. The same method of reasoning may be applied to fig. vi., Pl. XLVII., where there is a core of plagioclase surrounded by a broad rim of sanidine. This example is even more conclusive than the last, as here the plagioclase is twinned on the albite type, and it cannot therefore be pleaded that the mineral is untwinned plagioclase. Since sanidine is doubtless present in this crystal, it may be said with safety that the other unstriated feldspar possessing similar interference colours is sanidine.

Plagioclase is also present in crystals with idiomorphic outlines, and generally of a far larger size than the crystals of sanidine. Almost invariably, however, there is an investing mantle of sanidine, which sometimes is of far larger diameter than the core of plagioclase, but in other cases far smaller. In general, the plagioclase can hardly be called idiomorphic, as it passes in many cases gradually into the surrounding sanidine, the exact boundary-line being hard to determine. Occasionally, as in Pl. XLVI., fig. iv., there appears to be an outer zone of plagioclase possessing different optical orientation from the inner one. Cleavage-cracks can seldom be seen, and zonal structure is rare and inconspicuous when developed.

Twinning is splendidly developed, according to three well-defined laws—Carlsbad, albite, and pericline. The Carlsbad twins are exceedingly common, the two halves being frequently as sharply defined as in sanidine. The investment of sanidine, in every observed case but one, is also twinned, but its orientation is different from that of the plagioclase, although the composition plane is a continuation of that of the plagioclase. Since these two planes are coincident, the plane of twinning on the Carlsbad type in the plagioclase must be parallel to the clinopinacoid in the sanidine. But the twinning-plane of the albite lamellæ is parallel to the twinning-plane of the Carlsbad twins, and, as, according to the albite law, the lamellæ are twinned parallel to the brachypinacoid, it is evident that the composition plane of the Carlsbad twins is also the brachypinacoid. Hence in these crystals the clinopinacoid of the sanidine corresponds with the brachypinacoid of the plagioclase. The Carlsbad twins in the plagioclase show the same irregular intergrowth that forms a noticeable feature in the sanidine.

Albite twinning is exceedingly common, the lamellæ varying greatly in width, but on the whole they are narrow, the width being constant throughout their length. In a few cases the lamellæ are curved or broken, and possess undulose extinction, thus showing that the rock was subjected to considerable pressure or tension previous to its extrusion.

If a section of plagioclase is cut at right-angles to the brachypinacoid the extinction of the adjacent lamellæ of the twins would make equal angles on each side of the cross-wires. Although in the sections none of the plagioclase crystals are cut precisely in this direction, some of the surfaces coincide approximately with such a plane.

The following have been measured:—

Extinction on Right Side of Cross-wires.	Extinction on Left Side of Cross-wires.
1. 28°	1. 9°
2. 14°	2. 13°
3. 23°	3. 9°
4. 16°	4. 23°
5. 15°	5. 11·5°

These results, although rather high, tend to show that the species of plagioclase is andesine, a conclusion that will subsequently be shown identical with that derived by chemical analysis. It was found impossible to detach cleavage-flakes, so that the extinctions on the base or brachypinacoid could not be determined.

Twinning after the pericline law (twinning-plane the "rhombic section") is not nearly so frequent nor so well developed, the lamellæ being as a rule of variable length, frequently not traversing the whole breadth of the crystal, and leaving untwinned feldspar between the adjacent twins.

Plate XLVIII., fig. x., shows a crystal where this type of twinning is seen in combination with twinning after the albite law. The drawing is a faithful representation of the crystal as it appears between crossed nicols when the longer side of the crystal is inclined at an angle of 33° with the cross-wires. It would appear that *h*, *e*, *d* are broad lamellæ of pericline twins, *n* being a tongue of feldspar twinned on the albite law, the lamellæ appearing on rotating the stage. The lamellæ *h*, *e*, *d* are themselves striated with albite lamellæ, which also appear at *e*, *c*. The lamella *d*, on the other hand, has subsidiary striation due to twinning on the pericline law. *c d*, *e f*, all extinguish together, as do *n h* ; *m m* are grains of magnetite. The whole is surrounded with a mantle of sanidine, *a a*.

Magnetite is present in every section, but varies considerably in abundance. The grains exhibit great variation in boundary, as the usual form of the mineral is the rhombic dodecahedron and octahedron. Some grains show a fairly regular hexagonal boundary, and it is possible that ilmenite, which crystallizes in the hexagonal system, is present.

Augite is of doubtful occurrence, for though between thirty and forty sections have been cut there is no single occurrence of this mineral which cannot be questioned. One section shows an opaque crystal with octagonal outline, which is probably a section of augite in which both prisms as well as pinacoids are developed. As, however, almost the whole of the crystal has been changed into iron-oxide, its optical properties cannot be investigated.

Apatite is present in numerous prismatic needles which pierce the feldspar and ground-mass, and was therefore the first mineral to crystallize out of the magma.

Zircon seems to be represented in one slide where there are two short prismatic crystals terminated by obtuse pyramids, and possessing straight extinction as well as strong double refraction, indicated by brilliant colouring between crossed nicols. It would, however, be rash to assert from these isolated examples that zircon occurs in the rock, especially as it has been found in no other slides, including those prepared by Professor Ulrich.

The ground-mass of the rock is composed of feldspathic microlites, tridymite, and magnetite, and in rare instances there are globules of a greenish glass. Beneath the quarter-inch objective it cannot be determined to what species of feldspar these microlites belong, but, since sanidine has in the porphyritic crystals evidently crystallized subsequently to the plagioclase, we have a certain amount of right to infer that the microlites consist chiefly of sanidine. Irregularly-bounded tablets of tridymite will be observed in very thin sections to occupy a large portion of the ground-mass, but in thicker sections they are frequently over- or underlaid by microlites. It will be shown afterwards that a large proportion of the base must consist of tridymite.

Iron-oxides (magnetite, and sometimes hæmatite) are frequent in small specks without crystalline boundaries. Hæmatite, with a little limonite, is particularly abundant in cracks, and in all probability results from the further oxidation and hydration of the magnetite.

Beneath the highest power of the microscope (700 diameters) no isotropic matter indicating the presence of interstitial glass can be seen, but occasionally, especially from the vesicular upper surface of the lava-flow, there are inclusions of a greenish glass in globules of a spheroidal form, the structure in one or two cases being almost pisolitic.

A few of the sections were examined in convergent polarised light, and the following results were obtained:—

The large crystal in Pl. XLVII., fig. v., shows two hyperbolic brushes which meet almost in the centre of the field, and the section must therefore be cut almost exactly at right-angles to an axis of elasticity. Since in such a thin section both hyperbolas appear, and when furthest apart they barely disappear from the field, the axis of elasticity must be the acute bisectrix. With the quartz wedge the hyperbolas are far more widely separated, and the result therefore is equivalent to the thinning of the section, which shows that the optical signs of quartz and sanidine are opposite, and since quartz is positive the acute bisectrix in sanidine is negative. Further, since the section was shown to be cut in the orthopinacoid-basal zone, the acute bisectrix must be at right-angles to the orthodiagonal.

The acute bisectrix is thus shown to be negative, and at right-angles to the orthodiagonal, a result in accordance with the general optical properties of sanidine or orthoclase (Dana's "Text-book of Mineralogy," p. 325).

Plate XLVII., fig. vi., in convergent polarised light only shows one hyperbola, and is therefore not cut at right-angles to an axis of elasticity, although it is cut perpendicularly to the plane of the optic axes.

In convergent polarised light tridymite only shows faint indications of hyperbolic brushes, which appear only in the edges of the field.

Plate XLVIII., fig. ix., the supposed Baveno twin, gives uniform phenomena all over the crystal as far as can be seen, but, as it is not cut at right-angles to an axis of elasticity, this is not certain, as the brushes merely sweep across the section apparently in the same direction in all parts of the crystal. This militates considerably against the supposition that the crystal is a Baveno twin.

Chemically, this rock presents rather peculiar features, as will be seen from the following analysis. The first two analyses are of the same specimen, while the other three are of another specimen, collected from an adjacent locality :—

Specific gravity, 2·351 – 2·415.

SiO_2 ...	72·32	73·07	71·57	71·20	71·09
Al_2O_3 ...	13·95	13·75	16·07	15·57	15·45
Fe_2O_3 ...	2·44	2·55	1·51	1·49	1·50
FeO ...	—	—	0·28	0·28	0·34
MnO ...	Trace	Trace	Trace	Trace	Trace
CaO ...	3·41	3·27	3·52	3·46	3·25
MgO ...	0·88	0·99	0·90	0·87	0·89
P_2O_5 ...	Trace	Trace	—	—	—
K_2O ...	2·46	2·46	2·35	2·35	2·35
Na_2O ...	4·60	4·60	4·81	4·81	4·81
H_2O, and loss	—	—	0·07	0·07	0·07
	100·06	100·69	101·08	100·10	99·75

The large percentage of silica combined with such a considerable percentage of lime is a very unusual feature, but would be expected when the large amount of plagioclase is taken into consideration. The excess of silica over and above that required for combination with the bases is of course present in the mineral tridymite. The analyses tend to show that the feldspar present is chiefly a species of plagioclase—*i.e.*, a soda-lime variety—and this is confirmed by optical examination.

The presence of manganese was indicated by the bluish-green colour of the fusion mass, but this was not strong enough to warrant a special quantitative determination.

The percentage of magnesia shows that some ferro-magnesian mineral is present in small quantity, but microscopical examination shows that they are practically absent. Some of the larger accumulations of iron-oxide may possibly indicate the former presence of some ferro-magnesian mineral which has been re-fused owing to the relief of pressure, or some other changed condition subsequent to its original crystallization.

Phosphoric acid is of course accounted for by the presence of apatite crystals. No test was made for this substance in the last three analyses.

In the first two analyses the iron was all converted to the ferric condition before precipitation, and no determination of ferrous oxide was made.

From these analyses a rough approximation may be made as to the amount of free silica present in the form of tridymite, for, assuming that all the potash is in combination with silica in sanidine, and all the soda goes to make up the plagioclase (andesine), the excess of silica over that required for these combinations will be present as tridymite, as no interstitial glass has been detected.

Taking the average composition of sanidine as that given in Dana's "Text-book of Mineralogy," we find that it contains 16·9 per cent. K_2O and 64·7 per cent. SiO_2. In a rock containing 2·46 per cent. K_2O, 9·42 per cent. SiO_2 would be required for combination. Again, CaO and Na_2O make up 14·7 per cent. of andesine, while the percentage of silica is 59·8. Assuming that Na_2O and CaO are to a limited extent mutually replaceable in the andesine molecule, and taking the molecular weight of Na_2 (46) as equivalent to that of CaO (40), we have in this rock 8·06 per cent. of these bases, and they would require 32·60 per cent. of silica for complete saturation. Altogether, then, 42·02 per cent. of silica is required for combination, and the remaining 29 per cent. will be represented by tridymite. As, however, a very small proportion of the rock as seen in section is tridymite, it is fair to assume that a considerable amount must exist in the ground-mass.

As tridymite is stated to be soluble in caustic soda (Rosenbusch: "Microscopical Physiography of Rock-forming Minerals," translated by Iddings, p. 174), an attempt was made to estimate its percentage by taking advantage of that fact: 29·95 per cent. SiO_2 was dissolved out of the rock, but, as 15·05 per cent. Al_2O_3 was also present in the solution, the result is not satisfactory.

An analysis was also made of the feldspar, but it was found extremely difficult to isolate an appreciable quantity, and the result of the analysis cannot be considered strictly accurate:—

SiO_2	60·56
Al_2O_3	22·05
CaO	7·25
K_2O	3·54
Na_2O	7·93
	101·33

The result is almost the same as would be expected on consideration of the bulk analysis of the rock, except that the percentage of K_2O is rather high. Sanidine forms only a small border round the relatively large crystals of plagioclase that were the only ones obtainable for analysis.

No attempt was made to determine the species of plagioclase by means of its specific gravity, as the difference in this physical quantity between two closely-allied species of plagioclase is extremely small, and would be completely masked by the lower specific gravity of the mantle of sanidine. An approximate correction for this would give an eminently unsatisfactory and wholly unreliable result. The same applies to Szabo's flame reactions.

Although fully recognising the danger of theorising upon any subject when the data are insufficient, I cannot refrain from offering a suggestion as to the cause of silica crystallizing in the form of tridymite. The available data to reason upon are—

1. The invariable presence of tridymite in cavities;
2. Its frequent radial structure;
3. Its non-inclusion in other crystals.

All these point to the conclusion that the mineral was deposited subsequently to all the other minerals of the rock, and from a solution in some solvent. Silica if uncombined is well known to be insoluble in pure water at atmospheric pressure; but there seems to be every reason to suppose that it is soluble in water above its critical temperature and under considerable pressure. The experiments of Daubrée with water in glass tubes confirm this, and the theory to account for the fact that quartz is the last mineral to crystallize in granite shows that it is generally believed that silica can be dissolved in water of a sufficiently-high temperature and under great pressure. In lava, prior to its extrusion, the water present would probably be capable of dissolving silica, but on the eruption of the lava the pressure would be suddenly relieved and the temperature quickly lowered, and consequently the silica would be precipitated. Owing to this rapid precipitation the silica molecules might be unable to arrange themselves in their ordinary arrangement, or the molecular forces, owing to direct solution or the subjection to heat, might well be different from the ordinary molecular forces, and would tend to form a different geometrical solid from that formed under the normal conditions.

That the molecular forces under certain conditions are liable to variation is well shown by the production of dimorphous forms in $Ca\,CO_3$, native sulphur, and other minerals; and there seems to be no physical reason why variation should not exist in the case of others when the conditions accompanying crystallization also vary.

The extreme minuteness of the individual crystals would seem to indicate rapid precipitation, while inclusions of steam or other fluids would easily find their escape through the divisional planes between the different crystal plates.

It does not seem probable that high temperature alone, or sudden cooling, determines the system in which silica crystallizes, since in rhyolites and other lavas in which these conditions obtained the silica crystallized in the form of quartz. In the case of holocrystalline rocks, on the other hand, the cooling was extremely slow; and in the case of older lavas the molecules may have had time to readjust themselves in accordance with the normal forces after extrusion. In recent lavas containing quartz the absence of tridymite may be explained on the hypothesis that steam was not present in sufficient quantity or of a sufficiently high temperature or tension to dissolve the silica.

The juxtaposition of sanidine and plagioclase can easily be explained by assuming that under like conditions the molecules of plagioclase would have greater tendency to accumulate than those of sanidine, and the plagioclase would accordingly tend to crystallize first. With slightly-changed conditions sanidine might also crystallize, and because of the almost complete isomorphism existing between it and plagioclase it would crystallize round the already-formed core of plagioclase.

Possibly there is a gradual increasing acidity in the plagioclase from centre to margin, as well as a gradual change from the base Na_2O to K_2O. This would better explain the presence of the mantle of sanidine, for during crystallization there would not only be a gradual increase in acidity in the successive layers, but also a corresponding gradual change in crystalline form. The centre of the core of plagioclase might then be very basic, while the outside rim might be acid sanidine. The occasional presence of an intermediate differently-oriented layer of plagioclase between the central core and the sanidine lends this view considerable support. Again, the boundaries of the plagioclase very seldom show that sharp definition that would be expected if the change was sudden; and frequently there appears to be no actual line where the plagioclase ends, but it appears to pass laterally into the sanidine.

The nomenclature of the rock presents considerable difficulty, for it seems to form a connecting-link between three classes of lava.

If classification according to percentage of silica is adopted, the rock must be classed with the rhyolites or liparites, though the presence of quartz crystals is generally adopted as a specific character.

If Rosenbusch's classification is adopted, we should hesitate as to whether the rock should be called a trachyte or an andesite, the distinction hinging mainly on the preponderance of sanidine over plagioclase, or *vice versâ;* and as, according to analysis, the latter appears to be in excess, the rock would have to be classed with the andesites.

According to its mineralogical composition, a place might be assigned to it among the dacites; but, at the same time, tridymite would have to be considered a mineralogical equivalent of quartz. The absence of any ferro-magnesian constituent must, however, tell largely against its inclusion in this class.

The name tridymite-dacite would give the idea of presence of free silica, as well as the preponderance of plagioclase over sanidine, but would imply the presence of augite or hornblende. On the other hand, the feel of the rock, its specific gravity, the absence of a glassy base, and its very light colour, as well as, to a certain extent, its highly acid composition, all tell largely in favour of its being pronounced a trachyte; and I have therefore preferred to call it an andesine-tridymite-trachyte, the two pronomens being used to indicate its exceptional mineralogical characters.

In order to demonstrate the relations of the neighbouring rocks to this trachyte, several sections have been cut and some analyses made of the lavas that appear to have proceeded from the same orifice, as well as of the intrusive dykes and other neighbouring rocks.

Immediately underlying the trachyte, and undoubtedly proceeding from the same vent, is a black lava that resembles pitchstone except for large porphyritic crystals of feldspar. Cavities are fairly numerous, but not so abundant as in the overlying rock. Sp. gr. 2·46.

Under the microscope there are large idiomorphic crystals of sanidine, and occasionally plagioclase surrounded by sanidine, as in the overlying rock. The sanidine is generally twinned on the Carlsbad type, some splendid crystals of this twin being obtained. The plagioclase is twinned after both the albite and Carlsbad laws, but does not present such interesting or marked combinations as in the overlying rock.

Augite of a bright-green colour occurs in idiomorphic crystals, generally of small size, as well as in microlites. It is slightly dichroic, but calls for no special mention.

Magnetite and apatite are present in fair abundance. The ground-mass consists of microlites of augite and plagioclase and abundant interstitial brown glass. A quantitative analysis gave the following result:—

SiO_2	67·63	67·36
Al_2O_3	18·86	18·90
Fe_2O_3	3·37	3·46
CaO	3·23	3·30
MgO	0·91	0·98
K_2O	3·78	3·78
Na_2O	4·66	4·66
	102·44	103·44

The rock appears to be a dark trachyte, with a large percentage of plagioclase, and, from the close resemblance that the analysis bears to that of the overlying rock, there can be no doubt that they both have a common origin. The geological relations as mentioned above also point to the same conclusion.

At the top of the hill along the strike of the dyke another dark-coloured rock occurs of a far more basic character. The geological relations of this rock to the tridymite-trachyte are, however, exceedingly difficult to determine, as the whole surface of the hill near the outcrop is covered with grass.

The rock contains porphyritic crystals of plagioclase twinned on the albite law, generally with idiomorphic outlines. A few crystals of sanidine were also seen in section.

Augite is abundant, brown in colour, and displaying no dichroism. Polysynthetic twinning parallel to the orthopinacoid exists in the centre of some of the crystals, the more peripheral portions being untwinned. No olivine was observed in section. The ground-mass is glassy, with feldspar and augite microlites, and abundant grains of magnetite.

An analysis gave the following percentages:—

SiO_2	49·49
Al_2O_3	18·05
Fe_2O_3	12·94
CaO	9·81
MgO	3·24
K_2O	1·30
Na_2O	6·04

Both mineralogically and chemically this rock shows great resemblance to typical basalts, and should be classed with this species.

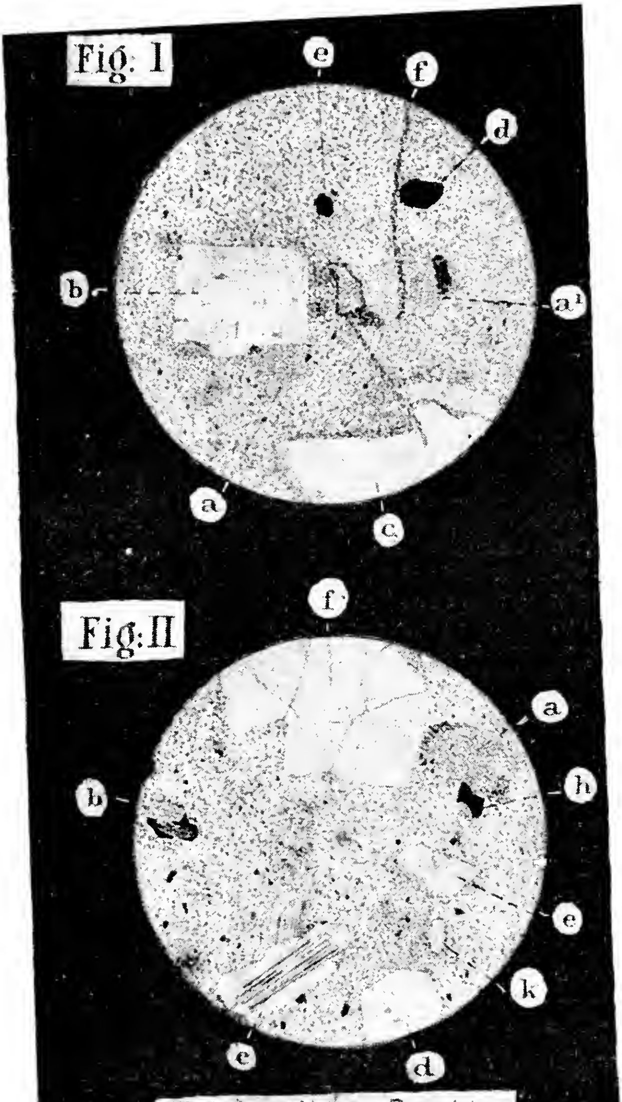
Sections were also made of the dyke that penetrates the rock at B. Feldspar of a plagioclastic variety is abundant, but no sanidine was observed. Augite is present in idiomorphic crystals of a brown colour, and is not dichroic. Apatite is particularly abundant, and grains of magnetite are of frequent occurrence.

SiO_2	50·82
Al_2O_3	14·79
Fe_2O_3	7·99
CaO	11·10
MgO	4·12

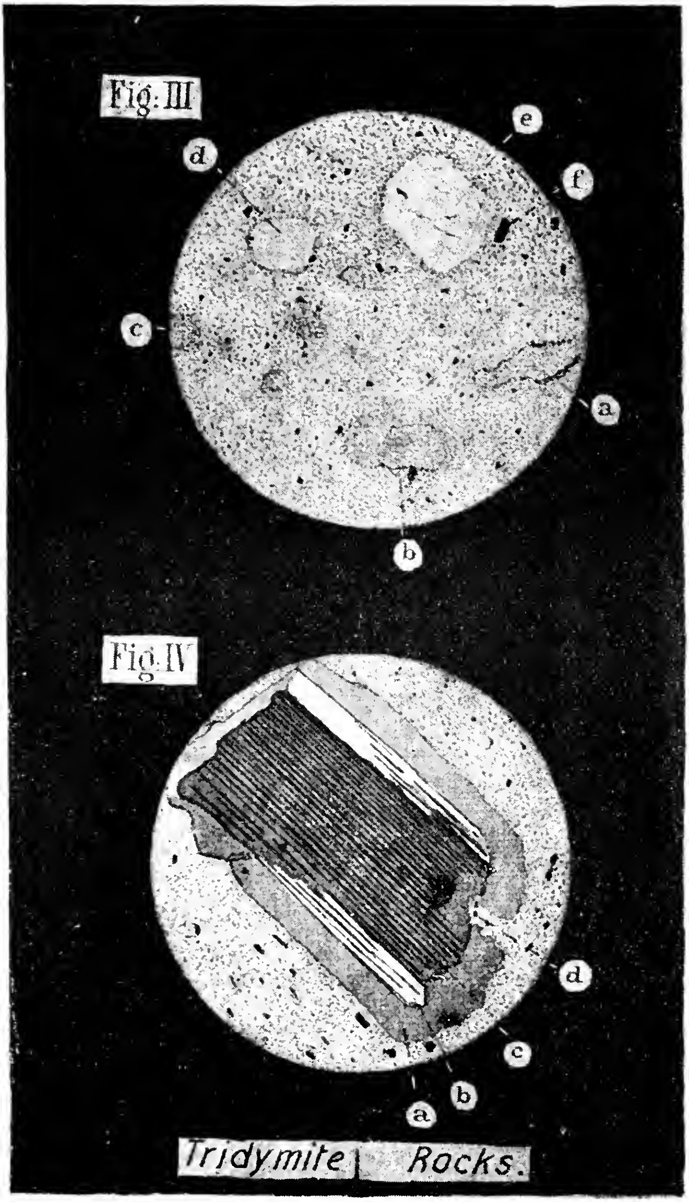
The alkalies were not determined. The rock is undoubtedly one of the ordinary augite-andesites of the Lyttelton system, and bears no relation to the previously-mentioned rocks.

Another rock outcropping close to the tridymite-trachyte was also examined. Its geological relations could not be made out, as all the surrounding slopes are covered with grass.

Under the microscope numerous large porphyritic crystals of plagioclase can be seen, and a few of sanidine, but the two do not occur in contact.



Tridymite Rocks.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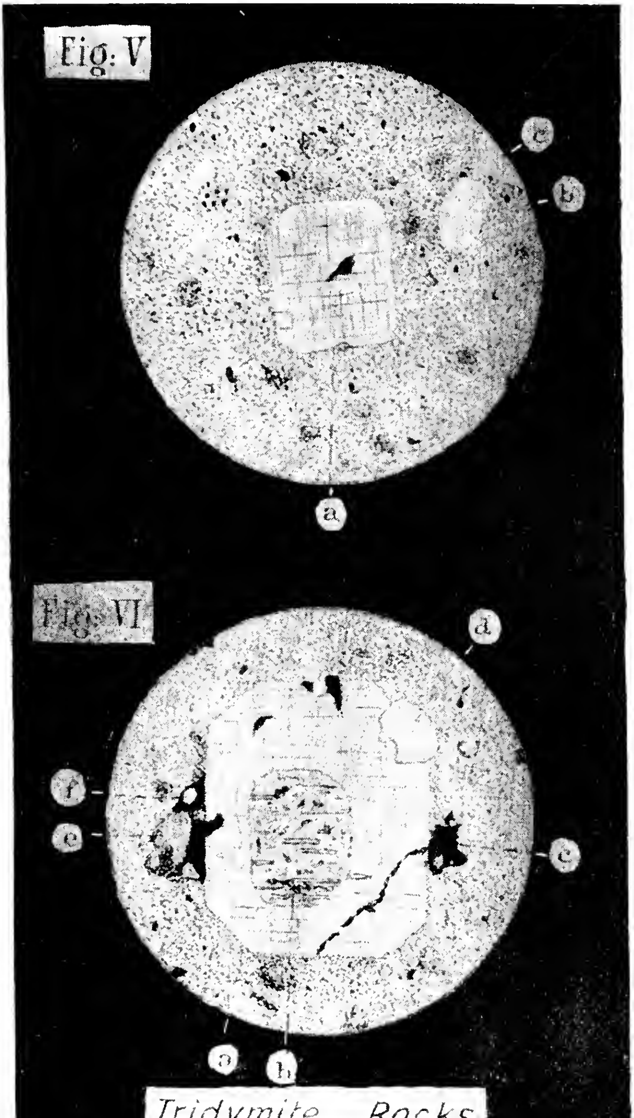
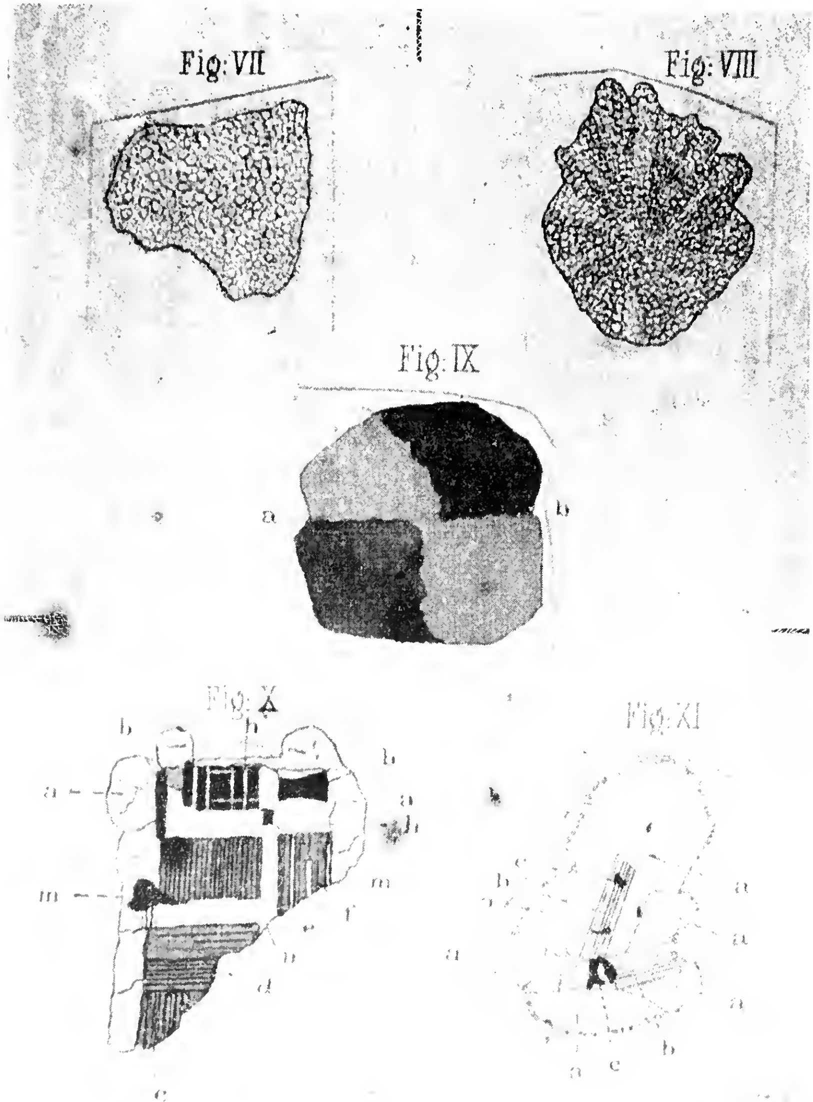
Tridymite Rocks.



Tridymite Rocks



Tridymite Rocks

J. M. del.

No augite was seen, but a highly-dichroic mica with parallel extinction, probably belonging to the biotite series, was present in a few crystals.

The ground-mass consists of crowds of interlacing crystals showing parallel extinction, their length being many times as great as their width. Their polarisation colours are greys and bluish-greys, not so high as those of the feldspars. They would appear to be orthorhombic zeolites, though no fibrous aggregates have been detected.

Microscopically, the rock is of a greenish-grey colour, with shining lustre in places. The specific gravity is 2·65. A quantitative analysis resulted as follows :—

SiO_2	58·93
Al_2O_3	23·95
Fe_2O_3	5·43
CaO	1·75
MgO	0·96
K_2O	4·32
Na_2O	5·61
H_2O, and loss	1·36
	102·31

These percentages bear a certain resemblance to those in phonolites, the high percentage of alkalies and small percentage of lime being particularly characteristic. As, however, the rock is evidently considerably decomposed, and no specimens of the unaltered rock could be obtained, little reliance could be placed on the analysis.

On digestion in cold hydrochloric acid a large quantity of gelatinous silica separated out, a reaction eminently characteristic of phonolites. It is highly probable, however, that the gelatinous silica is in this instance a product of the decomposition of the zeolites.

Judging from its chemical composition, it would appear highly improbable that this rock has a common origin with the tridymite-trachyte. No other rocks were found in the neighbourhood of the tridymite-trachyte except a few small dykes 6in. to 18in. wide, and, as they obviously have no bearing upon the origin of the lava-flows, they were not submitted to a critical examination.

In considering this small subsidiary eruption of the Lyttelton system as a whole, it may be said that the order of the extrusion of the rocks is wholly in accordance with Durocher's law of succession of igneous rocks. First we have an intermediate lava represented by the black trachyte; next comes the tridymite-trachyte, as a representative of the acid group; and finally the basic rocks, as represented by the basalt.

Although it is tempting to generalise as above, it must be carefully borne in mind that only three lavas have been found extruded from this vent, and there is little doubt that a more detailed examination would reveal the existence of other lavas, while there may also have been several previous eruptions, the lavas being covered by later accumulations.

It would therefore be safe to say, of all the rocks of this system so far examined, that the order of succession seems to be in accordance with that demanded by Durocher's theory.

SUMMARY. — The tridymite - bearing rock mentioned in Haast's "Geology of Westland and Canterbury" was erupted from a dyke formed during the paroxysmal convulsions of the central crater after its actual activity had ceased. It is not interstratified with the other volcanic rocks of the Lyttelton system. After the lava-stream had been formed fissures were torn open in it by continued paroxysms of the central volcano, and magma was forced into them, thus forming dykes through the consolidated lava.

The absolute age of the rock cannot be determined, but its age relatively to the products of the large crater can be easily ascertained. Investigation of its mineralogical and chemical constitution shows that the rock should be classed with the trachytes, its special characteristics being denoted by the name andesine-tridymite-trachyte. The rocks that have been extruded from the vent appear to be in the order of succession demanded by Durocher's theory.

EXPLANATION OF PLATES XLIV.-XLVIII.

PLATE XLIV.

Fig. 1. Chart of part of Lyttelton Harbour.

Fig. 2. Enlargement of part marked A in fig. 1: OE, dyke at the top of the hill; R, Lyttelton-Sumner Road; K, first outcrop.

PLATE XLV.

Fig. i. is a section showing the general structure of the rock. The magnifying power is 30 diameters. *a* a^1 are crystals of tridymite, the characteristic structure being shown more clearly than it actually appears under the microscope; *b* is sanidine, with almost rectangular boundaries, to which the cleavage is parallel; *c* is an irregular segregation of crystals of sanidine, the boundaries between the parts possessing different orientation being indicated by lines—none of the grains show any striation, and the boundaries are irregular; *d* and *e* are grains of iron-ore, probably magnetite, but possibly ilmenite; *f* is a vein of hæmatite or limonite that has evidently been formed during the weathering of the rock.

Fig. ii. is also a general section magnified the same number of diameters as fig. i. *a* and *b* are grains of tridymite; *c* is a feldspar crystal consisting of an irregular intergrowth of two crystals, sanidine and plagioclase, the former in both cases surrounding the latter; the large crystal is an irregular Carlsbad twin; *f* is a compound crystal of sanidine similar to *c* in fig. i; *e*, *d*, and *k* are other crystals of sanidine; *h* is a large grain of magnetite.

PLATE XLVI.

Fig. iii. is a section in which tridymite occurs to a greater extent than usual. *a*, *b*, and *c* are grains of this mineral; *e* and *d* are untwinned sanidine; *f* is a grain of magnetite. In all of these sections there is no attempt made to give the exact appearance of the ground-mass, since beneath such a low power it merely presents a cloudy appearance.

Fig. iv. shows a large crystal of plagioclase surrounded by a ring of sanidine, with a small layer of differently-oriented feldspar between. *a* is the sanidine, *b* the intermediate layer of plagioclase, and *c* the central core of plagioclase; *a* is extinguished in polarised light when the trace of the clinopinacoid makes an angle of 26° with the cross-wires; *b* is extinguished when the angle is 11·5°, and *c* when the angle is 33°. The colouring shown in the drawing is seen when the trace of the clinopinacoid makes an angle of 64° with the cross-wires.

PLATE XLVII.

Fig. v. *a* is a crystal of sanidine which was described when treating of the mineral generally; *b* is a vesicle; *c* is another sanidine crystal.

Fig. vi. This also was described previously. *a* is the outer ring of sanidine; *b* is the central portion of plagioclase; *c* is a mass of iron-ore; *e* is tridymite; *f*, air-space, or vesicle; while *d* is sanidine that has apparently intergrown with the larger crystal, but has independent orientation.

PLATE XLVIII.

Fig. vii. is a crystal of tridymite as seen under a magnifying-power of 70 diameters. The outlines of the different plates are quite noticeable with this power.

Fig. viii. is another tridymite grain in which an attempt is made to show the radial structure that is often so noticeable with polarised light.

Fig. ix. is the supposed Baveno twin, also magnified 70 diameters. Two opposite quarters of this crystal extinguish when the line joining *a* and *b* makes an angle of 11° with the cross-wires. The other two extinguish when the angle is 18°. When the angle is increased to 23° they are indistinguishable, and remain so until the angle is 79°.

Fig. x. was previously mentioned as a combination of albite and pericline twinning. *a a* is the surrounding sanidine; *b b* are lamellæ, apparently of albite twins on a broad pericline face; *c* is twinned on the albite and *d* on the pericline law; *e* and *f* are also pericline lamellæ, twinned according to the albite law; *h* is another pericline plate, which in certain positions shows secondary twinning; *n* appears to be an albite lamella which shows no secondary twinning; *m m* are magnetite grains. The appearance shown in the figure is presented when the lines of albite twinning make an angle of 27° with the cross-wires.

Fig. xi. is a compound grain of sanidine and plagioclase. *a a a*, &c., are sanidine grains, all with different orientation; *b b* are plagioclase; and *c c* are grains of magnetite. This kind of combination is very common in the rock. The last two figures are magnified 30 diameters.

All the crystalline outlines were drawn with the camera lucida, and, when shaded, polarised light was used.

Art. XLIII.—*The Volcanic Outburst at Te Mari, Tongariro, in November, 1892.*

By H. Hill, F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 12th June, 1893.*]

I think it ought to be placed upon record that a very important eruption took place on the Tongariro Mountain about the middle of November last year. At the northern end of the mountain, and outside what is properly the old Tongariro crater, are two centres of activity. One is known as Kehetahi, situated on the north-west side of the mountain, at a height of 4,900ft.; the other is Te Mari, situated at the north-east end, at a height of 5,600ft., and immediately above Lake Rotoaira. Few people have ever visited the latter spot, owing to the difficulties of reaching it; besides, its existence only dates back a few years. In a paper read by me two years ago on Ruapehu and Tongariro,* I pointed out that of all places in the volcanic district Te Mari is the spot for vulcanologists to visit, as it was here that volcanoes in embryo could be seen and studied. Ever since the time of the Tarawera eruption there has been a perceptible growth of volcanic activity in the group of volcanic cones forming the Tongariro Mountain system. Ngauruhoe and Ruapehu have by various explosions shown their growing activity, and the mud-pools, solfataras, and explosion-vents at Kehetahi have not only increased in intensity, but the area of activity has been slowly widening, and new places—like new wounds about an old one—are slowly breaking out near to the main centre of activity. Te Mari, when visited by me in March, 1890, consisted of three shafts of unknown depth, each having a crater like an inverted cone, whose centre was the mouth of the shaft. A gyratory force from below had evidently shaped the craters in this way as a prelude to the flowing of lava. Sulphur, or what seemed to be sulphur, was deposited here and there in the crater, and steam was rising in fair quantity from each shaft. The appearances betokened much activity below, and the loose sands and *débris* around showed that explosions had taken place at no distant date. To the north-west of the shafts, and separated only by a small ridge of lava, is an immense crater of great depth. The walls of this crater are finely banded, showing lava-streams of slightly different characters, and illustrate the way in which the lava must have

* Trans. N.Z. Inst., vol. xxiv., p. 607.

welled from the shaft. This crater was quite extinct at the time of my first visit.

Having heard that explosions had taken place at Tongariro, and being unable to obtain information as to its extent or exact locality, I determined to visit the district again during the Christmas vacation to see what had actually taken place, and to note any facts that might appear worthy of being recorded. The road to the mountains is now in such fair order that it is possible to drive as far as Lake Rotoaira, which is situated between the volcanic cones of Tongariro and Pihanga. This plan of reaching the district was adopted, and on the last day of 1892 a small party pitched tents on the south shore of the lake, and made preparation for the ascent of Tongariro on the morrow. The evidence of an eruption was very clear from our camping-ground, and on portions of the road running along the side of the lake the deposition of *débris* and a peculiar sweet earthy odour that arose therefrom showed the location of the spot, and in some measure the character of the eruption that had taken place. I had purposed leading our party up the mountain by way of Kehetahi, but the demands of the old chief living at Otukou compelled me to forbear, and it was decided to attempt an ascent of the mountain by way of the rift, or gut, which had been made from Te Mari down the mountain-side leading into Lake Rotoaira. Bounding the northern end of the range between 4,000ft. and 5,000ft. is a belt of bush and scrub. The eruption had cut a deep channel through this bush, and up this it was arranged to climb.

Our party, six in number, two of them being my own children, started to make the ascent on New Year's morning. A day's rations for each, with one to spare for contingencies, was prepared, and at seven in the morning we were on the march in the direction of the gut on the mountain-side. We were not long in reaching this place, and we found to our great delight that the travelling was comparatively easy; so much so, in fact, that ladies could ascend the mountain by this track without much difficulty. The gut varies in width from 30ft. to 60ft., according to the depth of the sides, and it continues up the side of the mountain to a little beyond the limits of the bush, and within 500ft. of the crater of Te Mari. There it terminates in a great face of black basaltic rock, which is polished and smoothed and pitted, and has the appearance of an old waterfall, although at the time of our visit no water was flowing down the gut from the mountain. It was curious to note that all the exposed rocks in the waterway were finely polished, although they appear to have been exposed since the explosion on the mountain. The gut or channel had evidently been washed out by the water, sand, mud, and stones ejected from Te Mari, and which it seemed had not only filled the channel, but had in places destroyed the trees which stand on the jagged banks. Most of the trees for a chain or so on either side of the channel had their leaves blackened, or reddened, or browned, as if they had been suddenly scalded by hot water, or the roots of the trees had been killed by hot water, the leaves remaining on the trees to brown and die. The material ejected from Te Mari on this side of the mountain was strongly impregnated with alum, and the water in the small water-holes at the base of every rocky face was very bitter and undrinkable, although as clear as crystal. The discoloration, and thereby the destruction, of the forest leaves in this way was to me of special interest in its suggestiveness, and I felt amply repaid for my trouble by the new light such an objective example threw upon a difficulty which had presented itself to me for some time in connection with the deposition of fossil leaves, &c. For several years I have occupied myself at intervals of leisure in collecting impressions of leaves, fishes, &c., from the Poverty Bay and Kidnapper Post-pliocene deposits. Some of the principal beds of the series are made up of a fine pumice, interbedded with a kind of pumice-mud, in which there are beautiful impressions of the forest flora—leaves, flowers, and ferns—of this country, mixed with impressions of fresh-water fishes (*koura ?*) and other traces of animal life. From the appearances represented by the leaves on the scalded trees, I am of the opinion that this mode of destruction explains and illustrates the manner in which the leaves in the Poverty Bay and similar beds were destroyed and subsequently deposited in a lake or estuary. The impressions on the pumice-mud are raised like the impress on a coin, and they show each vein and veinlet and all the surface irregularities such as appear on a green leaf. Such impressions, it seems to me, could only be made in the case of leaves whose growth had been suddenly stopped and destroyed without injuring the leaves. No doubt the reddened, browned, and blackened leaves from the dying or scalded trees on Tongariro will be carried into Lake Rotoaira, or, maybe, into Lake Taupo, and there deposited with the fine pumice-mud which is constantly flowing into these lakes from the numerous streams and springs in the vicinity of Tongariro.

Beyond the belt of bush and scrub there is little or no vegetation on the mountain. A few scattered plants were gathered, such as gentian, *Sophora*, *Celmisia spectabilis*, *Angelica*, *Ranunculus*, a sweet-scented *Pimelea*, a *Claytonia*, and a *Hectorella*.

On reaching the old crater which adjoins Te Mari, and to which reference has already been made, the extent of the eruption could be plainly seen. The mountain, extending from the old crater through the two shafts at Te Mari and passing along the slope of the mountain in a kind of circular direction, was rent in twain by an enormous fissure. This fissure had broken away a portion of the top of the mountain towards the north-east, and it had taken a direction along the foot of the higher slopes of Tongariro, so that the outer wall of the old original Tongariro crater has become a portion of the inner wall of the active vents at Te Mari. This new crater also includes the old extinct crater already referred to, and which on the south-west was showing signs of activity, it having been fractured in this direction at the time of the explosion. In the vicinity of the old shafts everything was in a state of intense commotion. Vast quantities of poisonous gases were rising from the rift, and the whole area on the north side of the rift was a seething mass of sulphur. Our party endeavoured to get near the central part of the rift, but the fumaroles and rising gases were found to be too dangerous for a venture; and our only means of seeing the centre of greatest activity was to ascend to the top of Tongariro overlooking the rift, and from this vantage-ground view the scene. Although the wind was favourable the depth of the rift could not be seen. Now and again water and mud were observed on the north-east, but no traces of flame or fire were noticed. From appearances near the rift it seemed that water, sand, and small stones were the only things ejected at the time of the eruption, and these all in the same direction, but the top of Tongariro Mountain seems to tell a different story. I had crossed this mountain several times previously, but no sign of pumice had been observed on its sides or top. Now, however, the mountain tells a different tale. Scattered thinly over the top, and in pieces varying in size from ordinary grit to small pebbles, is a deposit of pumice, and the question arises, From whence did it come? This pumice is sometimes heavier than the ordinary froth pumice, and has a somewhat duller appearance than that seen in the cliffs bordering Lake Taupo; but there is no doubt of the fact that it is pumice. I noticed with some care the extent of its distribution, and found no traces whatever in the direction of the Blue Lake, whilst the deposit increases towards Te Mari. The Red Crater, in the direction of Ngauruhoe, was unusually active on the western side, and it is certain that Ngauruhoe had sent out black smoke and great quantities of dust about the time of the outburst at Te Mari. This is not only stated to be the case by Mr. Chase, an intelligent half-caste of my acquaintance who resides near Wai-o-honu, but Mr. Blake, of Tokaanu, told me that the dust darkened the air for several hours during the day following the eruption. Te Mari showed no signs of pumice on the lower parts of the mountain; and the only explanation that appears to me satisfactory is to suppose that two eruptions took place at Te Mari, during the first of which water and sand were thrown out, the wind being at the time from the south-west. This was followed by a second explosion, when pumice was ejected, the wind at the time being from the opposite quarter of the compass. The event is an important one, because it suggests a new period of volcanic activity in the district. Whether Te Mari will become more active than it now is remains to be seen. It may be that the late eruptions represent the solfatara condition in the history of the Tongariro Mountain, but the expulsion of pumice is usually looked upon as the prelude to volcanic activity rather than as the termination of it. We know that these mountains must have thrown out vast quantities of pumice in some period of their history, as a basin a hundred miles long and sixty broad is mostly filled with it, and the slope of that basin is from the Tongariro Range. Our knowledge of volcanic phenomena does not allow of a prediction, and time alone will enable us to determine whether Te Mari is beginning or ending a career of volcanic activity.

Addendum.—I find that weak muriatic acid, if sprinkled over green leaves, destroys the green colouring-matter. Other acids will no doubt act in a similar way. It may be inferred, therefore, that water strongly impregnated with acid was thrown from Te Mari during the eruption, and that the leaves on the trees were destroyed in this way.

Art. XLIV.—*Notes on the Geology of the Country between Dannevirke and Wainui, Hawke's Bay.*

By H. Hill, F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 12th June, 1893.*]

The formation of a new road between Wainui, near Cape Turnagain, and Dannevirke, in the Seventy-mile Bush, is of much interest from a geological standpoint. The road runs in a north-west and south-east direction, and passes over the Puketoi limestone range at a point where the rocks are much fractured, or where they are so denuded as to show but small remnants or outlines. The distance between Wainui and Dannevirke is about forty-six miles, and from the latter town to the Ruahine Mountains the distance is about ten miles, so that a complete section is now obtainable of all exposed rocks from the Ruahine to the coast between the 40th and 41st parallels of south latitude. The road in question passes through three river-basins—viz., the Wainui, the Akiteo, and the Manawatu—the two former emptying their waters into the ocean on the East Coast to the south of Cape Turnagain, whilst the Manawatu discharges its waters into the ocean in the South Taranaki Bight, a few miles to the west of the Foxton Township. There is a great difference in the character of the country drained by these rivers. The Manawatu drains an area which is essentially Pliocene and Post-pliocene, whilst the country drained by the Akiteo and Wainui Rivers belongs either to the Older Tertiary or to the Younger Tertiary series. After quitting the Ruahine Mountains the Manawatu passes through a valley made up entirely of young deposits, except in the single instance of the Manawatu Gorge, below Woodville, which separates the Tararua from the Ruahine Mountains. The valley extends from the Ruahine to the Puketoi Ranges, and is important as being, as far as the gorge at least, the remains of an enormous rift or subsidence which has been filled from the products of streams derived in great part from the volcanic district which is now separated from the area known as Hawke's Bay district by the Ruahine Range, which was slowly rising as the rift took place, and was no doubt the primary cause of the rift.

The Ruahine rocks towards the south are made up mainly of sandstones, having a great similarity to the New Red Sandstone of England. When climbing to the trig. station known as Wharati, at the south end of the range, a short time ago, I noticed that the Maitai slates, which are exposed at Maharahara, and which thicken out further northward, were but slightly exposed here. Large boulders of jasperoid quartz overlying conglomerates were met with about 1,200ft. above sea-level; and at the highest elevation where there are traces of settlement blue fossiliferous clays were exposed, resting against the slates unconformably. I have seen them in a number of cases elsewhere. Beyond this point the sandstones appeared, and no other kind of rock was seen up to the trig. station, where every exposure shows the fine-grained compact sandstone. In the Ruahine, immediately opposite Dannevirke, the sandstone appears in connection with splintery or drossy slates, but the upper rocks are sandstone, with here and there traces of a compact conglomerate of the millstone-grit type. The same kind of grit appears in the Whakarara Mountains, between Hampden and Kereru, and it may be that the latter range was connected at one time with the Ruahine in the direction indicated by the grit stone. The whole of the valley between the Ruahine and the Puketoi Mountains is made up mainly of Post-tertiary deposits. They belong to what may best be described as the Kidnapper pumice and conglomerate series. These beds, which are very thick in places, rest on the blue-clay marls, which were once overtopped by limestones.

Along the banks of the Manawatu River, which passes down the valley two miles or so to the eastward of Dannevirke, there are exposures of these blue Younger Tertiary beds similar to what are seen in the Tukituki, just above the crossing between the Ongaonga and Ashcott, and also at the Kidnappers, immediately above the limestones, at the place known as the Black Reef. In several places a little further to the eastward of the river the limestones are seen similar to those at Heretaunga and at Ashcott, between the Tukituki and Tukipo Rivers. This, it seems to me, is important, because it connects all the limestones on the western flank of the Cretaceo-tertiary rocks into one great and continuous whole. These limestones are met with as outliers in a number of places flanking the Ruahine Mountain between Woodville and Kereru. The Mangatoro Stream, near to what is known as Hamilton's Homestead, appears to separate the younger from the older blue-clay marls. The latter marls are similar to those exposed in the cliffs between Waikare and Wairoa, but the fossils are too fragile to make a satisfactory collection. Between the younger and older series of blue-clay marls a calcareous sandstone is met with in places, which passes sometimes into limestone of fairly compact texture.

The limestone is finely exposed in a scarp some six miles or so beyond the Mangatoro Stream, and, as there is no stone suitable for road-metal between this place and Weber, or, indeed, between here and Wimbledon, no doubt it will be largely used for road purposes in the near future. This limestone is similar to that found in the gorge of the Tukituki River, on the side towards Waipukurau, and the same fossils, *T. angulare* and *O. ingens*, are common to both. The limestone found in the Wanstead Gorge appears to belong to the same series, and as an impure sandy calcareous deposit it is seen to pass between the two clay-marls midway between Patangata and Tamumu, on the right bank of the Tukituki River. The hills, which are topped by the limestone scarp, form the dividing-range between the east coast and the Manawatu basin, and from this place there are no rocks younger than these, which are, in reality, the youngest of the Puketoi rocks exposed in this direction. Proceeding further towards the coast the blue clays, wherever exposed on the roadside, are somewhat indurated, but they seem to be acted upon by strains at right-angles to the pressure, and they break from the rock in sheets with a kind of conchoidal fracture. These rocks have a great tendency to move glacier-like into the valleys; and the whole country can be read in the peculiar appearance presented by the moving masses towards the streams, which they sometimes dam back until a new channel has been cut.

At the stream known as Kereru, five miles or so from Weber, the rocks belonging to the upper greensands appear. These sands contain concretionary bands of impure limestone, which are fossiliferous, but exposure to the weather rapidly acts upon them, and they quickly decompose. The greensands are filled with black flakes resembling lamellar hornblende, but whether they are hornblende or not I cannot say. These greensands seem to me to belong to the same series which are so largely developed along the coast-hills between Porangahau and Wainui—Cook's Tooth being the central height—and are first met with on the top of the hills overlooking Porangahau on the Wallingford side. In neither of the latter places, however, have I observed a ferruginous limestone band, but, as traces of this greenstone extend to the hills overlooking the Roan Creek, a mile or so from the Weber Township, there can be but little doubt that they are the representative beds of the coast greensands, seeing that the Waipawa chalk-marls make their appearance in this creek. Between Roan Creek and the Akiteo Stream, where it crosses the road, the whole area is made up of chalk-marls. In some places these marls have a conchoidal fracture, but near their junction with the blue clay they weather into small cubical pieces, and the whole exposed surface has what may be termed cleavage-planes not unlike the splintery slates at the base of the Ruahine, except in the matter of hardness. The blue marls continue from the Akiteo Stream past Tea-tree Point, and thence onward to the top of the hill leading to the Wainui Stream. No fossils of any kind were observed in these blue marls.

At the bottom of the hill leading to the Wainui Stream the black and brown oil-shales are well exposed. They have been used here for road purposes, as they are the hardest rocks in the district. These shales have a very wide distribution along the east coast of the Island. Their most northern locality is at Port Awanui, a few miles to the south of East Cape. There they are largely exposed in connection with the greensands and the blue-clay marls. The next place where they appear as surface-rocks is near the Waipaoa homestead, on the Waipaoa River, thirty-five miles to the north-west of Gisborne, in the vicinity of the once much-talked-of Poverty Bay oil-springs. They are next seen well exposed near Baker's Brewery, at Waipawa, within half a mile of the town, and again on the top of the hills overlooking Porangahau. In each place named they are met with in connection with greensands and chalk-marls. Southward from Porangahau no trace of the rocks is again met with until reaching the Wainui Stream, when they are exposed three times along the high banks in a distance of six miles. Thus in a distance of 350 miles the black oil-shales are met with five times under almost identical circumstances. These shales contain a large percentage of vegetable matter. Numerous fish-scales have also been found, and peculiar tubes like compressed pipe-stems are very common throughout the beds. The Wainui Stream, between Wimbledon and Speedy's homestead, shows several fine sections where the black, red, and grey shales merge into each other, proving that the so-called oil-shales are not an isolated deposit, but are a part of a widely-distributed series of beds, which, though deposited at the same time, were deposited under different conditions. From Speedy's to the coast the rocks are either the greensands or the blue-clay marls, which are interbedded with them.

Up to the present time no minerals of commercial value have been found in the district under notice. Some years ago, I remember that a Mr. Wilie, who was postman and telegraphist at Wainui, showed me some fine specimens of agate which he had collected in various parts of the Akiteo river-bed. I have no specimens of the stone he collected, but similar unpolished specimens were lately sent to me by that hard-working member Mr. Taylor White, who found them in the vicinity of the same river. Quartzose boulders, but of an orange-yellow, with agate bands, are found over the hills between Wallingford and Porangahau—the last remnants of the greensands in these places. I have not yet had an opportunity of visiting the lower portion of the Akiteo River, but, from information, it appears there are some old rocks to be seen in that district. An old Maori legend says that it was near Akiteo that the Natives made their *meres*, or obtained stone for sharpening purposes; and Mr. Tone, a surveyor, who is a careful observer, tells me there are rocks—black rocks—which he thinks must be volcanic. When the bush about Wimbledon was being surveyed previous to being thrown open for selection I visited the place with the then Chief Surveyor, and in the bed of the stream thin bands of bright coal were seen interbedded with a greyish-blue sandstone. I have not visited the place since—now some eight years ago—but it would be well if the banks of the stream near the Wimbledon sawmill were carefully explored. The district is situated within a Cretaceo-tertiary area, and it is among the rocks of this period that the best coal deposits of New Zealand are obtained; nor need one be surprised to learn at any time that a coal deposit has been met with. Certainly the rocks in the district are favourable to such a discovery being made.

ART. XLV.—*Pebbles and Drifting Sand.*

By E. W. ANDREWS.

[*Read before the Hawke's Bay Philosophical Institute, 11th September, 1893.*]

IT has long been a proverb that "the constant dripping of water will wear away a stone." The specimens that accompany this short paper illustrate the central truth of the proverb in the case of another agent, for they show how drifting sand wears away stones.

The first set of specimens is from Wanganui. Just below the bluff on the Wanganui River, towards the South Spit, is a series of low dunes across which the sand is constantly blowing. In the centre of these dunes is a small level space, composed of clay, in which are embedded pumice-blocks, pieces of driftwood, and other *débris*, probably brought there periodically when the river is in flood, or when the sea washes over the sandhills at unusually high tides. For some reason or other the sand never stays on this clay-bed, but sweeps across it from dune to dune; and, as it sweeps across, it polishes quite flat all the *débris* fixed in the clay. I show herewith two pumice-blocks and a piece of wood thus worn away.

The other set of specimens comes from Wellington. Between Island Bay and Evans Bay—that is, between the harbour and the open sea—there is a narrow tract of land shut off by hills on the east and west, but open on the north and south. The result is that the wind that blows across this narrow isthmus has mainly either a northerly or a southerly direction, and the drifting sand, instead of polishing the stones flat (as it does at Wanganui, where the wind can come from any point of the compass) polishes them at a double slope, and gives them the shape of a Brazil nut. Sometimes, by some chance, these stones get shifted, so that their new axis is at right-angles to their old one, and then they assume a conical form. This form is necessarily the least often met with, and I have only one rather poor specimen, though I have seen much better ones.

It would be interesting if those who see these stones this evening would, when crossing a sandy tract, keep their eyes open for any pebbles that illustrate the erosive action of drifting sand. Facts of this nature, though small in themselves, often enable the geologist to formulate a new theory. For instance, the stones that are before you to-night might form a text for a sermon on the shaping of mountain-ranges by atmospheric dust—a sermon which I am sure you will be delighted to hear I am not now going to preach.

Art. XLVI.—*Notes on the Piako and Waikato River-basins.*

By Lawrence Cussen.

[*Read before the Auckland Institute, 23rd October, 1893.*]

I had the honour to read a paper before the Auckland Institute in December, 1888, on the Waikato River-basins.* There was little time to discuss the subject on that occasion, and, as the changes in the course of the river are of an interesting and somewhat recondite character, I believe some of the members will be glad of an opportunity of discussing them. I have been enabled to add considerably to my previous notes and to include portions of the Waipa and Piako basins during recent journeys through the districts, and fresh evidence of changes in the level of the land and alterations in the courses of the rivers during comparatively recent times will be submitted to you.

It has been my fortune during many years past frequently to visit every part of the Waikato basins, and, in conducting the topographical survey of the country, I was afforded an excellent opportunity of studying its surface configuration. Unlike many of the great questions with which geologists have to deal, the study of the earth's surface-features requires no special scientific training—it is within the limits of our most familiar experiences. One needs but the time and opportunity, with some experience. Nature's features are bare before us—we can read on the faces of the cliffs and the terraces, in the steep or gentle grade of the valley to the river, and in the character and distribution of the surface-soils and water-laid materials, the half-hidden history of the past. These notes refer to a comparatively recent time from a geological view—a period during which the surface configuration of the country was very much as we see it at the present day.

The Waikato River rises amongst the peaks of Ruapehu, and, flowing along the eastern base of the Tongariro and Ruapehu volcanic chain, receives the drainage of the great mountains and several considerable streams from the Kaimanawas, and enters Taupo Lake at Tokaanu. Taupo Lake is $24\frac{3}{4}$ miles in length, and $16\frac{1}{2}$ miles in width; its average depth is about 400ft. It is bounded in most places by steep lava-cliffs and associated tuffs. Two well-marked terraces surround the lake and the valleys leading into it. One stands 100ft. above

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* Trans. N.Z. Inst., vol. xxi., p. 406.

the present water-level, and the other 330ft., clearly showing that formerly the lake was at a higher level. The Waikato leaves Lake Taupo at Tapuaeharuru, and flows in a north-east direction down a well-defined valley for nearly twenty miles.

An inspection of the map will show that the Waikato basin here is bounded to the westward by a mountain-chain whose highest peaks are 3,800ft. above the sea. They run nearly parallel with the western shores of Lake Taupo. There is a general persistent trend in the range in a direction N. 40° E. Lateral offshoots diverge, but the general axis of the main chain has a dominant direction nearly north-east. This chain is continued on to Whakamaru and Tikorangi, and becomes confluent with the Patetere plateau and the high wooded country to the westward of Rotorua, where it disappears or becomes coalescent with the disjointed hills, Ngongotaha, Okohiriki, &c., which lie directly to the west of Rohorua, and stand from 2,500ft. to 2,600ft. above the sea. Twenty miles to the east of this main range lies the valley through which the Waikato River flows from Taupo Lake to Waiotapu Valley. The Waiotapu was evidently a continuation of the valley above through which the Waikato River flows from Taupo. The two together form the oldest topographical feature of the country, and along their course on either side are to be seen evidences of immense denudation as they were widened and deepened. To the west of them, extending to the main range, the ground is left projecting into high ridges and prominent isolated hills with valleys filled with alluvium, this general trend being from the range into the Waikato and Waiotapu Valleys. I think it is more than probable that the Waikato at one time flowed through the Waiotapu Valley to the sea on the East Coast, and that the main range before referred to formed the watershed of its basin on the north-west side. But its channel was obstructed, probably by subterranean disturbance or the volcanic action in the Rotorua district; it quitted the original valley, and eroded for itself a new channel in nearly a due west direction, through a pass of the range between Whakamaru and Titiraupenge.

The topography of the country and the land-sculpture in the new river-valley bear out this view. The waters of the river were poured back into the valleys, which they occupied for a time in the form of a serpentine lake or lake-like river with many arms spreading in between the spurs of the ranges. Round Tuahu, Ngautuku, and the other hills between Ateamuri and Taupo, are seen the old lake-beds filled with alluvial deposits. In the valleys between the hills are immense beds of pumice and sand in horizontal layers, sometimes over 200ft. in depth. Through these the streams have worn their channels down to the bed-rock, disclosing stratified layers of drift-pumice and light sands, enclosing the trunks of trees and carbonised wood. The worn shore-like sides which surrounded these pumice-beds, cliffs of tufaceous rock, often plainly waterworn, and the stratified horizontal layers of light drift pumice, leave but little doubt that a large area in this part of the Waikato basin was occupied by a lake through which the river flowed. In my opinion, deposits of light pumice sands such as are here found could only be laid down in still water.

The elevation of the outlet through the range was at first 300ft. above the present bed. A steep narrow channel was formed through the pass, the successive stages in the process of lowering being marked by horizontal terraces round the south end of the gorge and the lake-basins in the valleys above. These terraces are of immense proportions, ranging to 200ft. above the present river-bed. An excellent example of these terraces may be seen near Ateamuri Bridge, where the Rotorua–Taupo Road crosses the river. Below the gorge the river eroded a deep and narrow channel through the loose tufa country along the base of the wooded mountains of the King-country. Here one looks in vain for the characteristic features which mark an ancient valley. The country through which the river flows has the appearance of an old plateau, along the bases of the ridges and hills of which the water cuts its channel, and there is nothing to mark its course as an ancient feature of the landscape—no prolonged area of depression along the course of the river, and very little terrace formation.

Another remarkable deflection from its natural course would seem to have taken place in the Waikato at Hinuwera, fourteen miles above Cambridge. Here we have a broad, well-defined valley, bordered on either side by waterworn cliffs, from 30ft. to 40ft. in height, sloping down through Hinuwera in a north-easterly direction towards Matamata. It is confluent with the valley of the Waikato above. The trend and height of the river-terraces, the character of the alluvium, the waterworn cliffs, and the general topographical features of the land all point to the conclusion, I think, that this was its old natural valley, and that the Waikato once flowed down through it to the sea in the Hauraki Gulf. For the causes which brought about the change in the Waikato's course here we seek in vain amongst the topographical features of the land. There is nothing to show why its natural course was impeded, and why it is not now flowing down the Hinuwera Valley to the Hauraki Gulf, instead of taking the unnatural course it has through the ridges of the Maungatautari and Hinuwera Ranges.

Here, again, we have the same sequence of events recorded that took place at the Whakamaru. It would appear that the waters of the river were ponded back into the valleys above, which they occupied in the form of a sinuous lake, extending upwards for over eight miles, and covering the Waipa Plains, which were evidently the bed of a lake. The topography of the country bears strong evidence of this. We find the remains of a deep alluvial deposit which filled the valleys running in between the spurs in level plains. Through these deposits the streams, in eroding this channel, exposed strata, horizontally laid, consisting of rhyolite sands, pumice, and detritus, including the trunks of trees. At Paeroa, where the Auckland Agricultural Company's homestead at Cranston is situated, this deposit has a depth of 130ft., as exposed by the washed-out gully of the Piarere Stream. It extends down the Hinuwera Valley, and almost disappears at Parakau, four miles from the present bed of the Waikato.

Reference to the map will show the elevation of the lake-bed on the Waipa Plains to be 340ft. above sea-level. A terrace of about the same height fringes the valley of the Waititi Stream on the opposite side of the Waikato, and extends down the river-side to Piarere. It is a remarkable fact that the height of the old river-bed in the Hinuwera Valley is only 280ft. at Piarere, and the valley slopes gradually down towards Matamata. Were the contour and levels of the valley as we now find them there would be nothing to impound the water in the lake, the old Waipa lake-bed being 60ft. above the outlet in the Hinuwera Valley. I shall have occasion to refer to this question again in considering the causes which brought about the changes in the river's course.

The highest terrace in the Maungatautari Gorge has an elevation of 300ft. above the sea. Water-worn rocks appear on both sides of the river at that height, and between them on either side of the river are seven rows of terraces extending down to the present river-channel, which is cut deep and precipitous through the rhyolite rocks.

The broad plain in central Waikato, in which the towns of Cambridge, Hamilton, Ngaruawhia, &c., are situated, has an area of 500 square miles. All over the lower areas of this plain we find an alluvial deposit, varying in depth from 150ft. downwards. The character of this deposit is unmistakable—it is no doubt the alluvium of the Waikato River, and differs in no way from that at Waiotapu, Whakamaru, and Hinuwera. Pumice-drifts are not found to any extent in the beds of any of the other rivers which flow into the Waikato middle basin. How these deposits came to be laid down as we now find them is an interesting physiographical question. The surface-height of the land at Cambridge is 220ft. above the sea, at Hamilton it is 120ft., at Ngarato 125ft., and at Morrinsville 82ft.; whilst at the Taupiri Gorge the elevation is only 39ft. Yet we find that the Waikato carried its alluvium to the Rotorangi Swamps, eight miles in a southerly direction, against the present grade of the country, the natural fall being north and east, towards Morrinsville and Taupiri, at the rate of 7ft. to the mile. It becomes at once evident, on considering the relative heights of the land in the middle basin, that it never could have been occupied by a lake, nor could these deposits have been laid by the Waikato at all if the levels of the country were as we now find them. The lake would have four outlets: one at Morrinsville, one at Hapuakohe, one at Matahura, and the present river-bed through the Taupiri Gorge (supposing it to have existed at that time), all considerably below the bed of the lake. It may be suggested that the deposits are estuarine, and were laid when the middle basin was a bay of the sea. The whole topography of the country and the character of the alluvium are against this theory. There is no trace of marine deposits to be found, and if any existed they would easily be discovered amongst the detritus which is scored and exposed by the streams, frequently to great depths, all over the plain. Neither is there any trace of a sea-beach found fringing the swamps round the clay-hills in the plain which were islands dotting the lake. Hochstetter says of the Middle Waikato basin: "The whole basin was, previous to the last elevation of the North Island, a bay of the sea, extending from the Hauraki Gulf far into the interior. The steep margins of the surrounding hills continue to this day displaying the seashore of old, and the singular terrace formation on the declivities of the hills and the river-banks within the basin is the result of a slow and periodical upheaving." This being so, as the land gradually rose and the sea receded, tidal channels would have been left within the estuary, through which the rivers and streams would continue to flow out of the basin to the sea in the Hauraki Gulf—that is, if no change of the surface took place to prevent the natural course. We now find, however, that the valleys where these estuarine channels might be looked for are filled with an alluvial deposit of the detritus of the volcanic country brought down by the Waikato River, and placed in stratified horizontal beds, as they could only be laid in very slowly-moving or impounded water.

The depth of these deposits varies considerably. In the Rukuhia Swamp, between Hamilton and Ohaupo, they are from 50ft. to 70ft.; in the Piako Swamp, from 40ft. to 60ft.; at Hamilton, from 40ft. to 70ft.; and in the neighbourhood of Taupiri, the lowest point in the basin, it is a remarkable fact that the deposit is lightest. Beneath the deposit in many parts of the basin the old land-surface may be seen.

In the bed of the Waikato River at Hamilton several maire-trees appear standing as they grew, the present land-surface being 70ft. above them. In many of the gullies eroded by the streams trunks of trees are found lying horizontally, and some standing, their roots penetrating the old land-surface. The most interesting example of this character, because of the most recent occurrence, is that shown on Mr. E. B. Walker's property at Mona Vale, near Cambridge. A drain was cut about a mile in length through a spur of dry land to drain the Mona Vale Swamp into a gully which led to the Waikato River. During a heavy rainfall some years ago a scour started in this drain, which soon eroded a gully 70ft. in depth and several chains wide. At the bottom of this gully the ancient surface, consisting of a brown marly-looking soil, is exposed to view. The trunks of trees are seen lying on the old land-surface, and some are standing, their roots penetrating the old soil where they grew.

The Waikato flows in almost a direct course from Cambridge to Ngaruawahia in a north-westerly direction, crossing the former estuary diagonally. In a flat alluvial valley like this we should naturally expect to find a winding river and a broad and terraced river-valley, instead of which there is a comparatively narrow valley, a deep-cut channel, and the river runs in a direct course, until it is stopped by the Hakarimata Ranges, near Ngaruawahia; it then follows the base of the mountains to the Taupiri Gorge.

Five miles and a half east of the Waikato River, below Huntly, there is a wide valley extending from the Mangawhara Stream, in the middle basin, to the Matahura, in the lower. It is very evident from the topography of the country that this was at one time the outlet for the middle basin, and the Waikato flowed through it and down the Matahura Valley, through Waikare Lake and the Whangamarino Flats. That the Taupiri Gorge, through which the river now flows, was formed subsequently I think there can be very little doubt. Captain Hutton, in his paper "On the Alluvial Deposits of the Lower Waikato, and the Formation of Islands by the River," says: "There appears, therefore, to be no geological evidence of the sea having been in the Lower Waikato Valley since the upheaval of the Waitemata series—that is, since it has had any existence. I therefore think that the fact of the presence 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."* The evidence of changes in

* Trans. N.Z. Inst., vol. iv., p. 334.

the level of the land, and alterations in the courses of the river in the Lower Waikato basin, are numerous and interesting from the surface-geologist's point of view, and a great deal might be written about them, but it is not my intention to enter fully into a description of this basin at present. One of the most interesting features of the Lower Waikato basin is the Matahura-Whangamarino Valley, which lies to the westward of the wooded Hapuakohe Ranges. The Matahura and Whangamarino Rivers rise in the centre of it, the former flowing to the south and the latter to the north-west. Their sources are a very short distance apart, and are separated by a low saddle. This has evidently been the valley of a large river at some period, and does not owe its erosion to the small streams which now occupy it. There are evidences of vast erosion high up on the sides of the valley, the remains of ancient river-terraces now worn and wasted by the elements. This was probably the course of the Waipa River when the Waikato flowed into the sea in the Hauraki Gulf. The alluvium of the valley is quite different from that of the Waikato; it is an argillaceous deposit, free from pumice or the rhyolite sands which characterize the deposits of the Waikato. It is very fertile. The lands in the Matahura and Waerenga Valleys derive their rich qualities from it, the latter being some of the most fertile in the Waikato district. It is the same alluvium which characterizes the rich lower terraces of the Waipa River, from Ngaruawahia up into the limestone land in the King-country, and is traceable along the Mangawhara River into the Matahura Valley.

Passing now from the Waikato to the Piako basin, we find again evidences of changes, as shown by the raised beaches, ancient terraces, and the river-alluvium. The level, swampy plain extending from the Hauraki Gulf to Te Aroha is plainly a combination of the bed of the gulf: the base of the hills on the western side of the valley shows distinctly the remains of the former coast-line. At Maukoro, twenty miles inland from the sea, close to the western bank of the Piako, and near the confluence of the Waitoa and Piako Rivers, an old raised beach, standing about 17ft. above high-water mark, is to be seen. There is a consolidated slag or marl deposit containing shells and unmistakable crab-holes, such as we see on the soft beaches at present. Along the banks of the Piako there are numerous sand-banks and banks of sea-shells, clearly showing that at no very remote time the Lower Piako Valley was a shallow bay of the sea. The immense quantity of pumice and other detritus from the volcanic districts laid down as river-alluvium in this large valley shows that it was the valley of a great river flowing through a volcanic country; and I have no doubt but the Waikato brought down the alluvium seen in the upper portions of the plain, by Matamata. The alluvial beds of the lower areas of the Piako basin from the confluence of the Waitoa and Piako to the sea differ in a very remarkable manner from those higher up, and in the Waikato basins. Here we find a heavy argillaceous deposit similar to that of the Waipa River. A large area on the western side, and between the Piako and Thames Rivers, is covered with it. The land is extremely fertile, and if it could be drained would be some of the best soil in the country. The source from which the alluvium came is an interesting question. That it should be found in the lower area of the valley, whilst higher up, on the plains of Piako, Te Aroha, and Matamata, the alluvial deposits are of pumice and sands similar to those in the Waikato basins, is not easy to explain. The tributaries of the Piako may have brought down clay-alluvium from the Maungakawa Ranges, but it would necessarily be limited in quantity, from the small area of the ranges which they drain. I think it best explained by supposing it to have been brought down by the Waipa River from the limestone land in the King-country previously to the great upheaving and changes in the Waikato basins, and laid down in the lower part of the Piako Valley as an estuarine deposit when the Hauraki Gulf extended further inland. There is some evidence to favour this supposition. The Mangawhara Stream rises near Hoeatainui, within three miles of the Piako River at its confluence with the Waitoa. A low saddle in the fern-ridge which separates the head waters of the Mangawhara from the Piako Valley would seem to have been eroded by a river. Terraces are traceable on either side of the saddle. At Hoeatainui, and all along the Mangawhara Valley to the junction of the river with the Waikato at Taupiri, the alluvium is of similar character to that of the Lower Piako Valley. It seems probable, therefore, that at one time the Waipa occupied the Mangawhara Valley, and flowed into the Hauraki Gulf at Maukoro.

From the foregoing observations it would appear that the Waikato River for a long period of its history has undergone successive changes in its course. At each change it would appear to have left its natural valley, and, turning to the westward, found a new course through the ranges which separate one valley from the others. Each basin would appear to have had extensive lakes situated within it. The present topographical features of the country do not afford sufficient evidence of the causes which effected these changes. If the levels of the country were as we find them to-day there would be nothing to impede the Waikato River in its old and natural course by the Hinuwera Valley to the Hauraki Gulf. And the contour of the Middle Waikato basin would not permit of the existence of the lake: neither would the Waikato River occupy its present course directly across the plain, cutting through a series of clay-ridges, whilst the fall of the country from Cambridge is in a northerly direction. To subterranean movements altering the surface-elevation of the land it is evident these changes in the river's course are due; and these movements of elevation of the surface were of a paroxysmal character, or, at least, too rapid to allow the river to erode its channel deeper as the land rose. The evidences of elevation and depression we have are numerous. Captain Hutton proves submergence at the Thames by finding at a depth of 30ft. below sea-level, near Shortland, kauri-gum, raupo, and pieces of wood. He continues as follows: "It would thus appear that when the alluvium full of boulders found on top of the hills (near Shortland) was forming, the land was 1,000ft. lower than at present; that it then gradually rose until it was 100ft. higher than now; and at that time the Thames ran farther north than Shortland. The land then sank to about 10ft. or 12ft. lower than now, and subsequently has again risen to its present level." I would here remark that when the land at Hauraki was 1,000ft. lower than at present—assuming that the movements of elevation and depression were unequal in the different parts of the district (a supposition of which we have some proofs, as shall be shown later on)—the Waikato River would flow down the Hinuwera Valley to the Hauraki Gulf, which would at that time extend far up the valley. As the land rose until it was "100ft. higher than now," probably the axis of elevation would be along the main range from Cape Colville to Rotorua, with a contemporaneous subsidence to the south-west. The changes of level may be supposed to have ponded back the Waikato River into its valley above Hinuwera until it had graded a new channel through a pass in the Maungatautari Gorge. And the same explanation may be applied to the phenomena in the Middle Waikato basin. When the land in the Hauraki was "1,000ft. lower than now" the Middle Waikato basin was probably a shallow bay of the sea. As the land rose along the main range until it was 100ft. higher than now, the waters of the Waikato were impounded in the middle basin, covering all the lower areas of the valley as a shallow lake, which were then filled with the alluvial deposits we find there now. The formation of the Taupiri Gorge would probably have taken place at this period. The direct course of the Waikato River from Cambridge to Ngaruawahia, and the absence of a wide valley, may be taken as indicating the rapid formation of the river-bed, which was probably the result of the changes of level. Mr. James Stewart, in his paper on "Evidences of Recent Changes of Level in the Waikato District," gives the following: "The proofs of subsidence we at present adduce are two. The first lies in the sunken forest in Lower Waikato. Thus we find at a distance of forty-five or fifty miles from the sea the remains of an ancient forest, the trunks of whose trees are standing as they grew. They are found as snags where their roots are far below the level of high water in the ocean." The cylinders of the railway-bridge at Ngaruawahia are sunk several feet lower than high-water mark in Auckland Harbour, and at this depth river-pebbles and shingle were found, indicating an ancient river-bed.

In a section of a bore for coal at Huntly large gravel was found 60ft. below the level of the sea.

On the clay-hills in the swamps at Waikare Lake water-worn blocks of pumice are deposited in saucer-like depressions on top of the hills, 30ft. above the level of the lake, positions to which only the water of the lake at a former elevation could take them. Near the trig. station at Pukeotaka, near the Miranda, a mass of rounded boulders appear, which mark an old river-bed when the country was very much lower than now, and when the stream from the Lower Waikato basin flowed into the Hauraki Gulf at Pukorokoro. That elevation is plainly shown along the western side of the Hauraki Gulf within recent times is proved by Mr. Percy Smith in his paper on "Changes in Level of Coast-line in North New Zealand."* Whether these subterranean movements are going on at present or not we have no conclusive proof. The records of the height of the recent flood at various places, as compared with that of 1875, would appear to give some evidence of recent depression in the Lower Waikato basin. Thus, in the recent flood the water rose in the Waikato River at Mercer 2ft. higher than it did in the flood of 1875; at Hamilton it was 5ft. lower; at Ngaruawahia the same; and the Waipa at Alexandra did not rise within 6ft. of the flood of 1875. It may be that the flooded state of the Whangamarino Swamps and streams of the country generally caused the difference; but, considering that the flood was at its highest at Mercer for several days, and the enormous difference in supply which 5ft. of depth in the Waikato and Waipa would make, this seems scarcely probable.

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* Trans. N.Z. Inst., vol. xiii., p. 398.

Art. XLVII.—*On a Doleritic Dyke at Dyer's Pass.*

By R. Speight, M.A.

[*Read before the Philosophical Institute of Canterbury, 4th October, 1893.*]

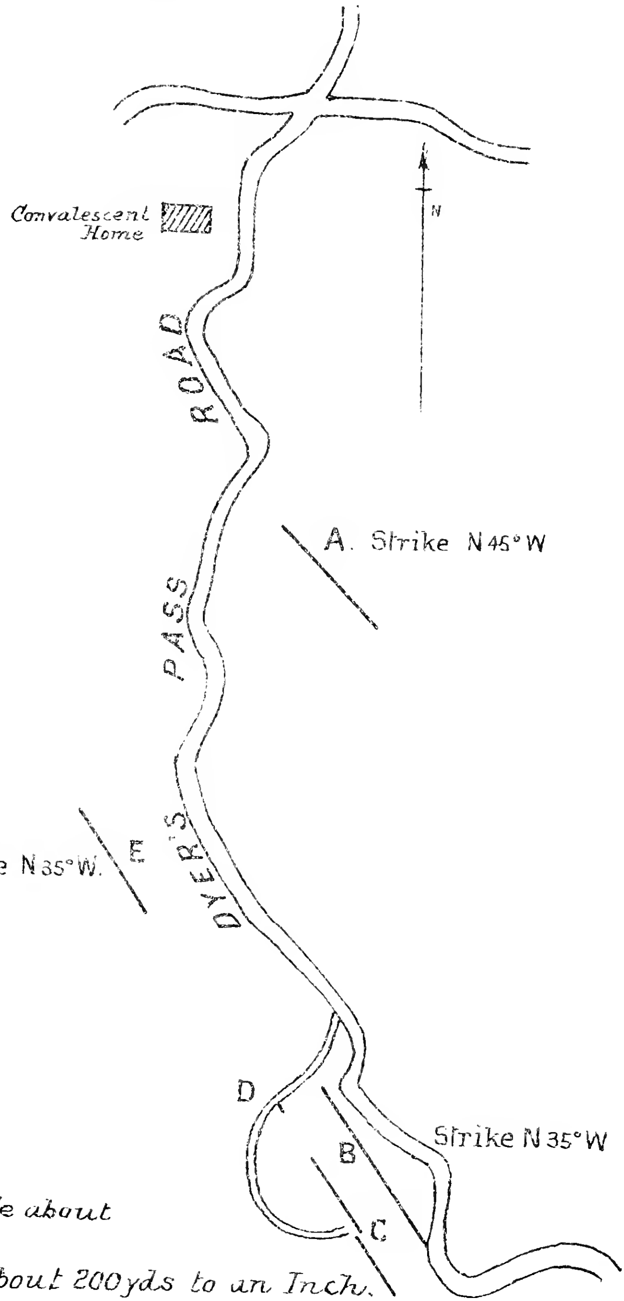
Plates XLIX.–L.

Locality.

On the Dyer's Pass Road, over the Port Hills to Governor's Bay, there occur several dykes. One of them (Pl. L., a), just above the Convalescent Home, runs north-west and south-east. It has been quarried for some distance, and is about 6ft. broad, and nearly vertical. It is probably classified as an andesite, but the deep weathering has rendered an accurate determination difficult. It seems to be composed of an interlacing network of feldspar microliths and augite grains, in which are porphyritic crystals of feldspar. This is probably labradorite, since the extinction-angles between twin lamellæ are greater than 37°, but not greater than 63°; also, a crystal in a section which shows no twinning, and is therefore probably parallel to the brachypinacoid, gave an optic axis out of the field, and a revolving axial shadow. There is no other porphyritic mineral. Probably augite is present, but only one large crystal was noticed, and that was greatly altered. The feldspar of the ground-mass is probably oligoclase, as the extinction is nearly parallel to the length of the microliths, and never greater than 5°; but the determination from the extinction of twin lamellæ did not give satisfactory results on account of undulose extinction. The augite of the ground-mass is greatly altered, forming brown grains of limonite.

Higher up on the road, on the south side, there is another dyke (b), running also north-west and south-east. It has not been quarried, and so it was very difficult to get satisfactory sections. It is about 10ft. wide, and shows a rudely columnar structure perpendicular to the sides of the dyke. The ends of the columns are easily seen, as on the lower side it appears as a wall about 12ft. high. This is probably basaltic, as sections show olivine to be present, though in all I obtained it is altered to limonite.

Below this dyke occurs an old quarry in a corner of a small gully (c). This has not been worked for some time, but quantities of stone lie about. This has been derived from a large dyke about 15ft. broad. The dyke runs generally in a north-westerly direction, but where the quarry occurs it has been bent, so that the two lines make an angle of about 15°. The dip of the eastern branch is about 75°, while the western is



Scale about 200 yds to an Inch.

To illustrate paper by Mr R Speight

nearly vertical. There are other outcrops up the western side of the gully, and at a road on the other side of the spur (D), and again on an adjoining spur (E), where it has been quarried. The country rock is an olivine-andesite, but in the neighbourhood beds of laterite occur, produced by the weathering of the andesitic and basaltic flows, and by the subsequent pouring over them of hot lava streams. In no place were the beds observed to overlie the dyke, so it is most probably of later origin. The country rock has been altered near the edge of the dyke into a black rock in which crystals of feldspar appear, while a little further away it has become a laterite.

The dyke is composed of a dark-grey rock on fresh exposure, but near the edge it becomes black. It is more crystalline in the middle, but contains vesicles throughout. These are not filled with infiltration products. Near the edge occurs a band of steam-holes, with their long diameters parallel to the edge of the dyke. There is not any well-marked columnar structure such as occurs in the dyke above.

Specific Gravity.

By weighing pieces of the rock in water a specific gravity of 2·77 was obtained, but on grinding to a fine powder, and using a specific-gravity bottle, a result of 2·86 was obtained. This is what we should expect from the vesicular nature of the rock. The further examination of the rock was carried on—(1) By a quantitative chemical analysis; (2) by a microscopical determination by means of thin sections.

I. *Chemical Analysis.*

The following result was obtained:—

Loss on ignition	1·78
SiO_2	48·60
Al_2O_3	17·87
Fe_2O_3	6·20
FeO	5·76
CaO	9·11
MgO	4·32
K_2O	2·06
Na_2O	4·66
	100·36

This corresponds fairly closely with a dolerite of Hailstone Hill, Rowley, with the exception of the absence of TiO_2. (Teall's "British Petrography," p. 213.) It is well within the basic series, as is shown by the percentage of SiO_2. The large proportion of CaO may be accounted for by the presence of anorthite as the porphyritic feldspar. This was never large enough to be analysed separately.

II. *Microscopical Examination.*

A microscopical examination of the rock shows it to be composed of a holocrystalline ground-mass, in which crystals of feldspar, augite, olivine, and magnetite are porphyritically distributed.

Porphyritic Minerals: Feldspar.—The feldspar is the most important porphyritic mineral. It occurs in lath-shaped and rounded forms up to $\frac{1}{16}$in. in length. The species of feldspar as determined by the extinction of twin lamellæ proved to be anorthite, as the angle of extinction was noticed in several cases to be 70°, and slightly over. However, the determination was rendered inexact and difficult by the frequent occurrence of undulose extinction. As no cleavage-flakes could be obtained, no reliable determination could be made with convergent light; but the examination of sections which showed no twinning, and would therefore probably be parallel to the brachypinacoid, gave a revolving axial shadow and an optic axis just outside the field of view. This would make it bytownite or anorthite. So the conclusion to be come to is that it is probably anorthite, a species of feldspar almost typical of basic rock.

Inclusions of magnetite are common, and on examination with higher powers there appeared numerous small acicular inclusions. These did not show straight extinction nor pleochroism, so they cannot be apatite. Many of the crystals show traces of alteration, and in some cases the crystals are completely honeycombed. These alteration products are often confined to the interior of the crystal, or arranged in zones, while the outside is altogether free from them.

The characteristic twinning is of the albite type, but cases occur which show the cross-hatching due to twinning on both the pericline and albite types, while one case showed three sets of twin lamellæ, one inclined at an angle of 20°, and the other at an angle of 70°, to what seemed the ordinary twinning of the crystal. This was parallel to the length of the crystal, and could be traced passing through the others as if it had been of the latest formation (Pl. XLIX., fig. 1). This may show that the state of polysynthetic twinning is the more stable state for feldspars near the surface of the earth. The twin lamellæ were noticeable for the fact that they frequently died out, or occupied but a small portion of the crystal. Several cases were noticed in which an internal kernel was twinned, while the outside portion was untwinned, or twinned in a different direction. The twin lamellæ sometimes end abruptly at the edge of the core, but occasionally are prolonged faintly to the edge of the crystal. The most characteristic feature of the feldspar is the curious evidence of crystal growth. In many cases the crystal seems composed of a kernel round which new material has been deposited (Pl. XLIX., fig. 2, and Pl. XLIXA., fig. 3). In some cases this may be true zonal structure, but sometimes the wave of extinction passes outwards gradually, so that there are no zones at all. The kernel is at times rounded in form, and seemingly corroded, but the resultant shape is idiomorphic. In one case the gradual approximation to the crystallographic outlines could be traced. This structure is not peculiar to the feldspar, but belongs to the augite in a small degree, and appears faintly even in the olivine. There are several facts which show that this has been produced late in the history of the crystal:—

(1.) The kernel is usually irregular in shape, as if it had suffered injury from various solvents, &c.

(2.) The alteration products and inclusions are usually confined to the core, while the periphery is usually free.

(3.) Cracks in the core suddenly terminate at its edge; of course, many instances occur in which they are prolonged through the surrounding portion.

(4.) There is often a zone of alteration products at the edge of the core, as if the crystal had been weathered there and had commenced growing afterwards.

(5.) Twin lamellæ terminate at the edge of the core, though a few sections showed them prolonged further.

(6.) The periphery is often twinned in a different direction from the interior.

These observations seem to show conclusively that the crystals had suffered weathering before they were added to. If this is the case the rock must have been solid at the time, and the question is, Where has the new material come from? If the crystal had been enlarged while the rock was molten it would be easy to understand, but the appearance of weathering renders such an hypothesis improbable. This has been noticed before by Professor Judd (*Vide* "Quarterly Journal of the Geological Society," vol. xlv., page 175), but in that case the crystals which showed growth were in a glass, and he supposes they grew at its expense under altered conditions of temperature and pressure. It would be difficult, however, in this case to account for new growth in this way, since the ground-mass is holocrystalline, and shows no alteration in the neighbourhood of the anomalous crystals. These rocks, being from near the surface of a Tertiary volcano, cannot have been buried under subsequent lava-flows, or under sedimentary deposits, so the growing of the crystals cannot have been caused by the influence of changed conditions of temperature and pressure on a glassy ground-mass. Nor can the crystals have been added to by water saturated with feldspathic minerals, forming accretions round minerals resembling the matter in solution, since the temperature and pressure required for this would not be such as would occur in a dyke which reached the surface. We can hardly suppose that the dyke suffered alteration while it was cooling, owing to the presence of imprisoned hot water, but, if it were the case, then it would explain all the facts. The water saturated with mineral matter would have both a disintegrating and a restoring effect. It would account for the presence of alteration products, and the deposition round a corroded crystal would proceed as the water cooled. There would be no sensible alteration in the ground-mass, though some of the material might be drawn from it. It is usually the case that the ground-mass is more acidic than the porphyritic mineral, and so the new outside layers ought to be more in accordance with this than the kernel. The fact that the twinning extends faintly into the periphery would not be contrary to this hypothesis, as there is evidence that twinning is a structure impressed on minerals as they cool. This is perhaps a hazardous suggestion, but the case seems difficult to explain. It may be that these anomalous crystals were part of an old lava-flow which had suffered weathering near the surface, and then been buried under subsequent flows; and that, as the dyke penetrated it, parts of it had been caught up and the crystals afforded nuclei for crystallization, just as a piece of alum put into a solution of an alum begins to crystallize afresh. All the phenomena observed would be explained by this; but it is rather hard to conceive that the occurrence should be so general throughout the dyke if produced by this means alone.

Augite.—Augite crystals occur abundantly as rounded grains, but occasionally in lath-shaped forms up to $\frac{1}{4}$in. in length. They are of a brownish colour in ordinary light, but at times they have a purplish tinge, and in these cases there is very faint pleochroism. They contain inclusions of magnetite, which are usually absent from the periphery. Their characteristic features are the zonal structure, which has been dealt with before, and a remarkably perfect cleavage. In some cases it approaches the perfection of that of diallage. In the sections which show this there is only one set of cleavage-planes, but in those which show two sets it is not so perfect by any means, and becomes mere irregular cracks. The sections which show one set of parallel cleavage-cracks will be parallel to the axis of *c*. In estimating the extinction-angles with these the maximum result recorded was 44°. The crystals which showed this were usually lath-shaped. Those which showed two sets were short and idiomorphic. In one of these latter the extinction was symmetrical to the cleavage-cracks, and also parallel to a twin lamella running through the crystal. The extinction-angle was 47°. The section would probably be parallel to OP. However, many crystals exhibited no cleavage-cracks at all. Crystals show both binary and polysynthetic twinning. In one case (Pl. XLIXA., fig. 4) a twinned band was observed to be faulted, but no disruption appeared in the crystal, the part which should have been occupied by the faulted lamella being occupied by the adjacent one. In one case a part of a crystal polysynthetically twinned was surrounded by a portion free from twinning.

Olivine.—Crystals of olivine occur throughout the rock. Occasionally they are unaltered, but in the great majority of cases cracks occur with alteration proceeding from them. The product of decomposition is limonite. In some cases the alteration has proceeded so far that only a pseudomorph of limonite remains.

Magnetite.—Grains of magnetite occur throughout the rock, both in the ground-mass and porphyritically, but they graduate into one another. In many cases they are included in the augite and olivine, thus showing it was the first mineral in order of production.

GROUND-MASS.—The ground-mass consists of a holocrystalline aggregate of feldspar microliths and augite and magnetite grains. The feldspar was difficult to determine, since the small crystals nearly always exhibited undulose extinction. By the method of extinction of twin lamellæ it proves to be labradorite or anorthite, since in most of the cases observed the angle was over 20°, and in some few over 40°. However, the method of extinction, with the length of the microliths, gave contradictory results, as nearly all extinguished in the length of the microlith, or at very small angles from it. This would point to oligoclase. This is not very uncommon in the ground-mass of a rock of the basic series, but the first method would probably be more reliable, and the conclusion to be arrived at is that it is probably labradorite or anorthite. The augite and magnetite showed no remarkable structure. There was no glass apparent.

GENERAL CONCLUSIONS.

The foregoing description shows that the rock must be classified as an olivine-dolerite, or, if olivine is to be considered as an essential mineral of the basalt group, it would be called simply a dolerite. The holocrystalline nature of the rock is probably due to slow cooling in a fissure at a slight depth beneath the surface, but not sufficient to allow large crystals to form.

EXPLANATION OF PLATES XLIX.-L.

PLATE XLIX.

Micro-photographs.

Fig. 1 represents a feldspar crystal with three sets of twin bands. The third appears as fine lines parallel to length of crystal. The altered parts are in the middle. (Crossed nicols. Magnified 25 diameters.)

Fig 2. is an instance of a crystal with a kernel of earlier formation. The inside is twinned faintly, and the twin bands die out at its edge. One small part is twinned on the pericline type, but very indistinctly. The dark lines parallel to the corners represent an outward wave of extinction. There is a row of alteration products just outside the kernel. (Crossed nicols. Magnified 25 diameters.)

PLATE XLIXA.

Fig. 3 is another crystal showing zonal structure. The inside is twinned, while the outside shows several waves of extinction moving outwards, but getting straighter in outline, till the form is idiomorphic. There is a zone of alteration just outside the core. The twin band is confined to the interior. (Crossed nicols. Magnified 30 diameters.)

Fig. 4 represents a twinned augite crystal. One of the bands is faulted. The fine parallel lines represent perfect cleavage. A large white crystal near the edge of the field is a crystal of feldspar greatly altered. (Crossed nicols. Magnified 25 diameters.)

PLATE L.

Map of Dyer's Pass Road.

ART. XLVIII.—*Geology of Nelson.**

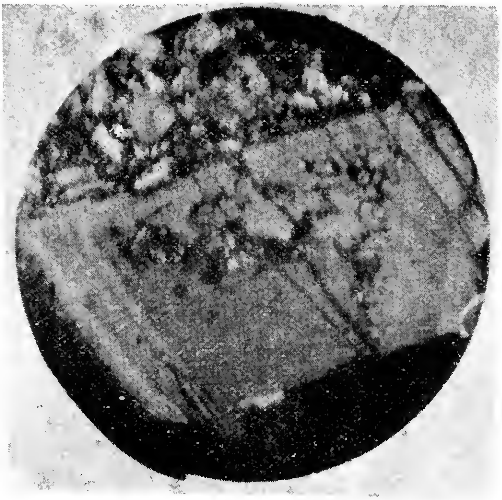
By W. F. WORLEY.

[*Read before the Nelson Philosophical Society, 12th June, 1893.*]

I AM only about to attempt the barest outline of the geology of this district, and in doing so must acknowledge my indebtedness to the Geological Reports, issued by the Geological Department, and to the "Outline of New Zealand Geology," prepared by Sir James Hector, Director of the Geological Department.

To describe the geology of Nelson it will be necessary to say a few words about the geology of New Zealand as a whole. New Zealand, there are good reasons for believing, is but the remains of what was once an extensive continent. Soundings made by the "Challenger," on her famous expedition, brought to light the fact that a submerged plateau extends for many miles to the eastward of New Zealand. The depth of water over this plateau varies from 300 to 600 fathoms, while the water of the ocean beyond the plateau has a depth of 2,000 to

* The maps and diagrams referred to in this paper were enlargements of geological map and sections issued with "Outline of New Zealand Geology."



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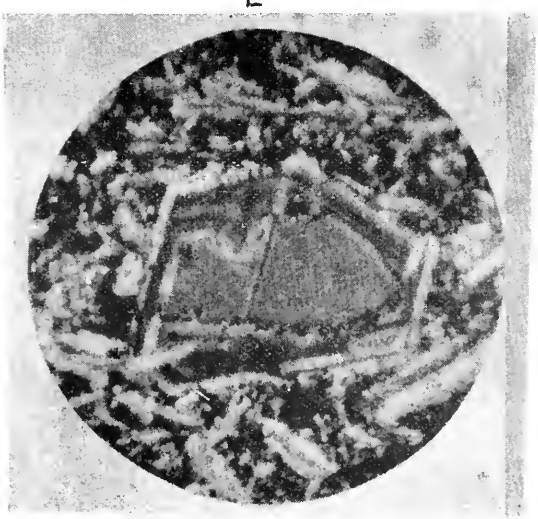

Dolerite Rocks

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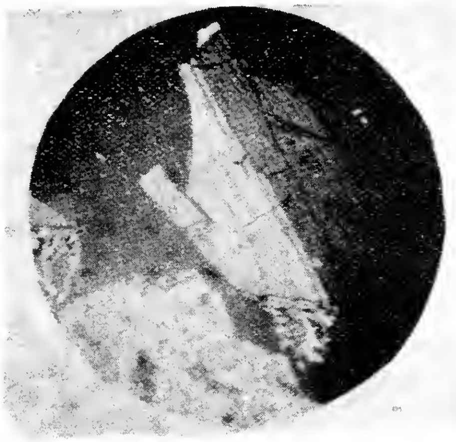

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Dolerite Rocks

2,600 fathoms. Owing to an insufficient number of soundings, the contour of the plateau has not been determined, but it is supposed to extend as far eastward as the Chatham Islands; while to the westward, especially in the south-west, the line of the plateau is almost identical with the coast-line. The coast-line itself also bears evidence of subsidence. Those who have travelled only from here to Wellington have probably noticed how the curve of the hills reaches almost to the water's edge. This shows that the land has had a downward movement in recent geological times. If the land had been stationary we should have had high cliffs, caused by the erosive action of the sea, presenting themselves; or, if the land had been rising, extensive sea-beaches would have fringed the coast. Small islands, near the coast, like Pepin Island, D'Urville Island, Arapawa Island, and Kapiti Island, also bear evidence of the subsidence of the land. These islands are but the tops of hills which once formed part of the mainland. A glance at the map of New Zealand also leads us to conclude that New Zealand had once a more extensive land-area. The coast-line, as you will see, is characterized by a few bold headlands with extensive bights lying between. These headlands are composed of hard rock which has been better able to resist the action of the sea, while the places into which the sea now flows, forming extensive bights, once formed part of the dry land. The remarks about the islands in Cook Strait will also apply to the Barrier Islands, White Island, and Stewart Island.

Let us suppose, then, that the submerged plateau of which we have spoken was once high above the water; that the contour of that plateau was the boundary of an extensive continent which extended from East Cape in the North Island to Shag Point in the South Island: then the place which we now call Cook Strait—I mean the narrow part—was merely a pass in the mountain-chain; and the place which we now know as Tasman Bay was a broad valley, through which probably flowed a large river, the upper reaches of which are represented by the streams which at present drain into the bay.

The greatest depth of Tasman Bay does not exceed 50 fathoms, while a great part of it has a depth of less than 50ft. When the submerged plateau, then, stood above the sea some hundreds, or probably thousands, of feet, Tasman Bay was not merely a valley, but an elevated one; and the mountains by which we are surrounded, having a much greater altitude, were covered with perpetual snow, and glaciers filled our now smiling valleys. This fact is borne out by the extensive glacial deposits found in the Nelson District. The Moutere Hills, and part of the Port Hills, are of glacial origin.

The moraines of glaciers are also found in the neighbourhood of Lake Rotoiti, and in the Takaka district.

While we have good reasons for believing that the surrounding district was once much more elevated than it is at present, we have abundant evidence to prove that it was once far below the level of the sea. Beneath the glacial deposit to which reference has already been made there lies a series of stratified rocks, which, by their lithological character, and by the fossils which they contain, give unmistakable proof of a deep-sea origin. These rocks consist of sandstones and clays, and many of the fossils found embedded therein are those of species now extinct. Some of the lower members of this series are well developed in the Port Hills. When walking round the rocks one is obliged to tread on the upturned edges of the lower members of this series, known as the Lower Miocene formation; while in the cliffs above, especially near the basin, the rocks may be seen dipping into the hill at an angle of about 50°. These rocks, when formed, must have been laid down in a horizontal position; hence their present upturned condition must have been brought about by a considerable amount of upheaval in the earth's crust. Numerous fossils may be found in the above-mentioned rocks, but owing to decomposition it is very difficult to get perfect specimens. A few good ones were found in the tunnel driven by Mr. Brown in his search for coal.

Passing from the Port Hills to Richmond another set of rocks is met with, known as the Wairoa series. These rocks extend from the hills about Richmond to the Wairoa Gorge. They belong to what is known as the Triassic formation, and are older than the Miocene deposits of the Port Hills. Their relation to the rocks of the Port Hills is shown on the sketch, where the rocks of the Wairoa series are seen to dip below those of the Port Hills, while the Port Hills series forms what is known to geologists as a synclinal arrangement. The Wairoa formation is exceedingly rich in fossil remains, some of the hills above the gorge being literally masses of fossils. They may be found in the bed of the river just before entering the gorge, and on the hill-slopes this side of the river, as far north as Richmond. It is the study of these fossils that has led to the determination of the age of the rocks in which they are embedded. *Monotis salinaria* and *Mytilus problematicus* are the most common. Mention is made in the "Outline of New Zealand Geology" of teeth having labyrinthodont characters having been found in this formation. This being so, we may well suppose that, while these rocks were being deposited in the shallow seas of that age, amphibious creatures of considerable size disported in the lagoons, or basked upon the mud-flats.

Leaving Wairoa Gorge, and travelling up Aniseed Valley, a still older series of rocks is met with. These rocks are known as the Maitai slates, and form part of a very extensive system, known to geologists as the Carboniferous system. These slates, in the lower part of the valley, consist of fine-grained clay-slates. Further up the valley the slates become calcareous; and finally a magnificent belt of mountain limestone is reached. This limestone, and the slates already mentioned, are the principal rocks of the Carboniferous system. These rocks are very extensive, and form the greater part of the mountain-chains of the district. They pass from end to end of the provincial district, forming part of the Spenser Mountains, St. Arnaud Mountains, and the low mountain-range running from the St. Arnaud to the Pelorus Sound. As offshoots from the main range they reach almost to the Town of Nelson—Fringe Hill and Botanical Hill being composed of this rock. Extending from Mount Franklyn to D'Urville Island, and running in the same direction as the mountain limestone and the Maitai slates, is a stretch of country known as the "mineral belt." This formation presents a marked contrast to the limestone and slates of the Carboniferous formation. The latter are covered with dense bush, having a luxuriant undergrowth, but, when the mineral ground is reached, the bush terminates abruptly, and gives place to a succession of bare hills, whose rugged grandeur cannot fail to impress the least observant. The lithological character of the rocks is also strikingly different. Instead of regularly-stratified rocks, such as are found in the Port Hills, the Wairoa series, and the Maitai series, we have masses of dark hornblendic rocks, diorite, serpentine, and dunite. Dunite, the typical rock of the Dun Mountain, is an olivine rock containing traces of chromium. The rock itself is crystalline, and of a yellowish-green colour; but where exposed to the weather its hue has changed to a rusty-brown; hence its appropriate name, dunite. It is this formation that contains the deposits of copper and chrome to which I shall refer more fully when dealing with the economic minerals of the district.

Reference has already been made to the mountain-forming character of the Maitai slates and the underlying Carboniferous limestone. I shall now attempt to describe how these rocks were formed, and how they came into their present position. Limestone, as most of you are aware, is of organic origin. Carbonate of lime exists in solution in sea-water. Certain marine animals have the power of extracting the carbonate of lime from the sea-water and of converting it into a solid substance, which they use as a protection or covering for their bodies. When these animals die the shells in which they lived are left behind, and by repeated accumulations of such shells vast deposits of calcareous rock are formed. All our great masses of limestone have been formed in this way, the coral polypi having had the greatest share in their formation. Try for a short time, then, to blot New Zealand as it is out of your memory, and conceive instead a coral reef in a tropical sea—something like the Great Barrier Reef off the coast of Australia. The sea-bottom is slowly sinking, but fresh layers of coral are formed, till several hundreds of feet have been produced. Then, owing to rapid subsidence or change of climate (or, perhaps, both), the work of coral-forming ceases, and layer upon layer of fine mud is deposited on the top of the coral-reef, till a thickness of several hundreds of feet of fine silt has been formed. This silt, of course, must have come into the ocean from the rivers of some adjacent land-area, and represents so much waste from that land. While this silt was being deposited the superincumbent pressure of its own weight, added to the weight of the ocean above, would consolidate it into a hard rock, and produce what is known as a clay-slate. Then an upward movement commences in the earth's crust beneath these rocks, and they are gradually raised till they stand thousands of feet above the level of the sea—not as we know them now, presenting an innumerable variety of landscape, made of valleys, and mountain-ridges, and mountain-peaks, but as a broad belt of elevated land. After a mountain-chain had been thus formed—or, probably, during the latter period of its formation—the pressure from beneath was so great that the overlying crust of limestone and slate gave way, and rock-matter, in a more or less plastic state, from the interior of the earth, was forced into the gap, thus giving rise to the mineral belt, which, as I have already stated, is composed almost entirely of crystalline rocks.

After the formation of the mountain-chain as a broad belt of elevated land, the work of denudation went steadily forward. The heat of the sun by day, the cold of frosts by night, the storms of rain, and the never-ceasing chemical action of the atmosphere began to soften and wear away the rocks. The rain-water, in its endeavour to reach the sea, would form watercourses, which, by the erosive action of the water, would deepen and widen their channels till rivers were formed. The rivers, especially in time of flood, aided by innumerable fragments of rock loosened from the parent rock in the manner already described, would continue to wear down the country, thus forming the broad and deep valleys so characteristic of the hilly parts of this district. When looking down into any of these valleys from some elevated spot, and remembering at the same time that the whole of the valley has been scooped out of the solid rock by the action of the river, two forcible questions present themselves to the mind: First, what has become of the material which once filled the valley from crest to crest of the existing hills? Second, how long did it take the river to remove that enormous mass of matter? The answer to the first question is comparatively easy. The matter thus eroded has been carried down to the sea, the lighter particles floating far out into deep water, and there settling down to form fresh deposits of sedimentary rock, while the heavier portion would settle at the mouth of the river, and there form a delta. Beneath our feet at the present moment lies the *débris* of the rocks which once formed an integral part of the mountains near us. The greater part of the Town of Nelson stands upon the delta of the Maitai, while the delta is still extending seaward by fresh accumulations brought down by every flood. In the same way the Waimea Plain has been reclaimed from the sea by materials brought down from the hills by the Rivers Wairoa and Wai-iti. The second question, "How long did it take the river to erode the valley?" cannot be answered definitely, but an approximation may be made. By calculating the amount of sediment held in suspension by several rivers, and by taking into account the rate at which they flow, it has been found that a river lowers the area of its basin about 1ft. in two thousand years. Not knowing the mean depth of our river-basins, I am unable to make any estimate upon this basis; but by making the most liberal allowances, in a rough guess, at least hundreds of thousands of years would be required for the formation of many of our valleys.

Thus far I have dealt almost exclusively with the geology of our own immediate neighbourhood. The fear of making this paper too long prevents me this evening from touching, even in barest outline, on the interesting geological facts connected with the Owen, the Wangapeka, the Baton, the Takaka, and the Collingwood districts. I shall therefore close this paper by a brief reference to the minerals of economic value found in the provincial district, mentioning, as I pass, the geological formations to which they belong. First in importance are the coal-deposits. The coal-deposits of New Zealand belong to the Cretaceo-tertiary formation. In this respect New Zealand differs widely from other countries, where coal is usually associated with rocks of Carboniferous age. The Cretaceo-tertiary formation comes between the Miocene rocks of the Port Hills and the Triassic rocks of the Wairoa Gorge. Its principal areas of development may be seen by a glance at the map, where the parts coloured green indicate the presence of Cretaceo-tertiary rocks. These coal-deposits must in the future prove a source of great wealth to the district.

The Buller Coalfield alone is estimated to contain 140,000,000 tons of good bituminous coal; the West Wanganui Coalfield, 25,000,000 tons of pitch-coal and 12,000,000 tons of brown coal; while the Brunner Mine contains about 4,000,000 tons. To the sum of these must be added the coal contained in the Collingwood Coalfield, which has an area of about twenty square miles. The output of coal for the Nelson District is about 200,000 tons per annum.

Gold, the next mineral of importance, is found in many parts of the Nelson District, Collingwood and the West Coast having so far yielded the largest quantities. The gold in the Nelson District is usually found in the gravels and drifts which have been derived from the older metamorphic rocks. These rocks stratigraphically underlie the Maitai formation, and are coloured sepia on the map. The gravels and drifts in which the gold is usually found are coloured red or yellow, red representing the older gravels, and yellow the more recent formations. On the map only the larger deposits of these formations have been represented. There are innumerable patches of recent gravels found in almost every river-valley of the district, which could not possibly be represented on a map of so small a scale. It must be borne in mind, however, that only the gravels from the older formations are auriferous. The Maitai slates, for example, as far as is known at present, are not gold-bearing; consequently, the gravels derived from them are not auriferous. The gold exported from the Nelson District last year was valued at £16,000, while since 1857 to the present time six million pounds' worth of gold has been obtained from the Collingwood district alone. Copper and chrome are found in many parts of the Dun Mountain mineral belt, but owing probably to the want of scientific prospecting these minerals have not yet been discovered in sufficient quantities to pay for working.

Argentiferous galena—that is, silver-bearing lead-ore—has been discovered at the Owen and at Wangapeka; and at Collingwood silver, lead, zinc, nickel, antimony, copper, bismuth, and iron are known to exist, in addition to the gold already referred to. Plumbago is also found in the Collingwood district, but not sufficiently pure for commercial purposes. The iron in the Collingwood district belongs to the class of ore known as limonite, or brown hæmatite. This substance is at present made into paint; but probably the time is not very far distant when iron will be smelted from these valuable deposits of ore. At the Hope Saddle an interesting iron compound is found; it is known as vivianite. It is an iron-phosphate, and is of a bluish colour. A specimen of it will be found upon the table, together with specimens of all the rocks and minerals mentioned in this paper.

Such, in brief, is the description of the geology of our district. It is very imperfect; but enough, I think, has been said to show how full of interest is the neighbourhood around us,—what food there is for the mind in the study of the rocks, the rivers, and the valleys by which we are surrounded. In the language of the poet, we may find "Books in the running brooks, sermons in stones."

IV.—MISCELLANEOUS.

Art. XLIX.—*Maori Implements and Weapons.*

By T. H. Smith.

[*Read before the Auckland Institute, 3rd July, 1893.*]

I have been requested by our President to contribute an item to the programme arranged for the present session in the shape of a paper on some Maori subject, the choice of one being left to myself. In compliance with this request, I have endeavoured to collect and put into shape a few notes on "Maori Implements and Weapons," meaning such implements and weapons as were used by the Maori in old time, but were speedily superseded by those introduced by the foreigner. Many of the former are now only to be seen as curiosities, and the fact of their having been superseded and discarded makes it next to impossible to get a complete list of them, and a difficult matter to give a very precise description of many of them. It has been suggested to me, however, that a brief description of some of the more noteworthy of these primitive appliances of peace and war might prove interesting, especially if illustrated by specimens from the collection of these articles which we have in our Museum. This task I have ventured to essay. In making the attempt, I do not expect to add much to the stock of information on the subject already collected. I shall tell my audience, for the most part, only what has been told before; but I may possibly render a service to some by bringing together and presenting to view items and scraps gathered from various sources; and I will hope that, though it may possibly be said of my story that the true in it is not new, it may not be added that the new in it is not true.

It will be scarcely necessary to tell you that the aboriginal inhabitants of New Zealand were unacquainted with the arts of extracting metals from their ores and of making pottery. Wood, stone, and bone supplied the material out of which all or most of the various articles they required were fashioned or manufactured, and the flax-bush supplied the staple of their clothing material. With a wooden spade the Maori tilled the ground, dug his fern-root, excavated the *rua*, or places in which his winter supplies of food were stored, and the *parepare* and *maioro*, or fortifications, of his *pa*. With fragments of stone of various kinds, ground down with infinite labour to a cutting-edge, he made axes and adzes, lashing them with flax to wooden handles; he felled the tree, hollowed and shaped it to form his *waka taua*, or war-canoe, 70ft. or 80ft. long; dubbed down slabs of equal length to form the *rauawa*, or bulwarks; shaped and fitted the *haumi;* and made paddles to propel his man-of-war through the water. With smaller tools made of the same materials, and a bit of shell or bone, or a flint, or flake struck off a block of obsidian, he carved the figures and scroll-work of the ornamental prow and sternpost. With the same tools he hewed out and dressed down slabs to form the *poutokomanawa*, or pillar-support, of the ridgepole of his house, and all the other timbers required in its construction—the *tauhu* and *papa*, the *maihi* and *matapihi*, with their elaborate carving and ornamentation. Some of these houses were very skilfully constructed, and finished in a style which surprises those who have seen good specimens of them. A minute description of a house built and finished in old Maori style for Mr. Colenso in 1844 is to be found at page 50, vol. xiv., "Transactions of the New Zealand Institute."

According to tradition, the ancestors of the Maori came over to this Island some eighteen or twenty generations ago. They came from a place or places referred to in their traditions as *Hawaiki*. They came in several canoes—the names of which are preserved—in separate and independent parties, at different times, arriving and landing at different places. The accounts of these migratory expeditions vary greatly, but, so far as I am acquainted with them, they contain little to aid us in an endeavour to identify or connect the people who came in these canoes, in respect of their implements, weapons, arts, or manufactures, with existing races in other parts of the world, or to trace them with anything like certainty to their original home. The generally-accepted theory is, I believe, that the New-Zealanders are a mixed race, combining the physical characteristics of the Asiatic and African types of mankind.

Taking into consideration the fact that these people, without any precise standard of measure, with such utterly inadequate appliances as they possessed or could procure, were able to achieve the results which are to be seen in many specimens of their handicraft, we cannot, I think, withhold our admiration. The carvings and sculptures with which they decorated their canoes, houses, and *patakas*, the palisades and *waharoas* of their *pas*, &c., though grotesque and certainly not true to nature as representations of the objects we suppose to have been intended to be represented, are yet not lacking in boldness of conception, breadth of design, and a certain artistic finish, which together evidence genius in the artist and consummate skill in the artificer. The canoes themselves, the houses, the *pas*, and the fortifications, of which now the traces only are to be seen, cause a feeling of wonder which will not be diminished when we inquire more particularly what were the instruments and appliances at the command of the men who formed and elaborated these things.

Most of the carvings we now see were not executed with the old tools, and are not, therefore, specimens of the art and skill of the old *tohunga*, but they are mainly copied from the older carvings, and though executed with better tools are not superior to them as works of art.

Entering upon my subject, I will first notice what may be called the agricultural implements used by the Maori of the olden time.

The *ko* was the principal implement used in such agriculture as was known to the Maori. It is composed of a shaft of hard wood, generally *manuka* or *maire*, from 7ft. to 9ft. long, flat at the lower end, and brought to an edge at the sides and foot. Five or six inches from the bottom is an attachment, which is movable, called a *teka* or *takahi*. The shaft is held with both hands and struck into the ground; and, the left foot being pressed upon the projecting *takahi*, or spur, it is driven down as far as necessary, and by lowering the shaft the sod is turned. The *ko* was also used in planting the *kumara;* also in digging *aruhe* (fern-root), which in the old time was the principal food, especially in winter, and in time of war, when the people often had to leave their ordinary dwelling-places and betake themselves to their fortified *pa*. Maori cultivations in those days were not so extensive as they became after the introduction of the potato. The *maara kumara* and the *taro* plantations occupied less space than was required when the potato came into general cultivation and extensive bush-clearings or *waerenga* were made. Before that time, the *kumara*, *taro*, and *hue*, or gourd, were almost the only plants cultivated for food. The *kumara* was brought to New Zealand by most of the original canoes. The *taro* is said to have been brought in the Mataatua canoe, by Ruaauru. The ancestors of the Ngatiawa of the Bay of Plenty came in this canoe, and it is in their country that the *taro* is most extensively grown at the present time. I believe the implement generally used in digging fern-root was shorter and smaller than the exhibit specimens of the *ko* in our Museum, but similarly shaped.

In a small volume published in 1830—a volume of the "Library of Entertaining Knowledge," which gives an exceedingly interesting account of the New-Zealanders of that day—an implement, described as "a pole with a crossbar fixed to it, about 3ft. from the ground," is mentioned as being used by the Maoris for digging. This, no doubt, was the *ko*. The spade and plough of the pakeha have entirely superseded the *ko* and the *kaheru*, which was an implement used by the Maori for such work as would now be done with the hoe, shovel, and rake. It was made of hardwood also, as indeed were all Maori implements used in tilling the ground. It was, I believe, used for loosening and levelling the surface of the ground in preparation for planting, for removing weeds, and for various other purposes. Other implements, as the *tihou*, the *tikoko* (a kind of shovel), and an instrument called a *tima*, used as a hoe, may be included in the list of tools once plied by the Maori farmer; also short wooden instruments, fashioned with more or less care, used for *ngaki*, or weeding, and *hauhake*, digging and gathering the *kumara* crop. These scarcely require special notice.

The Maori is an expert fisherman. His *kupenga*, or seine, was a very large one, often over 1,000ft. in length. Its material was the leaf of *harakeke*, or flax-plant, which was split by hand into shreds or strips. These were made up into bundles and hung up to dry, or to partially dry—treatment which made them softer and tougher and more easily handled in the process of netting. The manufacture of the *kupenga* was a great work, in which the whole community in a *kainga*, or village, took part, each family making an allotted portion. Strict rules were enforced to secure the orderly prosecution of the work. Restrictions were imposed with respect to eating and to the rules of *tapu*. The knot is the same as is used in the manufacture of our nets. The *takekenga*, or mesh, however, was formed over the bunched fingers, and was made closer and stouter in the middle part of the net where the strain is greatest.

The *kaharunga* and *kahararo* (upper and lower ropes of the seine) were made of undressed flax, *harakeke*, also strongly platted with three strands; the *pouto*, or floats, were made of the *whau*, and placed at intervals of 18in.; the sinkers were stones. The centre of the net was marked with a larger and ornamental float. Great care was taken of these nets, which, after use, were dried, folded, and laid up in a heap upon a stage. At the end of the season they were thatched, to protect them from the weather, and were thus made to last a long time. Landing-nets (*pukoro* or *rohe*) were also used, and several kinds of fishing-baskets, made of netting stretched over a hoop and fastened to a pole.

There is a legend told as to how the art of net-making became known to the Maori people: it was obtained or surprised from the *patupaiarehe*, or fairies. The legend is to be found at page 178, Sir G. Grey's "Polynesian Mythology" (1858 edition).

"Once upon a time a man of the name of Kahukura wished to pay a visit to Rangiaowhia, a place lying far to the northward, near the country of the tribe called Te Rarawa. Whilst he lived at his own village he was continually haunted by a desire to visit that place. At length he started on his journey and reached Rangiaowhia, and as he was on his road he passed a place where some people had been cleaning mackerel, and he saw the inside of the fish lying all about the sand on the sea-shore. Surprised at this, he looked about at the marks, and said to himself, 'Oh! this must have been done by some of the people of the district.' But when he came to look a little more narrowly at the footmarks he saw that the people who had been fishing had made them in the night-time, not that morning nor in that day; and he said to himself, 'These are no mortals who have been fishing here—spirits must have done this; had they been men some of the reeds and grass which they sat on in their canoe would have been lying about.' He felt sure, from several circumstances, that spirits or fairies had been there; and, after observing everything well, he returned to the house where he was stopping. He, however, held fast in his heart what he had seen, as something very striking to tell all his friends in every direction, and as likely to be the means of gaining knowledge which might enable him to find out something new. So that night he returned to the place where he had seen all these things; and just as he reached the spot back had come the fairies too to haul their net for mackerel; and some of them were shouting out, 'The net here! The net here!' Then a canoe paddled off to fetch the other one in which the net was laid; and as they dropped the net into the water they began to cry out, 'Drop the net in the sea at Rangiaowhia, and haul it at Mamaku!' These words were sung out by the fairies as an encouragement in their work, and from the joy of their hearts at their sport in fishing. As the fairies were dragging the net to the shore Kahukura managed to mix amongst them, and hauled away at the rope. He happened to be a very fair man, so that his skin was almost as white as that of these fairies, and from that cause he was not observed by them. As the net came close in to the shore the fairies began to cheer and shout, 'Go out into the sea, some of you, in front of the rock, lest the nets should be entangled in Tawatawa-uia-a-Tewetewe-uia!' for that was the name of a rugged rock standing out from the sandy shore. The main body of the fairies kept hauling at the net, and Kahukura pulled away in the midst of them. When the first fish reached the shore, thrown up in the ripples driven before the net as they hauled it in, the fairies had not yet remarked Kahukura, for he was almost as fair as they were. It was just at the very first peep of dawn that the fish were all landed, and the fairies ran hastily to pick them up from the sand, and to haul the net up on the beach. They did not act with the fish as men do, dividing them into separate loads for each, but every one took up what fish he liked, and ran a twig through their gills; and as they strung the fish they continued calling out, 'Make haste, run here, all of you, and finish the work before the sun rises!' Kahukura kept on stringing his fish with the rest of them. He had only a very short string, and, making a slip-knot at the end of it, when he had covered the string with fish he lifted them up, but he had hardly raised them from the ground when the slip-knot gave way from the weight of the fish, and off they fell. Then some of the fairies ran good-naturedly to help him to string his fish again, and one of them tied the knot at the end of the string for him; but the fairy had hardly gone after knotting it before Kahukura had unfastened it, and again tied a slip-knot at the end. Then he began stringing his fish again, and when he had got a great many on up he lifted them, and off they slipped as before. This trick he repeated several times, and delayed the fairies in their work by getting them to knot his string for him and put his fish on it. At last full daylight broke, so that there was light enough to distinguish a man's face, and the fairies saw that Kahukura was a man. Then they dispersed in confusion, leaving their fish and their net, and abandoning their canoes, which were nothing but stems of flax. In a moment the fairies started for their own abodes. In their hurry, as has just been said, they abandoned their net, which was made of rushes, and off the good people fled as fast as they could go.

"Now was first discovered the stitch for netting a net, for they left theirs with Kahukura, and it became a pattern for him. He thus taught his children to make nets, and by them the Maori race were made acquainted with that art which they have now known from very remote times."

The Maori had no rope-walk or fibre manufactory. Such *taura*, or rope, or cordage as he required—for his nets; for lashing on the *rau awa* (top-sides) to the body of his canoe, and stone implements to their *kakau*, or wooden handles; for rigging and cable, and for a multitude of other purposes—had to be made by *whiri* (platting) undressed flax, which was considered stronger than the dressed flax, the gum not having been removed. There were various *whiri*, or plats—square, round, &c.—all having different names.

The *aho hi-ika*, or fishing-lines, were made from dressed flax, which was *miro* (twisted) in the same way as in making the threads for weaving garments.

The *matau*, or fishhooks, were made from bone (often human bone), from wood, and from shell; and of various patterns, according to the fancy or ingenuity of the maker. They were generally, but not always, barbed. With some, bait was used; others, made of wood, were lined with pearlshell, or fashioned wholly of shell, with a barbed point attached, and shaped to look like a fish when drawn through the water. These are common enough to make minute description unnecessary; many specimens may be seen in our Museum.

The *hinakituna*, for catching eels, was a basket made of a creeping fern called *mangemange*. It was generally about 5ft. or 6ft. in length, and 18in. in diameter; cylindrical, but tapering at one end. Both ends were open—one, the larger, having an inverted funnel inserted, through which the eels passed into the basket; the other, fitted with a removable cover, or door, for discharging its contents. These baskets were placed in the *pa tuna*, or eel-weirs, and in the course of small streams, near their confluence with larger ones. The material of which they were made being very tough and durable, they were almost imperishable; and, as they perfectly answered the purpose for which they were constructed, they were regarded as a most useful and valuable item of personal property.

The *tapora* is a small net for *inanga*, the so-called whitebait of the fresh-water lakes and rivers.

The *taruke* is a basket for taking *koura*, or crayfish. The *rou kākahi* is an instrument used to collect the fresh-water bivalve *kakahi*, found in the lakes and esteemed as a delicacy, and a food suitable for sick persons and children; the liquor obtained from these shellfish (the *wai kakahi*) making a kind of broth, palatable and nutritious and easy of digestion.

The *rou* resembles a rake, to which a *rori*, a net or basket-like receptacle, is attached, into which the shellfish falls as it is raked up from the bottom. The fisherman stands up in his canoe and plies his *rou* until he has obtained a sufficient quantity. It is hard work, which has given rise to the proverb,—

> The husband who gathers *kakahi* shall be caressed.
> The husband who sleeps away his time in the house shall be cuffed.

A specimen of the *rou* is in the Museum.

Barbed spears were used for spearing flounders and other fish, which were attracted with lighted torches at night.

In snaring birds and *kiore* (the so-called Maori rat), the Maori was expert. The *kiore* was taken in a trap, *tawhiti* *kiore*, not very different from a mole-trap. These traps were placed at short intervals along tracks called *ara kiore*. Birds were noosed with loops of flax, placed in situations to which they were likely to come for water. They were also speared with a long spear (*tahere manu*, and *here*) tipped with bone or the sting of the ray. These were made of tawa or other light woods.

In a paper read by Major Heaphy, V.C., before the Wellington Philosophical Society in 1879 (Transactions, vol. xii.), a very good description is given of the *tahere*, and of the way it was used in spearing pigeons. Major Heaphy says,—

"On another occasion I accompanied a party of natives into the hills near Belmont to spear pigeons. The spears are about 12ft. long, and very slender—not more than ½in. in diameter at the thickest part. They have to be held near the point, and, on a journey, trailed behind until wanted for immediate use. The pigeons are probably feeding in low trees, or are about water-holes, and are scarcely frightened at the approach of the hunter, who quietly steals under them, sometimes even ascending the lower branches of the tree the bird occupies. The spear is then quietly directed amongst the foliage towards the breast of the bird, which takes little notice of the operation. When the point is within half a yard a sudden thrust is made, and the bird is transfixed. The point of the weapon is of bone, and barbed. This bone is hung securely by a lanyard at its base to the spear-head, but when ready for use is lashed with thin thread alongside the wood. The wounded bird flutters with such force as would break the spear were the whole rigid; but, as arranged, the thread breaks, and the bird on the barbed bone falls the length of the lanyard, where its strugglings do not affect the spear, and it is easily taken by the fowler's left hand. This mode of capturing birds very soon after our arrival went out of vogue. The spears were exceedingly difficult to make, and the few that were finished were eagerly bought by the whites as curiosities."

The Maori proverb inculcating the wisdom of forethought in providing for what may be required on a journey says, "Don't forget provender; there will be no *tarainga here* (bird-spear making) on the way."

Weaving, or Whatu.—The implements used by the Maori in the manufacture of the articles used for clothing were very simple. The so-called Maori mat, the beautiful *kaitaka*, with its rich *taniko* border at the foot; the *korowai*, with the pendent glossy black thrums falling in graceful curves over its folds; the handsome bordered *korohunga*—these Maori curiosities, now so admired and sought after by the tourist, were all manufactured from the fibre of the *harakeke*, or flax-plant. The process was called *whatu puweru.* In texture and workmanship, substance and durability, these fabrics excel the similar productions of the other islands of the Pacific, and were made without the aid of either the spinning-wheel, the shuttle, the loom, or of any apparatus beyond four pegs stuck into the ground to form the four corners of a frame, with a pair, or perhaps two pairs, of skilful hands.

The *turupou*, or pegs, were about 1ft. or 18in. long, generally ornamentally carved at the top, and placed at proper distances according to the size of the garment to be made. To these were fastened the threads forming the *aho* (the warp—though called the woof in the dictionaries). With the *aho*, which was fourfold, were knotted a number of threads of the *whenu* (the woof) until the intended width of the fabric was attained. The *whenu* is the woof, as it represents threads carried by the shuttle between the rising and falling threads of the warp in the ordinary process of weaving. The Maori method, differing from ours, is to raise and depress alternately two of the *aho* threads, at the same time crossing them by bringing the two outer over the two inner ones, which thus become outer ones; this forms a knot, which holds the woof-threads. It will be seen that thus, instead of the shuttle-thread or woof being carried between alternate threads of the warp, the warp itself is manipulated and brought over the shuttle-threads or woof.

By this process were woven a great variety of garments, much pains and care being taken in the preparation of the *muka*, or flax, more especially that used for the finer garments. It was spun or twisted into thread by the simple process of pressing and rolling between the palm of the hand and the knee two strands of the *muka*. A twist, tight or loose as required, is thus formed similar to one produced by spinning in the ordinary way. The border, *taniko*, at the bottom of the *kaitaka* was not made in the same way as the rest of the garment. The art of making the *taniko* border, however, if not lost, is, I believe, known to very few of the Maoris themselves at the present day. The *kaitaka* is peculiarly the garment of a chief, and was worn fastened over the right shoulder. The *korowai* is more usually worn by females of rank, and was worn wrapped round the body and fastened over the left shoulder, or in front, if fastened at all. Other garments, the foundation of which is flax, are made with strips of dogskin, as the *ihupuni* or *topuni*, and the *kahuwaero*, made from the long hair of the tail of the Maori dog. There were also garments made with feathers of birds, as the *kahu kiwi* (kiwi feathers); the *kahu weka;* the *kakapo* (ground-parrot—greenish feathers). These were incorporated or interwoven in the process of the *whatu*. There were also coarse garments for ordinary wear when travelling, or at work, or in wet weather: the *pihepihe*, the *pora* or *tatara*—a very great variety. Specimens of these are to be seen in our Museum, and bear witness to the patience and ingenuity of those employed in their production—generally the feminine part of the Maori community. With reference to the feather mats, however, Polack, in his book, "Manners and Customs of New Zealand," says, "The clothing of the birds of the shore and ocean are made use of to form a garment, a strong matting being the substance on which the ingenuity of the chiefs is expended in obtaining the aërial garment. In pursuing this occupation among the females the warrior realised no bad idea of the gallant Hercules at the feet of Omphale."

Floor-mats (*takapau*), baskets (*kete*), &c., were made by interlacing strips of flax-leaf, or the leaf of the *ti* (cabbage-palm). The process of making these is called *raranga*. Beautiful girdles (*maro*, or *tatua*) were also made by the same process from the *pingao*, a yellow rush growing near the sea. No implement was required for this work—the hand sufficed.

The culinary appliances of the Maori people were very simple; many of them were found ready to hand, requiring but little skill to adapt them to the purposes for which they were used. A *pipi* shell, or a chip of the *mata*, or obsidian, served as a knife, and was deftly and effectively handled in all such operations as required a cutting instrument. It is simply wonderful what can be, and is, done with a *pipi* shell in the hand of an unsophisticated Maori accustomed to its use.

The *oumu*, or *haangi*, in which food was cooked, was only a hole scooped in the ground of a size proportioned to that which was to be cooked. A fire of dry wood was kindled in this hole, and upon the burning wood were placed stones not liable to crack with the heat. These soon became red-hot, and, as the fire burned down, fell into the hole. The smoking half-burnt wood was then carefully removed; the hot stones were evenly placed in the hole and covered with green leaves well sprinkled with water, making a clean lining to the oven, upon which the food to be cooked was then laid, piled up and covered with more green leaves; water was then poured over the whole, which, finding its way down to the hot stones, was rapidly converted into steam, while a covering of old flax mats well wetted was spread over the leaves, and the whole quickly and closely covered up with earth to prevent the escape of the steam, which, in a short time, perfectly cooked the contents of the oven, the time required varying according to the mass of food subjected to the process. The *haangi* was then opened, the coverings carefully removed, and the food placed in fresh baskets made of the leaves of the *harakeke* (flax) or *ti* (cabbage-palm), and handed round. By this mode the food is steamed, which, excepting broiling or roasting, was the only one known or practised by the Maori. Not having any vessels which would stand the fire, baking could not be attempted, and boiling could only be accomplished by putting hot stones into water in a *kumete,* or trough hollowed out of a solid block of wood. This method of heating liquids was resorted to occasionally, in exceptional circumstances or emergencies.

The *paoi,* or wooden pestle for breaking or pounding the *roi* or *aruhe* (fern-root), was an instrument in daily use in the Maori kitchen. The preparation of this root for eating consisted in roasting it on the fire and then pounding it with the *paoi* upon a flat stone. This was generally the work of the female part of the establishment, and took up a good deal of time when the members of the family dining together were numerous.

For general purposes the shells of both the *pipi* and the *kuku,* or mussel, were constantly in request. In the preparation of the flax for making garments both these shells were used: the *pipi* for making the transverse cut across the back of the leaf, and the *kuku* for stripping, by which the boon, or worthless vegetable matter, was separated and left behind. Again, in the hands of a Maori Adonis, a pair of *kuku* shells served the purpose of tweezers for the removal of superfluous hair from the face, which, in his case, meant all the hair appearing there, more especially when the face was adorned with a fine specimen of the work of an artist who handled the *uhi,* or tatooing instrument. The Rev. Mr. Taylor says, in his book, "New Zealand and its Inhabitants," "To allow the beard to grow was regarded as a sign of old age, and a proof that the bearer had ceased to care for his appearance." The cultivation of a beard certainly could not consist with the full display of the exquisite *moko,* and it must therefore be suppressed.

In the hand of a *bonâ fide,* or professional, mourner at a *tangi,* or weeping function, a sharp fragment of such a shell judiciously selected and scientifically applied would soon convert the person of the operator into a mass of blood, tears, and other secretions calculated to excite mixed feelings, pity or disgust predominating according to the idiosyncrasy of the spectator. In poetic strain the bereaved or forsaken one calls for the *kuku-moe-toka* (the rock-sleeping mussel) with which to lacerate the soft skin which had lately known the tender caresses of the departed or beloved one.

A flake chipped off a block of *tuhua,* or obsidian, also made a very handy and useful cutting instrument, and was applied to a variety of purposes. Among others it was used for the *pure,* or cutting of hair, which was a far more serious, tedious, and painful operation as undergone by a Maori gentleman of the olden time than can be easily realised by us. The *tohunga*, or priest, was the barber; and a number of troublesome religious rites and ceremonies, with much personal inconvenience, were its accompaniments.

In connection with cooking, the mode of procuring fire, the preliminary requisite and *sine quâ non* of the practice of the culinary art, should be noticed.

The Maori cook had no box of matches, nor even a tinder-box with flint and steel, with which to procure the first requisite for his business. His apparatus comprised two pieces of dry wood, with which, by laborious, long-continued friction, combustion was induced. The instruments are the *kaureure* or *kaurimarima*, and the *kauahi* or *kaunoti*—the former a pointed stick, which is rubbed forwards and backwards in a groove made in the latter, which is laid on the ground. The *kaikomiko* and *mahoe* are the woods preferred for the purpose. The process, as described by Mr. Taylor in his "New Zealand and its Inhabitants," is "rubbing—or, rather, pushing—a wedge-shaped piece of wood forward and backward along a groove and collecting the charred dust at its extremity until it ignited. It was then placed in a lump of soft flax and waved to and fro, when it burst into flame." A fuller description of the process, as shown in England by two Maori visitors, is given in a small book, published in 1830—"The New-Zealanders":—

"A small board of well-dried pine was laid upon the floor, and the younger New-Zealander took in his hand a wedge about nine inches long, and of the same material; then, rubbing with this upon the board, in a direction to that parallel to the grain, he made a groove about a quarter of an inch deep and six or seven inches long. The friction, of course, produced a quantity of what, had it been produced by another means, would have been called sawdust; and this he collected at the end of the groove farthest from that part of the board on which he was kneeling. He then continued his operation, and in a short time the wood began to smoke, the sides of the groove becoming completely charred. On this he stopped, and gathered the tinder over that part of the groove which appeared to be most strongly heated. After a few moments it became manifest that the sawdust or tinder was ignited, and a gentle application of the breath now drew forth a flame, which rose to the height of several inches. This experiment did not always succeed the first time. Whenever it was repeated, whether after failure or success, the operator took a new wedge and formed a new groove; and it was stated that this was absolutely necessary. The process was evidently one of great labour. At the conclusion of it the operator was streaming with perspiration, and his elder countryman stated that his own strength was unequal to the feat."

There is a legend which tells about the origin of this mode of procuring fire which is concisely given in a paper by the Rev. J. F. H. Wohlers, read before the Otago Institute, and published in Transactions, vol. vii. The translation will be found at page 12. There are several versions of this legend, which vary considerably, but agree in the main features. I have selected one which has the merit of brevity :—

"In the neighbourhood of that place there dwelt a grandmother of Maui, of his mother's side, called Mahuika, who was the keeper of the fire. Now, it happened one day that the fire had gone out; and, as the servants were lazy and did not move when told to go to Mahuika to fetch fire, Maui offered to go. When he came to the place the old woman said, 'What has brought you, a stranger, here? Was it the wind that blows against my skin?' But when Maui told her that he was her grandson she became very friendly, and willingly gave him a stick of fire—namely, one of her fingers. Maui went away with it; but extinguished it, when out of sight, in the nearest water. Then he went back and asked her for another stick of fire, saying the first had gone out. So she gave him another of her fingers, which he likewise extinguished; and so on, till he had carried away all her fingers and her toes, up to the last little toe. Then the old woman perceived that he was mocking her, and became very angry, by which she raised a great blast to burn him; but Maui quickly transformed himself into an eagle, and swung himself up to the clouds. From thence he sent down rain upon the fire to quench it. Mahuika stirred up her fire to make it burn; Maui poured down large drops of rain upon it to quench it. Mahuika raked together her fire to keep it alive; Maui showered down thick snow upon it to extinguish it. At last, when the old woman saw that she could not keep her fire alive, she cast the rest into trees; in some it stayed, in others not, out of which former it can still be got by rubbing."

An item in the catalogue of Maori implements which must not be omitted is the *uhi*, the instrument with which the operation of *ta moko*, or tattooing, was performed. This was a sharp cutting instrument, or chisel, variously described as formed of bone or shell fixed into a handle of wood shaped like a hoe, with which the lines of the *moko* were cut into the skin of the face, and other devices upon different parts of the body. Most authorities are in favour of the bone, which is thought to have been that of the *toroa* (albatross). The *uhi* was struck with a light mallet of *mahoe*, the pattern being first traced upon the skin with a black pigment. The operator was a man who cultivated the art, and who, when skilful in its practice, was handsomely paid for his work. The marks on the face are called *moko*, and the operation *ta moko*. As Dr. Shortland tells us in his book, "New Zealand," it is not intended as a mark to distinguish different tribes, or to denote rank, but only to indicate arrival at man's estate, and a fashionable adornment by which the young men seek to gain the good graces of the young women. It only so far denotes rank as showing that the possessor of a handsome *moko* must have had the wherewithal to well remunerate the artist. He says: "As a general rule, two fully-marked faces (*moko-pu*) selected at hazard from different parts of the country would, on comparison, manifest merely some slight dissimilarities attributable to the difference of skill or taste of the artists who had executed the work. The operation is performed with a very small chisel, and, being extremely painful, can only be done bit by bit, according as the patient has courage to endure it."

The women have usually merely the lines on the lips and a scroll depending from the angles of the mouth.

The process of *ta moko* is described differently by different authors. The Rev. R. Taylor describes it in "Te Ika a Maui," at page 320. A somewhat different description of it is given by Rutherford, who, with other white men, his companions, underwent the operation about the year 1825. He thus describes it: "The whole of the natives having then seated themselves on the ground in a ring, we were brought into the middle, and, being stripped of our clothes and laid on our backs, we were each of us held down by five or six men, while two others commenced the operation of tattooing us. Having taken a piece of charcoal, and rubbed it upon a stone with a little water until they had produced a thickish liquid, they then dipped into it an instrument made of bone, having a sharp edge like a chisel, and shaped in the fashion of a garden hoe, and immediately applied it to the skin, striking it twice or thrice with a small piece of wood. This made it cut into the flesh as a knife would have done, and caused a great deal of blood to flow, which they kept wiping off with the side of the hand, in order to see if the impression was sufficiently clear. When it was not, they applied the bone a second time to the same place. They employed, however, various instruments in the course of the operation; one which they sometimes used being made of a shark's tooth, and another having teeth like a saw. They had them also of different sizes to suit the different parts of the work. While I was undergoing this operation, although the pain was most acute, I never either moved or uttered a sound, but my comrades moaned dreadfully. Although the operators were very quick and dexterous I was four hours under their hands, and during the operation Aimy's eldest daughter several times wiped the blood from my face with some dressed flax. After it was over she led me to the river that I might wash myself (for it made me completely blind), and then conducted me to a great fire. They now returned us all our clothes, with the exception of our shirts, which the women kept for themselves, wearing them, as we observed, with the fronts behind. We were now not only tattooed, but what they called *tabooed*, the meaning of which is, being made sacred, or forbidden to touch any provisions of any kind with our hands. This state of things lasted for three days, during which time we were fed by the daughters of the chiefs, with the same victuals and out of the same baskets as the chiefs themselves and the persons who had tattooed us. In three days the swelling which had been produced by the operation had greatly subsided, and I began to recover my sight, but it was six weeks before I was completely well."

The *uhi* is called in Maori poetry "*te uhi matarau*," "the hundred-pointed *uhi*." This corresponds with Rutherford's account better than with some others.

The pigment applied to or inserted in the incisions made by the *uhi* was soot, prepared by burning resin, or resinous wood—generally kauri.

Weapons.—The weapons used by the Maori warrior of olden time were fashioned out of wood, stone, and bone. Those of wood were: The *taiaha*, *maipi*, or *hani*; the *pouwhenua*, shaped like the preceding without the head, and used as a kind of broadsword; the *tao*, or *tokotoko*, a spear, in great variety, long and short; the *hoata*, a long spear generally carried by the warriors in the front rank during a charge; the *wahaika*, *tewhatewha*, or *paiaka;* with shorter weapons for use at close quarters, such as the *kotiate*, and others of various shapes and names but coming under the general name of *patu;* the *huata*, about which there is some doubt (Tregear gives "a barbed spear" in his dictionary, but I do not know upon what authority).

These were made of the hardest and toughest wood obtainable, most often of *manuka*. Of these weapons, the *taiaha* was the favourite; the head of it was carved, and often ornamented with the red feathers of the *kaka*, or parrot, and the long hair of the Maori dog, *waero*. The carved head is intended to represent a man's face, the tongue protruding from the mouth or jaws, as in defiance. The mother-of-pearl discs represent eyes. In single combat the *taiaha* or the *tao* (spear) was most frequently used. Regular rules of fence with these weapons were observed and taught as an art, proficiency and skill in which gave a warrior great advantage over a less practised or less skilled adversary.

The *taiaha* was also frequently carried by a Maori chief as a staff, and was oftentimes vigorously flourished by way of emphasizing and adding force to argument or accentuating oratorical flourishes, on great occasions and during warm discussions.

A book published by the New Zealand Government, containing illustrations prepared for the unpublished volumes of White's "Ancient History of the Maori," has among these some showing the different positions in which certain weapons were held and wielded in single combat. One example is a set-to with a *mere pounamu* and buckler against a *tao*, or spear; a second shows two combatants, both armed with the *taiaha*; and a third where both use the *tao*, or spear. I cannot vouch for the truthfulness of these representations from my own knowledge, but I presume they were drawn from life and should not be far wrong.

In Maori tales and legends there are many descriptions of encounters of heroes where the *taiaha* was the weapon chosen to test the prowess of the braves who wielded it. The duel between the famous Tama-te-Kapua and Ruaeo, whose wife the former had carried off from Hawaiki, is graphically described in Sir George Grey's "Polynesian Mythology," at page 92. It was fought with this weapon:—

"Early in the morning Ruaeo performed incantations, by which he kept all the people in the canoe (the Arawa, which had been hauled up on shore) in a profound sleep, and whilst they still slept from his enchantments the sun rose and mounted high up in the heavens. In the forenoon, Rua (who, with his 140 men, crouched along under the bulwarks) gave the canoe a heavy blow with his club. They all started up. It was almost noon, and, when they looked down over the edge of their canoe, there were the 140 men of Rua, sitting under them, all beautifully dressed with feathers, as if they had been living on the Gannet Island, in the channel of Karewa, where feathers are so abundant. And when the crew of the Arawa heard this, they all rushed upon deck, and saw Rua standing in the midst of his 140 warriors. Then Rua shouted out, as he stood, 'Come here, Tama-te-Kapua! let us two fight the battle—you and I alone. If you are stronger than I am, well and good, let it be so. If I am stronger than you are, I'll dash you to the earth.'

"Up sprang then the hero, Tama-te-Kapua. He held a carved two-handed sword (*taiaha*), a sword the handle (head) of which was decked with red feathers. Rua held a similar weapon. Tama first struck a fierce blow at Rua. Rua parried it, and it glanced harmlessly off; then Rua threw away his sword (*taiaha*) and seized both the arms of Tama-te-Kapua. He held his arms and his sword (*taiaha*), and dashed him to the earth. Tama half rose, and was again dashed down; once more he almost rose, and was thrown again. Still Tama fiercely struggled to rise and renew the fight. For the fourth time he almost rose up; then Rua, overcome with rage, took a heap of vermin (this he had prepared for the purpose, to cover Tama with insult and shame), and rubbed them on Tama-te-Kapua's head and ear, and they adhered so fast that Tama tried in vain to get them out. Then Rua said, 'There, I've beaten you. Now, keep the woman as a payment for the insults I've heaped upon you, and for having been beaten by me.' But Tama did not hear a word he said; he was almost driven mad with pain and itching, and could do nothing but stand scratching and rubbing his head, whilst Rua departed with his 140 men to seek some other dwelling-place for themselves. If they had turned against Tama and his people, to fight against them, they would have slain them all. These men were giants: Tama-te-Kapua was 9ft. high, Rua was 11ft. high. There have been no men since that time so tall as those heroes."

Mr. C. O. Davis, in his "Maori Mementos," gives a story which, epitomized, may be rendered thus in English:—

Tuteamoamo and Waihuka were brothers. The younger, Waihuka, had a very beautiful wife, Hineitekakara. The elder brother was envious, and plotted to destroy the younger and appropriate his beautiful wife. He persuaded Waihuka to go out fishing with him, and managed to leave him in the sea, out of sight of land, to perish. Waihuka, however, after a long struggle, aided by a whale, succeeded in reaching the shore, where he was found by his faithful wife, who had gone to look for his body, supposing him drowned. The reunited pair return to their house unseen by Tuteamoamo, and, by way of preparation for a hostile meeting with his brother, Waihuka essays practice with various weapons. Donning his *kahukiwi* (kiwi-feather garment), with hair dressed and ornamented with feathers, he seizes his *taiaha*, and, making passes, appeals to his wife, "Do I handle this well?" She replies, "Very well." He then lays down the *taiaha* and takes the *meremere*, and asks, "Do I look well with this?" His wife replies, "Put that weapon down." He then takes the *kotiate* with the same question, to which Hineitekakara replies, "Nay, it is ill with thee." He tries the *huata*, the *paraoa poto*, and all the other *patu*, repeating his question. His wife answers, "No, thou wilt be beaten." Waihuka then grasps his *taiaha* again, and as it strikes the earth the blade quivers, and Hineitekakara exclaims, "Ha, now thou hast it! Handle thy weapon so, and thy brother shall fall before thee." In the evening Tuteamoamo came and called to his brother's wife, "Hineitekakara! slide back the door!" "Enter, Tuteamoamo!" said

Hineitekakara. As he was about to do so his brother rushed upon him, and in a moment his head was struck off and he lay a corpse.

In Judge Maning's book, "Old New Zealand," the author tells us of an old warrior who was a great adept in handling the *tao*, his favourite weapon: "In the hot days of summer, when his blood, I suppose, got a little warm, he would sometimes become talkative, and recount the exploits of his youth. As he warmed to his subject he would seize his spear (*tao*), and go through all the incidents of some famous combat, repeating every thrust, blow, and parry as they actually occurred, and going through as much exertion as if he was really and truly fighting for his life. He used to go through these pantomimic labours as a duty whenever he had an assemblage of the young men of the tribe around him, to whom, as well as to myself, he was most anxious to communicate that which he considered the most valuable of all knowledge—a correct idea of the uses of the spear, a weapon he really used in a most graceful and scientific manner; but he would ignore the fact that 'Young New Zealand' had laid down the weapon for ever, and already matured a new system of warfare adapted to their new weapons, and only listened to his lectures out of respect to himself and not for his science."

The *tao* was the weapon most frequently used in the duels, which were often the outcome of a private quarrel, and in the *taua*, or small armed parties which would visit an individual or settlement to demand and obtain satisfaction for some affront or injury, as, for example, the abduction of a woman, a *kanga*, or curse, &c. Fierce encounters often took place on such occasions, but were seldom attended with fatalities. Generally both parties used *tao* (spears). Only flesh-wounds were inflicted, and, as Judge Maning says, "No more blood was drawn than could well be spared."

In the case of a quarrel between two individuals, a challenge would often be given and accepted in the same terms. "*To taua ata!*" ("We meet in the morning") was replied to in the same words—"*To taua ata!*" ("We meet in the morning"). In the early morning, accordingly, the principals, in appropriate costume, with spears in their hands, would meet and try conclusions with one another in the presence of their relatives and friends, who would attend to see fair play; but it was generally understood that a mortal thrust was not to be given, and a flesh-wound received by either combatant would terminate the affair.

In Rutherford's account of an engagement which he witnessed he says that one of the fugitives of the beaten party, in passing him, threw a short jagged spear, which punctured his thigh and had to be cut out with a shell, leaving a wound as large as a teacup. This corresponds with what I have been told—that barbed spears were sometimes used.

In a battle fought between the Ngaitahu and the Ngatimamoe, in the Middle Island, an account of which, furnished by the Rev. Mr. Stack, appears in White's "History," vol. iii., p. 237, the spears used by the Ngatimamoe were pointed with the *tarawhaiapu* (barbed sting of the ray, or stingaree). This is noted as an unusual practice, and in allusion to the circumstance the battle was spoken of as *Te Whai.*

The *tewhatewha*, or *paiaka,* was used in somewhat similar fashion to the *taiaha.* The warrior armed with it sought to fell his antagonist by striking him on the head with the back of the blade which forms the upper part of the weapon; if successful, he struck the pointed end into the body of the fallen man. The hawks' feathers attached to the blade were supposed to baffle, distract the attention, or dazzle the eyes of the opponent, and so give the opportunity for delivering the blow. This weapon, however, was less used for offence and defence than as an instrument by which the chief or leader directed the movements of his followers, the blade and feathers causing it to be easily seen.

An anecdote, related by my friend Major Mair, illustrates this: it is as follows: "On the morning of the last day of the fight at Orakau, owing to a temporary panic among the besieged, there arose the ominous cry of '*Kua horo te pa!*' ('The fort is taken'). The Waikato at the southern end rushed out, and, to the number of eighty or a hundred, appeared as if by magic in the open space. The bugles sounded the alarm, and, just as suddenly, the soldiers sprang to their feet, and opened a half circle of fire on the Maoris. Then a tall chief stood up, waved his plumed *tewhatewha* three times, and lo! the Maoris had vanished."

This use of the *paiaka* caused it to be called the "*rakau rangatira,*" or chief's weapon, it being so often seen in the hand of a chief when directing movements of his men, not only in war, but on other occasions. It was often used by the *hautu*, in the canoe, to mark time for the stroke of the paddles.

In Sir G. Grey's "Polynesian Mythology" there is a description of the killing of a monster named Hotupuku. After the creature was despatched it was opened, and in the stomach was found—besides the bodies of men, women, and children, which had been swallowed whole—what the narrator of the story calls a perfect armoury of weapons—*mere-pounamu, kotiate, patuparaoa, maipi, tewhatewha, pouwhenua, tokotoko* (*tao*), *paraoa-roa;* also a fine collection of ornaments, the enumeration of all which forms a tolerably complete list of such articles. The instruments used in the autopsy also are given, making a fair list of Maori cutting implements. The *miratuatini*, there mentioned, is a *patu*-shaped wooden instrument, with *mako* (sharks' teeth) set in the outer curved edge. It was, I believe, used in cutting up human bodies at cannibal feasts.

A formidable weapon was the *hohoupu*, an adze-shaped affair. The blade was of *pounamu* or other stone, the handle elaborately carved and decked with feathers. It was specially the weapon of a chief, and was used to cleave skulls withal. Polack in his book refers to one of these thus:—

"At a future period many aboriginal curiosities will be discovered by the European colonists in tilling the ground that will give much satisfaction to the antiquary, as the New-Zealanders have been from time immemorial in the habit of burying with their dead the favourite axes and implements of stone that were highly prized by their chiefs while in this existence. The removal of such articles a few years after being once deposited in a sacred place would be accounted the height of impiety and sacrilege, either by a foreigner or native; the former would be subjected to lose every article of property he might possess, the latter to death. This feeling is now fast giving way, but the knowledge of the places where those precious articles have been placed is lost, the priesthood only originally knowing the secret, and they are long since numbered with the dead. In 1835 an influential priest was bribed by us to dispose of an ancient adze, called *Toki-pu-tangata* by the people; it was extremely ancient, and had been buried in the sandy soil for many years; the place of its interment was only known to the priest, who had noted the spot by the branching of a particular tree called *rata*. We afterwards discovered that had the circumstance been known of the priest having sold it, probably the infuriated sticklers for sanctity would have sacrificed the seller to their resentment. The adze was formed of a blue granite inserted in a handle of the *rata*, or red-pine (?) wood, carved agreeably to native taste. This instrument, from disuse, is scarcely to be met with in the country."—(Polack's "Manners and Customs in New Zealand," vol. i., p. 71.)

Weapons of stone were much used by the Maori. Several kinds of stone were used, but the one most prized was the *pounamu*. The weapon made from this stone was called a *mere-pounamu*, and was perhaps the most valuable article a Maori could possess, more especially in the North, so far from the place whence the stone is obtained. There is some uncertainty as to the period when this stone was discovered or came into use by the Maoris.

There is a legend or myth in which it is spoken of as a treasure owned by a personage named Ngahue, who brought it to New Zealand, having been driven away from his home—Hawaiki—by a female named Hine-tu-a-hoanga. After much travelling in search of a suitable location for Poutini or Pounamu (his *ika*, or valued possession) one was found for it on the west coast of the Middle Island, where it remained, and is still found. The legend is given in Sir George Grey's "Polynesian Mythology," page 82. (The foot-notes on that page require correction: Poutini is the greenstone, or *pounamu;* Waiapu is obsidian.)

"Now pay attention to the cause of the contention which arose between Poutini and Waiapu, which led them to emigrate to New Zealand. For a long time they both rested in the same place, and Hine-tu-a-hoanga, to whom the stone Waiapu [Mata] belonged, became excessively enraged with Ngahue and with his stone Poutini. At last she drove Ngahue out and forced him to leave the place, and Ngahue departed and went to a strange land, taking his jade-stone [Poutini, or Pounamu]. When Hine-tu-a-hoanga saw that he was departing with his precious stone, she followed after him, and Ngahue arrived at Tuhua with his stone. Hine-tu-a-hoanga also arrived and landed there at the same time with him, and began to drive him away again. Then Ngahue went to seek a place where his jade-stone might remain in peace, and he found, in the sea, this island Aotearoa (the Northern Island of New Zealand), and he thought he would land there.

"Then he thought again, lest he and his enemy should be too close to one another, and should quarrel again, that it would be better for him to go further off with his jade-stone—a very long way off. So he carried it off with him, and they coasted along, and at length arrived at Arahura (on the west coast of the Middle Island), and he made that an everlasting resting-place for his jade-stone; then he broke off a portion of his jade-stone and took it with him and returned, and as he coasted along he at length reached Wairere (believed to be on the east coast of the Northern Island), and he reached Whangaparaoa and Tauranga, and from thence he returned to Hawaiki, and reported that he had discovered a new country which produced the *moa* and jade-stone in abundance.

"He now manufactured sharp axes from his jade-stone; two axes were made from it—Tutauru and Hau-hau-te-rangi. He manufactured some portions of one piece of it into images for neck-ornaments, and some portions into ear-ornaments. The name of one of these ear-ornaments was Kaukaumatua, which was recently in the possession of Te Heuheu, and was only lost in 1846, when he was killed with so many of his tribe by a landslip. The axe Tutauru was only lately lost."

The legend goes on to tell how the canoes were made which brought the ancestors of the Maori to this land, giving their names, &c., and proceeds: "The names of the axes with which they hewed out these canoes were Hau-hau-te-rangi and Tutauru. Tutauru was the axe with which they cut off the head of Uenuku. All these axes were made from the block of greenstone brought back by Ngahue to Hawaiki, which was called 'The Fish of Ngahue.'"

The signification of the legend is not clear, but it is, I think, symbolical. *Hoanga* is the name of the sandstone with which the *pounamu*, or greenstone, is cut, ground down, and polished. Hine-tu-a-hoanga (the Lady of the Sandstone) is the cause of a contest or rivalry between *poutini* (greenstone) and *waiapu* or *mata* (obsidian), which had previously rested quietly together in the same place. Both are used to make cutting instruments, but the *pounamu* could be ground down or attacked by the *hoanga* only, and Ngahue endeavours to place it beyond the reach of this enemy, he being the guardian of *poutini*, as Hine-tu-a-hoanga appears to be of *waiapu*.

May not this legend rest upon a foundation of truth? The idea is suggested that Ngahue, having discovered the *pounamu* in New Zealand, and taken a specimen to Hawaiki on his return thither, failed to give those who came here afterwards such directions as were needed to enable them to find its locality; and that their failure to do so, until comparatively recent times, led to the myth of Ngahue having hidden *poutini* to preserve it from injurious contact with *te hoanga*.

When the Ngaitahu crossed from the North Island to the Middle Island they were not acquainted with the *pounamu*. This appears certain from their tradition given in White's "Ancient History of the Maori," vol. iii., p. 255:—

"It is not till the Ngaitahu conquests reach Horowhenua that we hear anything of Ngatiwairangi, the tribe occupying the West Coast, who, like Ngati-mamoe and Nga-i-tahu, were descendants of Tura, and crossed over to the South Island almost at the same time with them. Hitherto they had been shut off from communication with the East Coast by what were thought to be impassable natural barriers of mountains, till a woman named Raureka discovered a way through them. Wandering from her home, this woman went up the bed of the Hokitika River, and then across what is known as Browning's Pass, and thence down to the East Coast. There, in the neighbourhood of Horowhenua, she found some men engaged in making a canoe, and, taking notice of their tools, remarked how blunt they were. The men asked if she knew of any better. She replied by taking a little packet from her bosom, which she carefully unfolded, and displayed a sharp fragment of greenstone. This was the first the natives there had ever seen; and they were so delighted with the discovery that they sent a party immediately over the ranges to fetch some, and it subsequently came into general use for tools and weapons, those made of inferior materials being discarded.

"The descendants of Maru-tu-ahu at Hauraki show a *heitiki* (greenstone ornament) which they say Marutuahu wore when he arrived in New Zealand. It has been handed down from generation to generation, being alternately in possession of his Taranaki and Hauraki descendants. It is quite possible that traffic in greenstone between Ngatiwairangi (of the West Coast, Middle Island) and the North Island tribes bordering on Cook Strait may have been in existence for many years before it became known to Ngaitahu."

Mr. White says: "There are four sorts of obsidian—*tuhua, waiapu, panetao*, and *kahurangi*, each having its appropriate use, as for cutting the skin at *tangihanga*, for cutting the hair, and for various other uses."

Judge Maning tells us: "Flint and obsidian knives were always used by the Maoris at the same time that they had the well-polished tools and weapons of stone. The polished tools were used for canoe-building, making paddles, spears, clubs, agricultural instruments, &c., and were exceedingly valuable. The obsidian splinters were not worth the trouble of making into a regular shape. The edge was as keen as a razor, but so brittle that it could not be used for cutting wood to any advantage. These knives were used for cutting flesh, flax, hair, and for surgical operations. The edge soon came off, when another chip would be split off the large lump of obsidian which every family that could afford it would have lying by the house or concealed somewhere near at hand. These blocks were usually brought from the Island of Tuhua by the Ngapuhi, when returning from southern expeditions, and were articles which fetched a considerable price in the way of barter. When I first came to the colony, in many inland villages the obsidian knife was still much used. It was merely a sharp chip, but, when split off artistically, exceedingly sharp."

In Shortland's "New Zealand" the author thus describes the *mere-pounamu*, the mode of grinding it, and the drill with which it was bored:—

"This weapon is to the natives as great a treasure as any of the most precious stones are to us. It is thought worthy to be distinguished by a name, as was King Arthur's sword 'Excalibur,' and is handed down, an heirloom, from father to son. I will therefore give some description of it, and of the stone from which it was fabricated.

"In the Northern Island it is called a *patu-pounamu*, or *mere-pounamu*. A very celebrated one which I saw in the possession of Te Heuheu, at Taupo, was of the form here represented, about 20in. long, the blade about 4in. wide, and three-fourths of an inch thick in the middle, tapering on either side to a tolerably sharp edge. The stone was of a pale-green colour, mixed with opal, so as to present a wavy appearance, like that of a mackerel sky, translucent at the edge, and not disfigured by a single black speck. This weapon was named Pahikauri, and was obtained from a chief on the East Coast, whom an ancestor of Te Heuheu had killed in battle.

"Specimens of the stone are found, in detached blocks or pebbles, in several mountain-torrents on the west coast of the Middle Island. The places most renowned, near which it is sought, are Arahura and Ohonu, on the north-west coast; Wakatipu, a lake in the interior, one of the sources of the river Mataura; and Piopiotahi, a torrent on the south-west coast. . . . .

"In search of this stone the natives of other places have been in the habit of making long voyages, and journeys across the mountain from the East to the West Coast. When procured it is fashioned and polished by rubbing it on flat blocks of sandstone (*hoanga*). This is a work of so much labour that to finish such a weapon as that above described often requires two generations. Hence one cause of the great value set upon it. Another cause of its value is that the extreme toughness of the stone enables it to bear a fine edge; so that, before the New-Zealanders knew the value of iron, they had a useful substitute for it, from which they made hatchets and chisels.

"By some the strange notion has been entertained that this stone was found in a soft state by the natives, it not being credited that they could have learnt the art of fashioning it otherwise. Mr. Banks and Captain Cook also expressed their wonder by what process this was done, as they found the stone so hard as to resist the force of iron. But sandstone will cut it as readily as it does iron; and holes are drilled through it with the aid of a little fine hard sand and water and a sharp-pointed stick, by a simple process which is described in another place. Stones of different qualities, determined by different shades of colour and transparency, are distinguished from one another by names, and have corresponding values. The best quality is called *kahurangi*, a word often used, in the same way as we use the word jewel in poetry, to denote a precious object:—

"*Whaia e koe ki te iti kahurangi,*
Kia tapapa koe: he maunga tiketike

(Seek the *kahurangi*—the jewel, the highborn:
When you stoop, let it be to a lofty mountain)

are lines which were applied to a woman of rank who had fallen in love with a slave, and were sung to her by her relatives, who disapproved of her unworthy connection. In Phillips's 'Mineralogy' this stone is described under the name of nephrite, and is said to occur in the Hartz, in Corsica, in China, in Egypt, in New Zealand, and in other islands of the Pacific. . . . .

"Here [at Waikouaiti] I saw for the first time, on a large scale, the native method of grinding the *pounamu*, or greenstone, from the rough block into the desired shape. The house belonging to the chief Koroko was like a stonecutter's shop. He and another old man were constantly to be seen there seated by a large slab of sandstone (*hoanga*), on which they by turns rubbed backwards and forwards a misshapen block of *pounamu*, while it was kept moist by water, which dropped on it from a wooden vessel. While one rubbed the other smoked. They made, however, so little progress on it during my stay that it seemed probable that it would be left for some one of the next generation to finish the work. It is not, therefore, to be wondered that what has cost so much labour should be regarded as the greatest treasure of the country. Here also I saw the drill with which holes are bored through this stone. It is formed by means of a straight stick, 10in. or 12in. long, and two stones of equal weight, which are fastened about its central point, one on either side, opposite each other, so as to perform the office of the flywheel in machinery, and to exert the required pressure. One end of the stick—or, as we may call it, shaft of the instrument—is applied to the *pounamu* where the hole is to be bored. Near the other end are tied two strings of moderate length. One of these is wound round the shaft, close to the point of its attachment, and its extremity is held in one hand while the extremity of the other string is held in the other hand. A motion is now given by pulling on the former string, which, as it unwinds, causes the instrument to revolve, and the other string becomes coiled round the shaft. This is then pulled on with a similar result, and so the motion is kept up by alternately pulling on either string. The point of the instrument can thus be made to twirl round, backwards and forwards, as rapidly as the point of a drill moved by a bow, and merely requires to be constantly supplied with a little fine hard sand and water in order to eat its way through the *pounamu* or other stone, on which steel would make no impression."

In the vocabulary at the end of his book Dr. Shortland gives the names *mania* and *papa* for a "thin lamina of sandstone used for cutting the *pounamu*. The natives fasten them in frames after the manner of a stonecutter's saw"; and "a hard sandstone, found in thin slabs, used as a saw to cut the *pounamu*."

In using the *mere-pounamu* the warrior tries to seize his adversary by the hair with the left hand, and, having his weapon firmly grasped with the right, and secured by a thong or strap wound tightly round the wrist, he thrusts or drives its sharp end against the temple of his victim. Another mode was to grasp the body of his antagonist and drive the weapon under the ribs with an upward thrust. The direct blow with the long edge was not often given when the combatants faced one another. There have been many famous *mere-pounamu*, the names of which are probably known almost all over New Zealand. Among these may be mentioned the Ka-ore-ore, owned by the Ngaitahu chief, Tama-i-hara-nui, whose tragic history and fate form one of the most sensational episodes in Maori history; Pahi Kauri, which belonged to Te Heuheu, the great Taupo chief, and was recovered after being buried with its owner under an avalanche of mud which overwhelmed the village where he lived. Te Rau-o-te-huia was another famous *pounamu*, the possession of which was long the subject of contention between some of the Arawa chiefs. The Piopiotahi is another, owned by the chief Tohi te Ururangi, of the Arawa, who lost his life while leading a party of our allies in the late war. Many others might be named, locally or generally famous.

Other weapons of stone were used by the Maoris—the *onewa*, a club or *patu* of grey stone ; *okewa*, one of black igneous stone, shaped liked the *mere*, but thicker, and made of hard fine-grain stone. There is ground for belief that some of these stone weapons are much older than any of the *mere* and *toki* made of *pounamu*, and date back to a time long anterior to the discovery of the *pounamu* on the west coast of the Middle Island. In vol. xviii. of the Transactions will be found a very interesting paper by Professor Haast on "The Stone Weapons of the Moriori (Chatham Islanders) and the Maori." He says,—

"The stone axes and other implements"—of the Chatham Islanders—"were first roughed out by fracturing and chipping with other ones until the approximate shape was obtained. I may here add that the stone implements are made of Lydian stone, aphanite, dioritic and basaltic rocks—for the greater part, doubtless, obtained on the Chatham Islands, though there are some specimens in the Canterbury Museum, received from that locality, of chert and some other material, which appear to have been imported from New Zealand. After the approximate shape had been given to these stone axes the Morioris used grindstones (*hoanga*). These were made of a coarse sandstone generally found on the sea-coast at various places. They had generally a flat surface, were otherwise somewhat round, and varied in size from 7in. to 12in. on the average. This *hoanga* was placed flat on the ground, and the implement ground by rubbing it to and fro thereon with water.

Numbers of these *hoanga* are to be seen at the Islands, easily recognisable by the hollow in the centre, shaped like a saucer —a sign of their frequent use. Mr. Shand observes that he 'need scarcely remark that the operation was tedious in the extreme'; and one can easily see that such was the case by the examples of ill-ground axes, especially some of the smaller ones with round shoulders (*uma*) unreduced, like an ill-ground European axe. On the other hand, however, there were a number of really beautifully finished axes (*toki*) that must have taken an infinite amount of time and skill to get into such a perfect shape. There are many unfinished axes lying about at the Chathams in the rough state, evidently intended to be ground, but afterwards thrown away. When not using them, the owner generally hid his *tokis* to avoid their being stolen. Now and again a number so buried are discovered in ploughing or in digging up old places of residence. Mr. Shand observes that he has 'never seen—in fact, doubts the existence of'—any of the *toki-titaha*, or large axes used by the Maoris, and common also to New Guinea, used for chopping the top and bottom edges of a cut, the ordinary form being used to cut out the chip by chipping sideways, like an adze. 'It may be of interest,' Mr. Shand continues, 'to state that the mode of making and tying a handle on to the *toki* or large stone axe was identical with that of the Maoris, of which race the Chatham Islanders evidently formed a part in the original departure from Hawaiki. This is shown also by their traditions, legends, and the causes assigned for their leaving their so-called Hawaiki home.'

"The Morioris also used flint (*mata*), which they split into thin, irregular, wedge-like shapes, as knives, there being no volcanic glass (*tuhua*) obtainable in any quantity, although a reef of it is known to exist under water at the south-east corner of the island at Manukau. The micaceous clay-slates or argillaceous schists, with layers of quartz, occurring on the northern coast of the main island, were used for making the *patus*, and were also employed in the same way as the *mata*, though their edges cannot be made so sharp as that of the latter. Both are used with or without handles in cutting up grampus, or any other variety of whale, for food, the blubber of which was considered a great relish by the Morioris. . . .

"Besides the large weapons made of nephrite, to which exclusively the Maoris apply the term *mere*, they also used stone weapons of similar form, manufactured from melaphyre, aphanite, and other fine-grained basic rocks, for which weapons the generic term *okewa* was used. . . . Concerning the stone implements used by the Maoris and their ancestors, I have already stated that they called all those made of nephrite *mere*, and the rest *okewa*. It is evident that the stone clubs, possessing the same form as the *mere*, but made of hard black igneous rocks, are of a far more ancient date, though they have been worked with great care, and their form and polish are perfect. They have been found in such positions that there can be no doubt as to their great age. I was therefore much interested in obtaining two Maori stone implements, which are very different in form from those just alluded to, and which in many respects agree far more with the stone weapons of the Morioris than those of the Maoris. . . . Until further specimens of the same material and form are found of these remarkable New Zealand stone weapons it would be premature to speculate upon the affinities between them and the stone weapons of the Morioris; but it seems evident to me that they date back to a time anterior to the discovery of nephrite at the West Coast, and its subsequent use in the manufacture of *meres*, which must have supplanted the inferior material used till that time."

Of Maori weapons made of bone the *hoeroa* is the most worthy of notice. It was made from the rib of the whale. It is one of the ancient weapons, and there is some doubt as to the mode of its use. Some say that it was used as a projectile—thrown at an approaching foe, but recovered by an attached lanyard held in the hand. It was a weapon very highly prized, and exclusively possessed by a chief. Specimens of this weapon are to be seen in our Museum.

Shorter weapons, also made of whale's bone, are the *kotiate*, the *mere*, the *patuparaoa*; but these are, for the most part, merely imitations of the weapons of the same names fashioned out of wood or stone.

It is, I believe, a debatable question whether the Maori used missiles in warfare. At page 66 (Maori) of vol. iii. of White's "Ancient History" there is a plate in which is shown something, called *kotaha-kurutai*, which has the appearance of a missile to be projected by means of a stick and lanyard which would become detached as the missile is hurled. I have seen a description of such a missile as is there represented and of the mode of using it, but have forgotten where it is to be found. A specimen of the *kotaha* and *pere*, or dart, is in our Museum. I have also been told by a Rotorua chief that his father was killed with a *totaha*, hurled a considerable distance from a *pa*, situated on an elevation, which he, with his people, were besieging. The missile in this case was described as a blunt instrument. Judge Maning tells us that red-hot stones were sometimes slung into a besieged *pa*, with the intention of setting the houses on fire. The burning of the Arawa canoe by Raumati is said to have been effected by slinging darts carrying fire across the Maketu River, and setting on fire the thatch which formed its covering.

To revert briefly to the *pounamu*: It was not only as a material for a weapon that this stone was used and highly prized by the Maori. His most effective tools were fashioned out of it. The axes with which he felled large trees, and the adzes with which he shaped his canoe, dubbed down and dressed the *rauawa* and the timbers and slabs used in the construction of his house, food-store, palisades, &c., of his fortified *pa*, were of *pounamu*, ground, polished, and lashed to wooden handles. They were called *toki*, and were of various shapes and sizes, adapted to the work on which they were used.

The *toki-titaha*, used for felling large trees, was fixed by lashing to the end of a stout pole or shaft, with which it was thrust or driven against the tree to be felled. By successive blows two deeply incised rings, a foot or more apart, were carried round the trunk, the scarf between these being wedged out with smaller axes or adzes. The ringing and wedging process was repeated until the centre of the bole was reached and the tree fell. Sometimes a staging was erected around the tree, standing upon which a number of men could work together in this way; the axe-strokes being given simultaneously, to time marked with shout and song, in the same way as in paddling a canoe. Fire was also used as an auxiliary to the work of the axes and adzes. There were *toki-tarai*, *toki-hangai*, used for shaping and hollowing the trunk which formed the body of the canoe; *toki* in endless variety in shape and name. The adzes were lashed to handles, shaped so as to hold the cutting-stone at the proper angle. There were *toki-paneke*, or *paneke*, for finer adzing-work, and these diminishing in size down to the *purupuru*, or *whao*, a small chisel using in wood-carving. *Kapu* was a general name for an adze—a handle for which was often formed from a human leg- or arm-bone. The *pounamu* was also made into ornaments of various kinds, worn on the person, as the *heitiki*, a grotesquely-carved representation of the human figure, which was worn suspended from the neck; also ear-ornaments, the *kuru*, *tau*, *poria*, and many others. These were regarded as jewels, and many of them were named and famed in tradition, as were also the axes and other *pounamu* tools: *e.g.*, the *toki* Tutauru, and Hauhau-te-rangi, which were made from Ngahue's *ika*, or fragment of greenstone, taken by him to Hawaiki from New Zealand, are said to have been used in the making of the seven canoes named in the legend as those which brought the first emigrants to these Islands. The ear-ornament Kaukaumatua, also made from a portion of the same block, is referred to in the song or lament of Te Iwikau for his brother Te Heuheu, the great Taupo chief, in whose possession that famous jewel was when he met his death, in the manner previously mentioned.

I will not further trespass upon your time. Other articles of Maori handicraft formed with the tools I have attempted to describe must be passed over with slight notice: *Heru*, combs of various kinds of wood and of bone; the *putara*, or conch-shell, used as a trumpet; the *pukaea*. Musical instruments: the *koauau*, *kowauwau*, or flute, with which Tutanekai serenaded and charmed the maiden Hinemoa; the *pakuru*, the *putorino*, and many others. The limits of a single paper will not allow of more than a rapid glance at some of the more interesting items in the Maori repertory of tools and weapons.

I beg now to thank you for having so patiently listened to me, and to say that, if my imperfect attempt to deal with an interesting subject should lead to further inquiry on the part of some of my audience, I shall feel that the time occupied by me in putting together these few notes, and by you in listening to me, has not been altogether wasted.

Art. L.—*Why should School-teaching provide only for the Counter or the Desk?*

By James Adams, B.A.

[*Read before the Auckland Institute, 28th August, 1893.*]

It is not usual to associate, in idea, the work of the missionary with the advancement of science—the one seems to depend so much on the warm feelings of the heart, the other on the cold reasoning of the mind. So bright a halo of self-sacrifice appears around the labours of the missionary that we can imagine conversions as the result of sublime enthusiasm alone. But as a matter of fact the missionary and the scientist work hand-in-hand—an alliance that can be seen by studying the manner in which any particular mission has been established. Indeed, we shall find that practical scientific knowledge is a more powerful aid to success than pious enthusiasm or even than fiery zeal.

A good example of this is afforded by the mode of establishing the mission sent in 1814, to convert the Maoris. First of all the mission party gained a firm footing in the island by securing beforehand the friendship of a Maori chief who admitted the missionary and his party to membership of his tribe. This same chief had not only been to Sydney, but also to London, where he formed some idea of the wealth, the genius, and the might of the English. Ignorant, as he was, of the language, he could not have understood anything of the burning questions of the day on war, on religion, or on political reform; but he might well have looked with astonishment at the result of their knowledge of the forces of nature in producing food, making clothes, building houses, and fashioning weapons. Some of these wonders effected by science he no doubt tried to impart to the men of his tribe, but with little success until the arrival, some years later, of the mission party. His new friends arrived in a large ship provided with stores of all kinds. They landed with the importance of men who possessed superior wealth, superior knowledge, and superior goodness. The houses placed at their disposal were soon stored with all manner of goods, sufficient to enrich not only the whole tribe, but, to the imagination of the savage, all the tribes of New Zealand. It was soon found also that the stores belonged to men who knew well how to make use of them. The blacksmith, the builder, the ship-carpenter, the flax-dresser, and the farmer were soon busy, each at his own occupation, preaching sermons, so to say, by the wonderful works of their hands, while the missionary was busy mastering the rudiments of the language. With what admiration the natives must have watched a party of these new members of the tribe carrying on their operations in a kauri forest. The trees fall with startling rapidity under the blows of the keen axe; the logs are moved about by levers, slid along a plane, rafted to the saw-pit, and there the crane, with its mighty iron hand, lifts them into position. After the logs are sawn into planks comfortable houses are built; while, at the same time, a large ship rises up before their eyes, that is finally launched into deep water apparently with the blow of a hammer.

All these great works were accomplished in less time than the natives would have been able, without the white man's aid, to fell a tree and trim it that it might be made into a canoe. And still new wonders were every day displayed. The blacksmith's forge was soon aglow with the molten iron, and curious articles were fashioned before their eyes. The flax-mill sent forth its hum and the fibre came forth in quantity, very different from the tedious and laborious scraping with a pipi-shell. Strange animals—horses and cows and sheep—were landed and enclosed near the missionary's house. The ploughing and harrowing and sowing went merrily on. New vegetables were grown, and fruit-trees of all kinds were planted. Abundant crops of corn were soon gathered in, which the miller changed into flour and the baker into bread. The Maori who saw all these wonders performed must have been very dull indeed not to recognise that the mythical works ascribed even to their deities were as nothing in comparison with what could be done by this wonderful missionary and his party. And all this reputation was built up on their practical, scientific knowledge. Their knowledge of the mechanical powers gave them the strength of a giant, with the rapidity of a divinity. Their knowledge of the properties of water enabled them to grind their corn, to conduct the water where they pleased, and even to make it rise from the earth at their own doors. The blacksmith was the metallurgist, and the missionary was the chemist and the doctor.

If some intelligent Maori had asked them, "How is it you are able to perform all these wonderful things?" some of them would no doubt reply, "We have learned how to do many of these things in England, and from books we can learn how to do anything else that we may wish." This, then, was the clue to knowledge and power; and need any one be surprised that the chiefs were anxious for schools to be established that they and their children might learn how to do all those wonderful works? Poor simple-minded savages! They were soon to find out that schools were not established to teach anything more useful than what was required to become a clerk or a shopman. They were not to encourage self-reliance and self-help, but to inculcate the necessity of the individual being always guided by authority.

Even this instruction, poor as it was, only applied to the middle-class schools at that time in England, for in the primary schools reading, writing, and arithmetic were of little importance compared with the catechism and the geography of Palestine. As for the college education, the highest honours were conferred on those who showed most knowledge of the languages of two nations that were barbarians in comparison with the English. The Maori might be surprised to hear that in this much-bepraised classical learning there was very little of it true, and none at all useful; and that a more helpless person, so far as education is concerned, can scarcely be imagined for the colony than a man who had graduated with the highest honours at a university. The Maori, however, got his heart's desire. Schools were established and examinations held, but what effect they had on Hongi and his braves is not very clear; but the benefit of the lessons in practical science is praised by no less a person than the renowned Darwin. He writes, "Moreover, native workmanship, taught by missionaries, has effected this change: the lesson of the missionary is the enchanter's wand. The house had been built, the windows framed, the fields ploughed, and even the trees grafted by the New-Zealander. At the mill a New-Zealander was seen powdered white with flour, like his miller brother in England. When I looked at this whole scene I thought it admirable. It was not merely that England was brought vividly before my mind, yet, as the evening drew to a close, the domestic sounds, the fields of corn, the distant undulating country with its trees, might well have been mistaken for our fatherland; nor was it the triumphant feeling at seeing what Englishmen could effect, but rather the high hopes thus inspired for the future progress of this fine Island."

And these high hopes are certain to be realised—all that Darwin found sombre and gloomy have during the past sixty years nearly vanished. The dense forests have been removed, and corn-fields, pasture-lands, and orchards have taken their place. Large districts, like the Canterbury Plains, that afforded no food for the natives, have now become the granaries not only of New Zealand but of England. The bare shingle-slopes that the natives seldom approached now feed thousands and thousands of sheep. Metals and minerals hidden deep in the earth are being worked out and employed in the service of man. Every harbour and river-mouth has its rising town, well drained, well built, with public parks and public buildings, while the country in the neighbourhood of the town is but a succession of lovely gardens. It is the knowledge of science, that increases more and more, which acts like an enchanter's wand, and has changed this country, gloomy and unattractive even to the eye of Darwin, into the lovely country that visitors and residents alike agree in calling it. It is to our knowledge of the laws of nature that we look for aid in all troubles, bodily or mental, or municipal or national. We had depression, and depression disappeared, not through prayers in the churches, nor through the eloquence of our representatives, nor through the vigorous policy of the Government, but from the fact that scientific men have shown us how to produce great cold in a chamber, and in this way beef and mutton can be carried fresh and good to the European markets.

Now, it was pointed out above that sixty years ago the school-teaching was not in harmony with the duties of life. Young people while at school, with the exception of learning to read and write and cipher, were trained to have their judgment controlled entirely by that of others; whereas the producers, from the farm-hand to the F.R.S., must depend on his own judgment and on his knowledge of the laws of nature.

What steps, then, we may well ask, have we taken so that the teaching in our schools shall be a fit preparation for the requirements of later life?

In answer to this question, it may be as well to show what we do with the very pick of our boys and girls. In the month of December a bell is rung, to speak metaphorically, that calls to all to "come up and be examined." This is eagerly responded to by boys and girls of all ages and from all kinds of schools, from the dame school to the university college.

At present, however, we have only to do with those who are competing for the District Junior Scholarships. I need hardly say that very much more importance is attached to their literary than to their scientific attainments.

We may suppose the examination over, and that some practical man, not acquainted with our school-teaching, on being requested to address the successful candidates, speaks as follows: "Boys and girls, you have been awarded the highest distinction for scholarship in the district schools; and there are, as you know, not only honour but also certain emoluments attached to this distinction. The object of this is to give you the power of developing your natural talents so that you may prove a benefit to this young country. You know that all that has been done in developing the wealth and resources of New Zealand is the work of scientific men; try, therefore, by diligent attention to your teachers, and by devotion to your studies, to become worthy successors to these great men who have done so much, and are doing so much, for New Zealand."

Now, after this exhortation, let us see what we do with these young people—the hope of the country. They are at once put to work on their new course of studies, and Latin is made of primary importance. Let us be under the mark, and say seven hours with a teacher and eight hours per week private study: that is, fifteen hours out of the whole number—say, forty hours per week. The twenty-five hours that remain are for the study of English, French, history, mathematics, and science.

This great devotion to Latin is not the whim of the schoolmaster. The course is laid down by the higher powers for those who wish to give proof of their diligence and ability by the offer of senior scholarships, at which examination four times as many marks are assigned for Latin as for chemistry. The real question, then, for an ambitious and talented candidate is, How can Latin be best learned? The only answer is, Devote plenty of time to it.

After the student succeeds in gaining this scholarship another goal is placed before him—the University Junior Scholarship—where the great subject is Latin. Thus we see that at the lowest computation the study of this much-revered language absorbs at least one-third of secondary school and of college life—say, three years out of nine. Try and imagine what reams and reams of paper are used yearly by each student in writing this language, whilst, if we take into account all the students since an impulse was given to Latin studies, some twenty years ago, the paper used would make a vast pile. If all this Latin-covered paper was made into bricks there would be sufficient to build a tower of Babel that, if erected in a prominent place, with a suitable inscription, ought to convey an important lesson. Such a structure would show the earnest untiring efforts made by the most talented youth in this colony in order to learn a language that can afford little or no information. Indeed, it is difficult to say what is the actual gain from this study. There is far less information to be gleaned about Italy and its people from the whole range of Latin classics than can be obtained with respect to New Zealand from a shilling almanac. The Romans were ignorant of art and science, and gloried in their ignorance.

> Excudent alii spirantia mollius æra,
> Credo equidem; vivos ducent de marmore vultus;
> Orabunt causas melius; cœlique meatus
> Describent radio, et surgentia sidera dicent;
> Tu regere imperio populos, Romane, memento,
> Hæ tibi erunt artes.

Stripped of the rich apparel of figurative language, the orders were: "Noble Roman, do not trouble your head about science and art and literature; your business is to take possession of the property of others, and to make the vanquished work for you." Nor is Virgil the only one who mentions the humble acquirements of the Romans. Lucretius and Cicero are equally plainspoken; so that it is wonderful to see the great prominence given to this subject in the school course, and the astonishing ardour with which the language is studied by the most talented of both sexes.

It is now time to turn to what must be considered the most important part of our education system—I mean, of course, the instruction given in the district schools. In them we require instruction that will prepare the intelligence of the youth to develope the resources of this country, as it is from these schools that come the farmers, miners, workers in metal, in wood, in wool, and in fibres—all alike get their living, and contribute to the welfare of all, by knowing the laws of nature in relation to their several occupations, and acting in accordance with them.

It is, then, rather surprising to find that little, very little, of the study of nature or her laws enters into this school course. There is a little science prescribed for the Fourth, Fifth, and Sixth Standards, but it is so badly taught that this is what is said by the Inspectors of Schools for Auckland Province: "In our last report we mentioned that we found, when questioning a class in elementary science, that the answers were too often given by a very small portion of the class under examination. We notice but little improvement in this respect. We have again to urge the absolute necessity of teaching this subject experimentally. . . . We recommend those teachers who can conveniently do so to attend the

Saturday science lessons at University College, Auckland, that they may acquire skill in experimental work." This, I may remark, is not a report of the state of science-teaching in 1832, but in 1892.

The advice given to the teachers is good, but no great hopes can be entertained for those who commence late in life to study science. Like all important studies, early training and a real love of the subject are the essentials to success. Science is not a subject that can be taught without years of practical work. It has a language of its own, copious and definite, the full meaning of which is acquired by experiments. Indeed, to attempt to teach the most elementary scientific book without full practical knowledge must result only in failure.

The Inspectors also refer to the teaching of drawing in no flattering terms; and this is another essential in technical education. It may now be well asked, At what are the children engaged for the eight years they are at school?

For four years they learn reading, spelling, arithmetic, grammar and composition, geography, and drawing, until they reach the Fourth Standard. Then for another four years they learn the same, with the addition of history and science, which has been already dealt with.

The school instruction only fits them for clerks or shop-helps, and yet, in our unreasoning way, the cry is raised that the boys and girls, on leaving school, want to go to the desk, or the counter, or to become teachers.

The Colony of Victoria has now gone in for retrenchment, and, as a part of it, dismisses school-teachers. Now, if the schools were preparing the producers for real life, nothing could be more foolish; but it is found that the real product is shoals of clerks and store-helps, which it is thought can be produced more cheaply. A farmer on a large scale who has got into difficulties dismisses stewards, overlookers, clerks, but takes good care to keep his good workmen. He saves in out-building, household luxuries, and race-meetings, but he cannot do without his good workmen, or utter ruin would ensue; and teachers would be equally essential to the colony if their instruction increased the number of intelligent producers. We are not left in any doubt how primary education will be carried on in Victoria, for our method that was adopted a few years ago is quite bad enough to imitate.

It would be strange if some ardent admirer of educational retrenchment had not, ere this, thus expounded the manner in which education is so cheaply carried on in this province: "In a school with an attendance, say, of four hundred, there are seven teachers whose wages range from 7s. 6d. to £1 a week; then two at £1 10s. and £2 respectively; while the head-teacher's salary fluctuates with wet days, measles, whooping-cough, and other visitations, for which he is properly held responsible."

Of course the number of teachers varies with the attendance, but more than half the number are at a salary of from £20 to £30 per annum. It is certainly very economical to have a standard of forty or fifty pupils taught for 7s. 6d. a week; but where do the discipline and education come in?

There is a certain silence and order preserved, or dismissal results; but what becomes of the mental discipline, which is the great gift a teacher can impart?—that power, I mean, of devoting the entire attention to the subject of study, from which arise order and silence. One thing, however, is certain: that the result of having this work cheaply done is that the pupils who pass the Sixth Standard are now, so far as my experience goes, very inferior in attainments to what they were three years ago. I mean, of course, in those subjects that would fit them to be office-boys and shop-apprentices, for the system seems to have no other object in view. The breach is yearly becoming wider between the school and the realities of life. Our education, whether in higher or lower schools, is subjective to an extreme degree—just of the kind to produce the discontents and riot that characterized the latter days of the Roman Republic, when the belief in words was equally strong. This devotion to the study of mere words appears, like the serpents in the Laocoon group, to poison individuality and to crush objectivity out of existence.

I mentioned what the Auckland Inspectors said of the teaching of science; but all the Inspectors throughout New Zealand have the same report. The Inspectors for Wanganui are especially outspoken. They say, "To call the matter taught in the schools science is a misuse and degradation of the term."

We must therefore honestly confess that, so far as public education is concerned, the instruction in science has scarcely begun, and that no regular plan has been so far adopted with the desirable object of having the instruction in school in harmony with the requirements of actual life.

There is, however, in my opinion, a simple remedy in our hands not requiring any great change in the present system, and little, if any, additional expense. In fact, there need be no change in the present instruction until the children have passed the Fourth Standard. After this the pupils, instead of continuing to attend the same school, would go to a central school, where the education would be for the most part scientific.

Say that there are five schools, with a total attendance of two thousand. These would supply an average attendance of one hundred and eighty for the central school. This school-building would be provided with six suitable rooms, for natural science, mathematics, drawing and sewing, English, science, and a laboratory.

Then a competent teacher would be required for each department. This might prove a slight difficulty at first, but every year would help to remove it. There are many suitable assistants available who are now teaching children to spell, while the teacher of science at present would be more suitably occupied in their places. I do not think any one would doubt that a three years' course in such a school would put new life and new vigour into this young country. I hope I have said enough as to the utter futility of employing any but competent teachers.

To enumerate all the benefits arising from such a change would compel me to double the length of this paper, which is already too long; but, at the risk of being tedious, I will enumerate a few.

It will enable science to be at last properly taught, which cannot be done without a teacher that knows it, and the scientific apparatus that illustrates it.

It will realise the long-desired benefit of having drawing taught in a manner suited to the wants of mechanics.

It will supply the right kind of students to the various technical schools that are now being founded in the colonies. But I need hardly point out that such schools will prove failures unless a better preparatory training be given to the pupils.

It will enable parents to provide a higher education for their children, when they do not desire Latin and French as an essential part of it. A central school such as I advocate would soon furnish the teachers of the sciences and of mathematics at the University College with the best stamp of students—students that would be trained to develope the resources of this colony, while now they fritter away their best years on subjects that are but the shell and husks of an education.

At the commencement of this paper I mentioned that the philosopher Darwin was delighted with the skill that the Maoris at the mission-station displayed as agriculturists and as artisans. And now, in conclusion, let me ask, Is it not in our power, before this manual labour is commenced by our own people, to impart to them not only the principles of the operations, but also the power of reading with ease the scientific books that relate to each one's own occupation?

ART. LI.—Description of a Compound Seismograph.

By W. ALX. CAREW.

[Read before the Philosophical Institute of Canterbury, 1st November, 1893.]

THE object of this seismograph is to register an exact record of earthquakes, at whatever time and at whatever angle they may come, both horizontally and vertically, as well as the number of waves, their magnitude, direction, and the exact time of the commencement and termination of the disturbance, in hours, minutes, seconds, and fractions of seconds. To gain these results I have united a number of the standard instruments of the present day into one compact machine, all working together, and recording on smoked-glass plates, all driven by the same agency—clockwork.

I will begin by describing the pendulum seismograph which is to be used for marking the hour, &c., when the disturbance takes place, and which gives a condensed record on an almost stationary plate.

The frame of this machine is about 3ft. 8in. high by about 16in. wide, with a foot of about 2ft. 10in. long. From the top of this frame descends the pendulum for 2ft. 6in., terminating in a lead ring 6¾in. in diameter, and 1$\frac{3}{16}$in. in thickness and depth. This will weigh about 10lb. On the top of this ring is a glass plate, upon which works a screw, carried by an arm from the framework, to give the friction required to stop the pendulum from swinging owing to inertia. Through the centre of the ring is a metal rod with a conical hole in its centre, in which works the top end of the indicator. The indicator is a piece of steel wire working on a bearing at 2in. from its top, and 6in. down it terminates in a slide to carry a needle which rests on a smoked-glass plate, and gives record magnified three times.

The bearing referred to above is composed of two knife-edges placed in a piece of wood, which crosses the frame about 2in. below the ring of the pendulum, on which rests a ring with two Λ-shaped niches cut to receive the knife-edges. These are to prevent the ring being carried off the knife-edges in an earthquake. Another pair of knife-edges are fastened on to the indicator, and rest in V-shaped niches in the ring at right-angles to the knife-edges under the ring.

It will be seen by this that the record on the glass will be drawn in the opposite direction to the movement of the pendulum.

Beside the pendulum is a spiral spring, which forms the vital part of a vertical-action seismograph, and which is 2ft. 6in. long when stretched. This descends from the top of the frame beside the pendulum, and terminates on a lever at about 3in. from its fulcrum. This lever is made forked, and provided with two parallel fulcrums so that it cannot swing from side to side—as it would if not so provided—but only rise and fall; after passing the point at which it receives the spring it is carried out 3ft., when it is met by the short end of a bent lever, the fulcrum of which is carried by two arms coming out from the uprights of the stand. Situated on top of the forked lever, near its junction with the bent lever, is a lead weight with a glass plate suspended from it, on which work friction-screws. The long end of the bent lever carries a needle, and marks on another glass plate.

Besides the pendulum for recording horizontal motion, there are a pair of bracket seismographs working at right-angles to each other. They are made as follows: A piece of wood, which must be substantial and about 8in. high, with a piece projecting 2½in. from top and bottom, carries a steel rod, both ends of which are held in place by steel bearings. Standing out from this about 3in. is another framework to carry a column of lead measuring 6in. high and 2in. in diameter. To the bottom of the lead is fixed an indicator 2ft. long, with a place at its end to carry a needle. This will record on the same plate that the vertical action is recorded upon.

To receive all these records, and to give the exact time of the shock, I have designed that two glass plates should be used —the one, 1ft. in diameter, under the pendulum, to receive a condensed record with small amount of magnification, turning round once in twenty-four hours; the other, 3ft. in diameter, turning once in the hour, to receive the record from the vertical action and the duplex-bracket seismograph.

To economize space I intend that the small plate shall be put as far under the pendulum as possible, and the large one allowed to go under it, or over, as far as will be allowed by the bearing of the small plate, or the indicator of the pendulum. The large plate will be supported from the front of the stand which is carried out at each side to give the groundwork for the brackets, the two indicators of which will reach out away from the pendulum, and record on the furthest part of the plate from it.

Each of the plates is carried by a star-shaped support made of thin wood, to give them stability.

Art. LII.—*The Effect of Current Electricity on Plant-growth: Further Experiments.*

By H. N. McLeod.

Communicated by the Secretary.

[*Read before the Hawke's Bay Philosophical Institute, 9th October, 1893.*]

In the "Transactions of the New Zealand Institute" for the year 1892 other previous experiments are detailed at some length.* The results which I obtained then were favourable to the growth of plants being accelerated by feeble and by comparatively powerful currents of electricity. For poles or plates to conduct the current through soil, silver and copper had been used. In one case more silver than the amount contained in a threepenny piece was incorporated in three-quarters of a cubic inch of soil. Plates of a substance not decomposable were substituted in two experiments, and, in a third, small quantities of guano were made to take the place of plates.

Experiment A.—Continuing with the same kind of plant as previously, two pieces of carbon were inserted in the ground ¾in. apart. Wires connected them with the poles of a Daniell cell of the common type, which gives a pressure of one volt. This current was sufficient to overcome the resistance of the soil between the carbons, and circulate round two seeds placed there. Moistened litmus paper proved the existence of not a small current, and, on reversal of the paper, change of colour was produced at the opposite end. The plants were subjected to the conditions of a hothouse, and the current was reversed every twelve hours. In five days from the time of sprouting one electrified shoot was 1in. higher than either of two ordinary plants which came up at the same time; the other electrified plant, appearing later, gained ½in. Comparing this result with that of experiment 5 given in my last paper, we are led to conclude that the silver dissolved in the earth in the course of the experiment retarded the growth.

Experiment B.—Again, small pieces of carbon were used with a one-cell current, but they were put in the earth after the plants appeared above the ground, and subjected to the ordinary conditions under which plants grow. At the end of two weeks these electrified plants were leading by ½in.

Experiment C.—This time thirteen small cells, each giving

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* Trans. N.Z. Inst., vol. xxv., p. 479.

about half the current of a Daniell, were brought into play in the following manner: I filled two glass tubes of 1in. length with guano, and at one end of each tube fitted a section of carbon with wire attached. The sections of carbon and 1in. of each wire were then covered with guttapercha. This prevented any current passing through the earth, except by way of the guano in the tubes.

Two mustard-plants nearly 1in. above the surface of the ground were brought between the open ends of tubes, and the current turned on. During the period of three weeks the current was passed through the circuit intermittently, and always in the same direction. At the end of that time the gain over plants, equal in size at the commencement, was 2in., with size in proportion.

With seeds soaked in water, which were placed within a strong magnetic field, little or no effect was apparent. With zinc and carbon and zinc-cum-copper couples placed at distances of 1 and 2 yards, with rows of peas between, distinctly beneficial results have been observed.

Art. LIII.—*Some Recent Evidence in favour of Impact.*

By A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 1st November, 1893.*]

Plate LII.

In the years 1878–79–80, I read before the Institute a series of papers on cosmic evolution, founded on the theory of impact.

The reasoning on which the theory was based was of so obvious a character as to leave little doubt on the mind of any one acquainted with the modern doctrine of energy as to the substantial accuracy of the induction. At the same time, there seemed but small probability that any phenomena would occur, sufficiently striking to actually demonstrate the theory. It is often said, however, that it is the improbable that occurs, and this seems to apply with special force to what Nova Auriga has done to demonstrate the theory of constructive impact.

The theory suggested the existence of dark suns, and, although in my earliest papers I stated that Algol was probably a dead sun revolving around a brilliant one, there then seemed little likelihood of the surmise being proved. Many will remember, however, that a few years ago the peculiarities of Algol were so disclosed by its spectrum as to enable us not merely to prove the existence of the dark body, but actually to measure it, to weigh it, and to estimate its velocity. It has proved itself to be almost exactly the size of our own sun, and its motion has demonstrated that there must be a still more stupendous dark globe around which Algol is revolving. It would not surprise me were Professor Boys to prove the existence of this globe by his micro-radiometer.

The peculiarities of the motions of Sirius have also shown it to have a dark companion that has not only been weighed, but in powerful telescopes can be actually seen as a feebly luminous body.

The existence of dead suns having been proved, it remained for Nova Auriga to show us the phenomena of the clashing of a pair of such suns. Between the 8th and 10th December, 1891, a star appeared where no trace of a star existed before. No eye saw it for many weeks, but it continued to record its existence automatically by photography. It showed first a considerable increase of light, then a falling-off, then in February it was seen visually. Soon many of the most powerful telescopes in the world were at work, armed with all the resources of our modern methods, and step by step the amazing character of the phenomenon became apparent. The star was double, it had unprecedented velocities, a third body was detected, it expanded into a nebula, it fluctuated in intensity, &c.

But first let me gather together the salient features of impact as described in my papers, and then compare these with the phenomena disclosed by the new star. Were two dead suns to attract each other they would increase their velocities and move in curved paths. If they grazed, their velocities would be many hundred miles per second—five hundred was mentioned as a reasonable mean in the papers. The effects of the collision would only tell on the parts meeting each other, and the impact, instead of extending to the whole body, would affect only a part. This partial impact would produce an intensely heated body that would remain between the two escaping suns, and that would have so little mass that its temperature would cause each molecule to travel in an outward direction until the mass is converted first into a hollow shell of gas (a planetary nebula), and is then finally dissipated entirely into space.

The enormous velocity of the molecules in all directions would cause the spectral lines to broaden into bands with ill-defined edges.

The two impacting suns would be sheared by the impact, would recover their sphericity, and continue to pulsate for some time; they would spin, and show occasionally their hot and scarred sides. Were they moving in the line of sight they would have their spectral lines displaced—those of the advancing body towards the violet, and of the retreating body towards the red.

The middle body would be made up from the two original bodies, each of which in retreating would entangle highly-heated matter from the other; hence almost all the spectral lines would be identical for the three bodies, and, as the three spectra would overlap, almost all the lines would be triple.

The total light from the planetary nebula would be very feeble, and, if the two wounded suns presented to us their dark sides, the star would nearly disappear, reappearing as the rotation continued.

To put the matter into a few words: A grazing impact generally produces three bodies, a temporary and two variable stars, the temporary star becoming a planetary nebula, and then, as a rule, disappearing; the two variables showing variability for periods ranging from a few years to possibly many centuries, and in about half the cases becoming double stars.

We will now compare this statement of the results of impact, as read in my first papers before the Institute, with the observations on Nova Auriga.

The new star was triple. As the result of his study of eighty-five observers, Alfred Taylor sums up that there was no doubt of that. Professor Vogel gives the velocity of the three bodies as 420, 300, and 23 miles per second respectively. My paper in 1878 showed that when a pair of stars impact the two stars will leave each other, and a third will be produced between them. In 1879 my papers were illustrated by diagrams, one of which showed the three bodies and the character of their motions as already mentioned, the initial velocity being 500 miles per second.

The new star showed remarkable fluctuations of light, and almost absolutely disappeared, so that for several months it was not looked for. It was accidentally rediscovered, and found to be of the tenth magnitude. In my papers I called attention to the fact that the central star would increase in intensity and then slowly and steadily diminish; that the two sheared stars would recover their sphericity, would pulsate, and would also rotate, giving us extraordinary fluctuations of light. If the dark sides of each body were presented to us at once the star would obviously disappear altogether, supposing the central body to have dissipated.

Astronomers incessantly call attention to the fact of the spectrum of all three bodies being identical. Father Sidgreaves is so amazed at this coincidence, and at there being three bodies, that he suggested a local disturbance as a solution. Obviously this identity of spectra must follow with a grazing impact. Each of the two bodies must entangle a great deal of heated matter from the other, and the middle body is, of course, actually made up of parts of the two originals.

Every element represented in the spectrum had its line or lines in triplicate—one being very broad and having two others superimposed on it. It is evident that a body expanding with incredible velocity in all directions, as I have demonstrated the central body must do, is bound to give broad bands, because of the molecular motion in all directions.

The new star became a planetary nebula. Gregory states in a long article in "Nature" that this is demonstrated in two totally different ways; and Professor Bernard, the discoverer of Jupiter's 5th satellite, says that it had become a planetary nebula of 3secs. of arc, with a tenth-magnitude star in the centre. This observation shows that at this stage the chief light was not from the nebula but from the star. Of course, this is exactly in accordance with the theory of impact, suggesting, as the latter does, a gradual and steady diminution in the intensity of the third body and the occasional reappearance of the struck stars. Professor Bernard also states that the nebula was not there at first. Hence the prediction that a partial impact must produce a hollow shell of gas or planetary nebula is in exact accord with the observation of Nova Auriga. The new star must have been produced by the impact of two very large orbs. Probably the amount sheared off may have been many times as large as our sun; yet it was not likely to have been at all a large fraction of the whole—possibly not large enough to cause the two suns to become orbitally connected into a double star; nor is it even likely to have been large enough to allow the resultant planetary nebula to become permanent; but the data at our disposal are rather conflicting. Taking the average of the best observations, I have calculated that the two impacting bodies were respectively four thousand and eight thousand times the mass of the sun; that the velocity of the smaller body at impact would have been about 4,000 miles per second, and of the larger one about 3,000 miles per second. This would give for the swiftest a velocity of 600 miles per second sixteen days after contact. There seems every reason to suppose that a very large proportion of the luminosity of the two resultant variables will die down within the first year or two. At the same time, there is a large probability that they will be periodically bright enough to show themselves for scores of years. In about ten years their habits will have become regular enough to enable us to predict their ultimate durability.

It may be very difficult to distinguish the light of the two stars, unless satisfactory photographs can be taken. If this be possible a decade should give us a fair insight into their future. I believe that astronomers will then be able to predict that their variability will last more than a century.

Should it be possible to photograph the disc of the nebula through a spectroscope, the disc presented by the different elements will probably be of different dimensions, that of the lighter atoms being the larger. I do not know if any observations to this effect were made, but in the original photographs the bands of the different elements should have been of different widths, the lighter elements being the widest.

If we could get the increased size of the disc and the width of the same elementary band at intervals of time, it would enable us to calculate the actual distance of the body. Everything points to the star being at an incredible distance—at least a hundred times as distant as Alpha Centauri, and, although its light has only just reached us, the fact that the telescope has not divided the two stars, and the small size of the nebula, suggest that it probably occurred before the hero of Creçy was born. The high velocities so long after its birth suggest that it must have been an event of the most gigantic character.

The following gives the state of the theory up to the present time:—

Summary of the Principles of Constructive Impact.

1. There are over a hundred million bright stars in the Milky Way.

2. The companion of Sirius and the dark component of Algol prove the existence of dead suns. These are possibly very numerous.

3. Stars have an independent velocity, or "proper motion," of about ten miles a second upon an average.

4. This motion is apparently without much order, and will tend to alter the relative distance of stars, and may bring them near each other, and possibly into impact.

5. If they are brought near each other their mutual attraction will alter their velocity, and curve their courses into hyperbolic orbits. If they do not graze they will ultimately again attain their original proper motion.

6. When very near each other their attraction will cause them to be distorted into an egg-shape.

7. The tendency to collision will therefore be increased in these two ways by their mutual attraction. This increase over chance impacts will probably average about a hundred times. The increase in the case of two such bodies as our sun would be over a thousand times.

8. All impacts brought about in this way by deflection will be of a grazing character; consequently, nearly all stellar collisions will be of a grazing character.

9. The average velocity of stars at impact will be hundreds—in many cases thousands—of miles a second. The average proper motion will not appreciably affect the velocity at impact. Thus a proper motion of ten miles will only add one to a colliding velocity of one hundred.

10. A mere graze of the atmosphere of stars obviously will not cause them to coalesce. As a mean result when more than a third of each of two equal bodies collide, coalescence will ensue, but this will depend on the original proper motion. Were nine-tenths of 1830 Groombridge to collide with a similar star the remaining tenth would not be stopped in its course; it would pass on in space, the bulk of the two stars temporarily coalescing.

11. The effect of the collision will be to intensely heat the colliding part.

12. The heating effect of a graze of two stars, of two star-clusters, or two nebulæ, or even of a star plunging through a star-cluster, &c., will not appreciably extend to the parts not colliding. To emphasize this fact such impacts have been called "partial."

13. Partial impacts generally result in the formation of three bodies; the parts of each whose momentum is destroyed by impact remain behind, and the two cut stars pass on in space.

14. Partial impacts of a third of two equal stars having considerable original proper motion would make the two into three equal bodies; two of them would travel in space in opposite directions, the third would remain at rest between them. If there had been no proper motion the three bodies would coalesce; but if less than a third be cut off each the two bodies become three bodies orbitally connected.

15. The temperature produced by an impact will depend upon the velocity destroyed and upon the chemical constitution. High velocities and heavy molecules both tend to produce high temperature. Consequently the temperature will not depend upon the amount of the graze. Were one-tenth or one-hundredth grazed off the stars, the temperature of the coalesced part would be the same.

16. Although the temperature will be the same, the gravitating-power of the coalesced part will depend upon its mass.

17. Heat is a molecular motion. In a small graze of any given pair of stars the molecules will have the same velocity as in a large graze; but the gravitating force holding the body together will be different. In a large graze the body may be

stable, the velocity not overcoming the attraction. In a small graze the body will expand indefinitely in consequence of its small attractive power, and every particle will have so high a velocity that it will, in general, become an independent wanderer in space.

18. Space will consequently be dusty with free molecules.

19. The mass of gas will obviously expand temporarily into a hollow shell of gas. Herschel tells us this is the condition of planetary nebulæ.

20. A partial impact of stars will consequently generally produce in less than an hour an intensely heated body that will expand enormously without much diminution of heat. It will consequently become very bright indeed. It will then continue to expand until it becomes a planetary nebula. Then it will disappear by dissipating completely into space.

21. The molecules on the far side of the sphere will be retreating from us; those on the near side advancing towards us. The spectrum of such a body will consequently be crossed by broad bright bands, each with a maximum in the centre, and gradually dying imperceptibly away. If this body has any motion in the line of sight, as it probably will have when the two colliding stars are unequal, the line of maximum intensity, although in the centre of the band, will be displaced from its true position.

22. Immediately after the impact the temperatures of different kinds of molecules will be very different from each other. Were the colliding spheres of oxygen they would be sixteen times as hot as if they were similar spheres of hydrogen. The temperature at impact will be proportionate to the atomic weight.

23. In a mixed sphere these inequalities of temperature would quickly equalise themselves. Then when the temperature was uniform the hydrogen would be moving four times as fast as the oxygen. The velocities would vary inversely as the square root of the atomic weights.

24. This difference of velocity will tend to sort the molecules into layers like a lily-bulb, the hydrogen on the outside followed by lithium, &c., in the order of their atomic weights. If there are elements lighter than hydrogen, as spectroscopic observations of the corona suggest, these will, of course, precede hydrogen. In my lectures and papers on this subject I have called this action "selective escape."

25. Space will be thickly spread with free molecules of the lightest elements. This fact is important as one of the interesting agencies that prevent the theory of dissipation of energy being of cosmic application.

26. A telescopic view of a new planetary nebula produced by a partial impact, if looked at through a prism, should give

a series of discs of diameters diminishing with increase of atomic weight.

27. This fact taken in conjunction with the broadening of the lines into bands will enable us to calculate the distance of such a body.

28. The hydrogen will rob the heavy molecules of their energy; hence in any considerable graze the heavy metals might not expand indefinitely. They would lose their velocity by radiation and work done; they would be attracted back again and form a star. Some planetary nebulæ have such stars.

29. In a partial impact the coalesced part will not have all its motion converted into heat. On the two sides the momentum will not be exactly balanced; the body will consequently tend to spin. It is generic of partial impact that it tends to cause rotation in all the bodies produced, and the rotation is all in the same direction.

30. It is a peculiarity of oxygen that it tends to render its compound with metals less volatile than the metals themselves. Almost all oxides are less volatile than the metals forming them. Consequently when metal and oxygen come together they produce molecules that tend to coalescence. Thus nuclei form in a nebula and it becomes dusty. If the nebula be rotating this dust tends to move in orbits, constantly picking up other dust and molecules. Thus a rotating metallic nebula tends to aggregate, not necessarily into a single body, but into a mass of bodies orbitally connected. If the mass be large it will become a star-cluster; if small, a meteoric swarm.

31. In star-clusters impacts should be frequent. These groups should be photographically watched to notice sudden increase of intensity, and then the pair of impacting stars should be watched for nebula and for variability.

32. Meteoric swarms when near the sun would be distorted, and the constituents would impact with extraordinary frequency; they would become very brilliant, and show as comets. There would be tremendous development of electricity.

33. It is certain that the matter of the tail of a comet does not belong to the comet. It is like the motes in air illuminated by a search-light. The phenomenon of the tail is almost certainly electrical.

34. Such a swarm when near the sun would have its near part drawn in advance of, and its distant part left behind, the general swarm. Its weak attractive power would cause it to divide into a train.

35. The two stars that grazed would have a part cut out of each. This would expose the hot interior. A portion of

each body would also be entangled by the other, further increasing the temperature of the cut part.

36. The star would recover its sphericity chiefly by the molten interior welling up. This by momentum would overfill the space, and there would be a rhythmic tidal action, the molten lake overfilling and then sinking.

37. The retardation of the cut and entangled material would cause these bodies to spin. This would act chiefly on the outer layers. The inside would tend to retain the original rotation of the star.

38. Thus in the sheared stars there are three tendencies struggling with each other—the original rotation, the new rotation, and the tidal action.

39. But the new rotation would be a large component. We have, therefore, a star which rotates and shows us alternately the hot and cool sides. The old rotation and the tidal motion produce other fluctuations of intensity, and also inequalities of the rate of motion.

40. Evidently such a body would be a variable star, and for a time such stars would be in pairs.

41. Such is the case. This duplex character is so striking a phenomenon that the probability of its being the result of chance is one to one hundred sextillions.

42. Conduction, convection, tidal motion, and the contending rotations will tend to bring about equality of temperature. This condition of variability will consequently be a temporary one. The star will ultimately become of uniform luminosity. These are all known peculiarities of variable stars.

43. Convection is due to difference of density. This may result from differences of temperature and from differences of chemical composition. The lake of fire will consist of heavier molecules than the remaining surface, and it will be at a higher temperature. These two will tend to neutralise each other, so that equality of temperature due to convection will not be brought about quickly. It is surprising what a number of agencies there are tending to retain this inequality of temperature. This condition may as an extreme case last thousands of years.

44. The work of cutting the star will be infinitesimal in relation to its available energy, and will not appreciably lessen the velocity of the escaping stars, but the middle body will exercise a powerful attraction. It will exercise a retarding influence preventing the retreat of the two bodies, equal to three times the mass either body loses. Hence when two equal bodies lose a third each they do not become free from the new central body.

45. If the original proper motion were large and the graze small the two stars would escape each other. If the original

motion were small, and the graze on an average more than a tenth, then the two stars would become orbitally connected.

46. Such a pair form a permanent double star. Proctor and other astronomers are of opinion that impacting stars that become orbitally connected could not make double stars, as they would impact again. They overlook the fact that the nebula that retarded their escape will have dissipated before they return, hence the eccentricity will lessen greatly, and, as a rule, instead of impacting again, they will be scores of millions of miles away at perihelion.

47. Double stars should be more often variable than single stars. Struvé has proved that they are hundreds of thousands of times more so than ordinary stars. They should be more frequently coloured. This is also most strikingly the case.

48. They should be associated with nebulæ. Herschel says the association of nebulæ and double stars is truly remarkable.

49. They should be highly eccentric. This is also well known to be the case.

50. A large number of agencies tend to render the orbit less eccentric. These are fully described in my papers of 1880.

51. If stars come into partial impact the tendency to form definite nebulæ other than planetary or cometic seems to be entirely destroyed by the outrush of the high-velocity gas. This is not the case with the impact of nebulæ.

52. Impact may take place between nebulæ, between star-clusters, between meteoric swarms, and, of course, between any two similar or dissimilar celestial bodies. The graze may be large or small; the original bodies may have had a little or great proper motion. Of course, all these peculiarities will tend to vary the results.

53. If two nebulæ come into a slight grazing impact a double nebula will result. This will show a spindle at the centre. As they are parting company they may have temporarily a dumb-bell appearance, but the two sides of the coalesced nebula are moving in opposite directions. A spiral begins to form at the centre, the ends travel on in space, the spiral increases, and ultimately a double spiral results.

54. One or both of the original nebulæ may be entangled in the spiral.

55. If the impact be considerable the two nebulæ do not escape each other, and an annular nebula results. It has gauzelike masses of nebulæ at the poles of the rings, produced by the outrush during the impact.

56. If two universes such as the Magellanic Clouds impact, an annular universe will result. The poles will be covered with nebulous matter, due to the outrush of gas during the millions of years of the impact.

57. Stars will pass through such caps of nebula and will be entrapped, and will attract nebulous matter, and will become nebulous stars, or they may be volatilised altogether and become globular nebulæ.

58. Where globular nebulæ are thick we should expect double, spindle, and spiral nebulæ. These nebulæ are actually found amongst the nebulæ at the polar caps of the Milky Way.

59. Where stars are thick we should expect the result of the impact of stars—such as planetary nebulæ, temporary and variable stars, double stars, and star-clusters. These are all chiefly in the Milky Way.

60. If the universe were formed by such a graze we should expect a greater density of stars where the motion chiefly directed the two original universes. There are two such clustering masses.

61. If the universe were the result of impact there would be much community of motion in adjacent stars. This is a remarkable peculiarity of the stars in the Galactic Ring. Most of these agencies are debated in my paper "On the Origin of the Visible Universe."

62. Nebulæ would tend to entrap bodies passing through them. These bodies would become orbitally connected, and when the nebula settled down to a sun the bodies would produce a system with planets in all azimuths, in the same way as the comets that our solar system has entrapped are in all azimuths.

63. Were such a body to impact with a similar one, or with a sun, and were the graze considerable, all the planets would be spun roughly into a plane, and the central mass would become a bun-shaped nebula. The agencies that would convert this into a system similar to ours are discussed in my paper "On the Origin of the Solar System," and in the paper "On Causes tending to lessen the Eccentricity of Planetary Orbits."

64. It can be shown that if two gaseous suns without original proper motion impact completely, and were the whole of the motion converted into heat and this into expansion, the new sun would have a diameter the sum of the diameters of the original suns. It can also be shown that this condition is one of stable equilibrium.

65. The complete impact of two suns brought together by gravitation does not make a nebula of them, but as soon as the paroxysm of the encounter is over they are of the same temperature as before, and have only increased to the sum of their original diameters.

66. Were there great original proper motion they might become a nebula by complete impact; but were the impact of great energy, then an infinitely diffused cold nebula would

result. Such a nebula would be unstable. Croll's theory to account for an increase in the age of the sun's heat by the impact of two suns is therefore untenable.

The Cosmos possibly Immortal.

67. If our universe be proved from its form and character to have been formed of two previously-existing universes, as appears probable from 56, *et seq.*, then the entire cosmos may be made up of an infinity of universes.

68. Meteoric swarms prove space to be dusty with wandering dark bodies, and "selective escape" proves it also to be spread with countless myriads of molecules of light gas. It is probably due to the dust of space that we see no distant universes other than the Magellanic Clouds.

69. If this be the case, radiation must all be caught by the dust of space, and, unless some agency be found to take this heat away, the dust must be gradually increasing in temperature.

70. Bodies not in orbits occupy but a short time at high velocity. They occupy longer and longer periods as the velocity is reduced. Hence hydrogen gas, independent of matter, will be generally moving slowly. But slowly-moving gas is cold: hence hydrogen gas may be at a lower temperature than any other matter in space.

71. Whenever, by their mutual motions, hydrogen strikes cosmic dust it will acquire the temperature of the latter—that is, it will increase its molecular velocity. It will thus have a new start of motion.

72. Unless it strikes something, the molecule can only lose this motion by radiation, or by doing work. When it has done work it will be further from matter, or in a position of higher potential; and Crooks's experiments prove that molecules do not radiate in free path excepting after encounters.

73. Moving matter not in orbits will tend to move most slowly where there is least matter—that is, where gravitation potential is highest—because in these places it has done most work against gravitation. Where bodies moving indiscriminately move most slowly they obviously tend to aggregate: in other words, the hydrogen of space tends to accumulate in the sparsest portions of space.

74. Thus radiant energy falls on the dust of space, and heats it. This heat gives motion to hydrogen, and the hydrogen then tends to use its new energy to pass to positions of high potential, thus converting low-temperature heat—that is, dissipated energy—into potential energy of gravitation—that is, into the highest form of available energy.

75. This action will tend to go on until attraction is equal in different parts of space; but then we have in one part of space bodies in mass, in another diffused hydrogen.

76. But long before this equality of distribution could ensue another action is set up. The mass of hydrogen will become a retarding trap to indiscriminately-moving bodies.

77. Free bodies moving indiscriminately will tend to pass through such a group of masses as our universe, as 1830 Groombridge is passing through it now. But they will tend to be trapped in any mass of hydrogen. Thus the place that was most void of matter now commences to have more than the regular distribution of matter. A new universe has begun to form.

78. Mutual gravitation between the entrapped bodies tends to concentrate the diffused mass. The new universe is taking form.

79. Where three bodies pass near each other one at least has its velocity increased. In this way it is possible to account for the enormous velocity of 1830 Groombridge. Whenever the velocity is great enough to escape the attraction of the universe the body is lost to it, and some of the other bodies are moving more slowly. If this should occur once only in a thousand cases, seeing that when it does occur the body escapes, if we give time enough, most of the energy of any individual system must be used up in allowing the escape of bodies.

80. We have in these phenomena a complete series of agencies tending to overcome the dissipation of energy and the aggregation of matter. Impact developes heat, separates bodies, and diffuses gas. Radiation falls on, and is absorbed by, the matter of space. As hydrogen loses its velocity it is carried to positions of higher potential by the heat of the dust of space. This gas tends to linger in the empty parts of space, and then becomes a trap for wandering bodies. These wandering bodies are separated from systems by the mutual action of three bodies.

81. Thus, in opposition to the theory of dissipation of energy, there is seen to be the possibility of an immortal cosmos, in which we have no evidence of a beginning or promise of an end.

EXPLANATION OF PLATE LII.

Diagrams to illustrate Summary of Impact.

Fig. 1. Pair of stars distorted and coming into impact.
Fig. 2. Pair of stars in impact.
Fig. 3. Stars passing out of impact, and formation of third body.
Fig. 4. Showing entanglement of matter in each body.
Fig. 5. Two variables and a temporary star.
Fig. 6. Central body in process of expansion into nebulæ.
Fig. 7. Planetary nebula expanded beyond variable stars.
Fig. 8. Stars associated into a double star by attraction of central body.
Fig. 9. Lessened attraction on return of stars prevents recurrent impact, and makes orbit more circular.

Art. LIV.—*A New and Simple Graphic Method of projecting Occultations and Solar Eclipses not hitherto published.*

By T. B. Harding.

Communicated by R. C. Harding.

[*Read before the Wellington Philosophical Society, 6th September, 1893.*]

Plate LIII.

If any apology be necessary for bringing the following paper before the Society it will be found in the fact that there will be a good occultation of the planet Venus on the evening of the 13th instant. Conjunction of ♀ with the Moon takes place at 4h. 49m. p.m., New Zealand standard time, and the planet's hour-angle is then 2h. 45m.; so that, while those bodies are sufficiently high in the heavens for observation, it will be late enough to see them well defined. To proceed: When we consider the abstruse and difficult methods usually employed for the computation of the circumstances of an occultation or solar eclipse for any particular station on the Earth's surface it will be conceded that a ready and easy process of doing this is a desideratum to many who, while they wish to perform the work, are deterred by the labour of the methods usually employed. In this now proposed, and used by myself for several years, we have such a method, and one in which the mathematical work so much dreaded by the ordinary individual is almost entirely eliminated, and by which any person of only ordinary intelligence and skill in the use of rule and compasses may very readily perform the work.

For this purpose we require—(1) An ordinary diagonal scale, by which we can get three places of figures; (2) a sector, or line of chords (which is to be found on any good scale), for measuring and setting off angles; (3) the "Nautical Almanac" for the year.

To understand the details of the scheme, we have to suppose ourselves, *pro tempore*, at the star's (or sun's) centre, from which we are able to see the Earth and Moon as circular discs, revolving in their orbits, and during an occultation we observe that of the Moon passing between us and the Earth, and covering a certain zone of her disc. We note the parts so hidden from us, and the times at which they are covered and reappear.

We find all the data for this in the pages of the "Nautical Almanac," where the calculations are made for the Earth's centre; but from our position we are able to note places on the Earth's surface projected to a plane passing through that centre. The data for the forthcoming occultation of ♀ required are the following:—

1. The equatorial horizontal parallax, corrected for the latitude of the place and diminished by that of ♀ (P.)
2. The geocentric latitude of the station (l).
3. The declination of ♀ (δ).
4. The difference of δ of ♀ and ☽ ($\triangle$).
5. Time of ☌ in R.A.
6. Hour angle of ♀ at that time.
7. Moon's semi-diameter (μ).
8. Moon's hourly motion E.
9. Moon's hourly motion S.

Unless great accuracy be required, the corrections for parallax and latitude need not be made, but the figures taken as they are given in the "Nautical Almanac." They will be sufficient to tell us when to watch for the phenomena. The corrections being made, great accuracy can be obtained.

P. The corrections for parallax have been calculated for all latitudes, and may be found in books of nautical tables. It is 0″ at the equator, and increases towards the poles, where it amounts to 12″, or $\frac{1}{5}$ of a minute of arc. In the present case P. is 56′; the correction is 5″, to which we add that of ♀ =7″, making together 12″ to be subtracted: 56′−12″=55′ 48″= 55·76′. Take then from the diagonal scale in the compasses 55·8 for Earth's radius, and describe a semicircle, to represent the S. half of Earth's disc. The centre ⊕ represents Earth's centre. From ⊕ erect a perpendicular, which is the axis of projection, through which passes the plane of projection (at present perpendicular to the paper). The planet's declination (δ) is 9° 57′ S. We suppose ourselves in the plane of the paper towards the left hand. Our declination being S., the S. pole of the Earth must be turned towards us by the amount of our δ. Mark off the arc of 9° 57′ (10°) towards the left of axis of projection, through this draw the axis of Earth. We next want the parallel of Wellington. Its latitude is =41° 17′ S., its co-latitude 48° 43′. Adding 6′ for correction, we have 48° 49′ (say, 50°) which set off from the polar axis in the same direction and mark the point l. Set off the same (50°) to the right of polar axis, mark it l^1, and through these points draw the parallel of latitude, whose centre is on the polar axis.

Now, looking from the left, we see these three points l, c, and l^1 projected on the axis of projection. We have, however, only to do with two of them, l and c, l being our place when ♀ is in transit, and c our place at her 6-hour angle.

We next imagine the whole diagram turned a quarter round, so that from being at the left in plane of the paper we (♀) are brought in front, the points *l* and *c* to the axis of projection, the polar axis coincident with that of projection, and we are prepared to plot the path of the station along the plane of projection through a revolution of the Earth, as seen from the planet Venus. If there were no declination (if ♀ was at the equator) all the circles of latitude would appear as straight lines across the Earth's disc; at 90° (the poles) they would appear as concentric circles; between these extremes they appear as ellipses more open as our declination increases; at our declination of 10°, as an ellipse whose semi-major axis equals the radius of the circle of latitude (not being shortened by projection), and whose semi-minor axis equals the distance between *l* and *c* on the axis of projection.

We have only to do with one quarter of this ellipse—that from Venus's meridian passage to her 6-hour angle. To draw this quadrant is not a matter of difficulty, as the following will show:—

1. Draw a line across the diagram through *c* perpendicular to the axis of projection. Measure from *c* towards the right at quantity equal to radius of circle of latitude. Mark that point 6.

2. With distance *c*–6 in the compasses and centre *c* describe the large quadrant from 6 downwards till it meets the axis of projection; and

3. With distance *c*–*l* and same centre describe the small quadrant, concentric with the other.

4. Divide both by lines radiating from centre (*c*) into six equal parts (of 15°) (hours).

5. Through all the five points of division on the small quadrant draw horizontal lines, and through those of the larger one perpendicular lines. *The intersection of these lines marks at the same time the curve of the elliptical quadrant, and the points of the hours* from 1 to 5. These are the positions of ♀ at her hour angles, as projected.

Next we want the place of the Moon at conjunction, and her path in orbit during her course between ♀ and the Earth.

The difference of declination ($\Delta = 29{\cdot}75'$) must be measured from the same scale as before; and, as it is S., it must be measured upwards from the Earth's centre on the axis of projection. Mark this point; also mark it the time of ☌, which is when the Moon's centre is there. This in ♀ hour-angle time is 2h. 45m.; from this point and time she is moving eastward and southward. We get from the "Nautical Almanac" her motion in both directions, and from these plot her motion in orbit.

1. Her motion E. (R.A.) is given in time for 10m. as 19s. Six of these go to an hour, and 4sec. of time = 1′ of arc. We

therefore call seconds of time minutes of arc. Add one-half the quantity and we have her hourly motion E., 28·5′.

2. Her motion S. (δ) is as easily got: for 10m. it is 141″ —that is, 14·1″ for 1m., or 14·1′ for the hour.

To avoid confusion we set these quantities off to the left of the diagram, and draw the diagonal through the point of ☌. This diagonal, being measured on a narrow slip of paper, is divided into 12 parts of 5m. each, and these divisions, set off on the Moon's path in orbit, continued to the right as far as necessary. We have the position of the Moon's centre at these times. The elliptical quadrant being also so divided where it is found necessary, we have the relative position of the two bodies.

Now, in the compasses (or on a slip of paper) measure the semidiam. of the moon; add that of ♀ (15·20′ + ·11 = 15·31′), and, laying it between the two paths, we shall find two points where it will just reach the same time on both. The first of these, 3h. 30m., is the time of first contact; the second, 3h. 59m., that of last contact. To these times, if we add that of ♀ meridian passage, 2h. 4·5m. (2h. 5m.), we get 5h. 35m. and 6h. 1m. as the New Zealand mean time of these phases.

The south point of the Moon is that at its apex in the diagram (Plate LIII.). Its vertex is on a line drawn through its centre parallel with one joining Earth's centre and star. The angles are measured in the usual way. In a solar eclipse the Sun's hour-angle is the same as apparent time.

EXPLANATION OF PLATE LIII.

The semicircle represents the southern half of the Earth's disc, as seen from the planet Venus, when ⊕ is Earth's centre, and the horizontal line passing through ⊕ the origin of co-ordinates. Any convenient scale of equal parts may be used, but the larger the better, as enlarging the time divisions. The divisions of the scale are taken as minutes of arc. P. is Earth's radius as seen from Moon's centre, μ is Moon's semidiameter seen from Earth's centre, and the two bodies bear the same relative proportion when seen from Venus. We take the parallax of Venus from that of the Earth so as to ascribe her slight motion to the Earth, and leave her in one position during the occultation. Also, we use the co-latitude of Wellington, because we measure from the pole and not from the equator. At conjunction the centres of the three bodies are in one plane, and while the Moon is moving eastward and southward in the line of her orbit Wellington is travelling along the curve of the ellipse, the places of each being indicated by the time marked on the respective lines.

Fig. A.—*Elements:* ♀. Hour-angle time ☌, 2h. 45m. P. Relative parallax, 5·5′. δ. Declination of ♀ S., 10°. Δ. Diff. of declination of Moon, 29·75′ S. l. Wellington reduced co-lat., 48° 49′. ☽'s hourly motion E., 28·5′. ☽'s hourly motion S., 14·1′. μ. Moon's semidiam., 15·2′. ♀'s semidiam., 6·5″. μ + ♀, 15·31′. *Results:* First contact, 3.30 = 5h. 35m. N.Z. mean t.; last contact, 3.59 = 6h. 1m. First contact, 120° E. of south point and 80° E. of vertex; last contact, 173° E. of south point and 126° E. of vertex.

Fig. B.—Apparent path of ♀ behind Moon during the occultation on the evening of the 13th September, 1893.

ART. LV.—*A Further Note on Rainbows.*

By T. B. HARDING.

Communicated by R. C. Harding.

[*Read before the Wellington Philosophical Society, 26th July, 1893.*]

Plate LIV.

ON Friday, 16th June, 1893, at about 3.30 p.m., I had an excellent view of a peculiar and splendid double rainbow. It formed in appearance a semicircle, and a quadrant sprang from the ends of the same chord. It was first seen from the Hyderabad Road, leading from the Spit towards the Town of Napier, and close by Battery Point, Scinde Island being on the left hand, and concealing the greater portion of the arch. At this point the two bows did not appear to cross at the terminals, but to unite on the end of the chord. The phenomenon continued visible for fully half an hour, or until I was a good distance on the Taradale Road. The chord appeared 4° or 5° above the horizon. Both bows were of unusual brilliancy and, as I reached a point where Scinde Island did not intervene, completeness. The bows gradually approached each other as the sun drew nearer the horizon. Between myself and the sun there lay an extensive sheet of water, the inner harbour of Napier, perfectly calm and reflecting the sun as from the surface of a mirror. The first thing that struck me on seeing the phenomenon was that the two bows were not concentric, as would have been the case with an ordinary primary and secondary bow. The next was that *they were both primaries ;* and the question occurred, How is this?

On turning towards the sun I saw at once that there were practically two of them—one a few degrees above the horizon, and the other just as much below it, apparently shining upward through the water. The explanation was at once evident, and the phenomenon became of much interest to me. The reflected sun gave a bow of more than half a circle, the true sun one of less, and the two arcs actually crossed each other well above the horizontal line. The lower bow appeared to be the arc of a much larger circle than the upper one, but this was probably owing to atmospheric causes, which, as is well known, give an enlarged appearance to objects near the horizon. It is probable they were of the same diameter, with some 20° difference of centres. The best effect was observed from the causeway on the Taradale Road, where the Town of Napier could be seen on the left hand, clear of Scinde Island.

From this point the crossing of the bows was very striking, the buildings at Napier being, as it were, behind a blaze of coloured lights, as were also the objects fronting and hiding the Township of Meanee. The sun was now near setting, and further travelling along the road cut off the reflected sun, and ended observation.

Although I had not noticed such a thing before, nor even heard or read of such, I think it cannot be of infrequent occurrence. Given a very calm morning or evening, the sun bright, rain falling in the quarter opposite to the sun, and, lastly, a sheet of still water between the sun and the observer to reflect the rays from the sun—and it *must* appear.

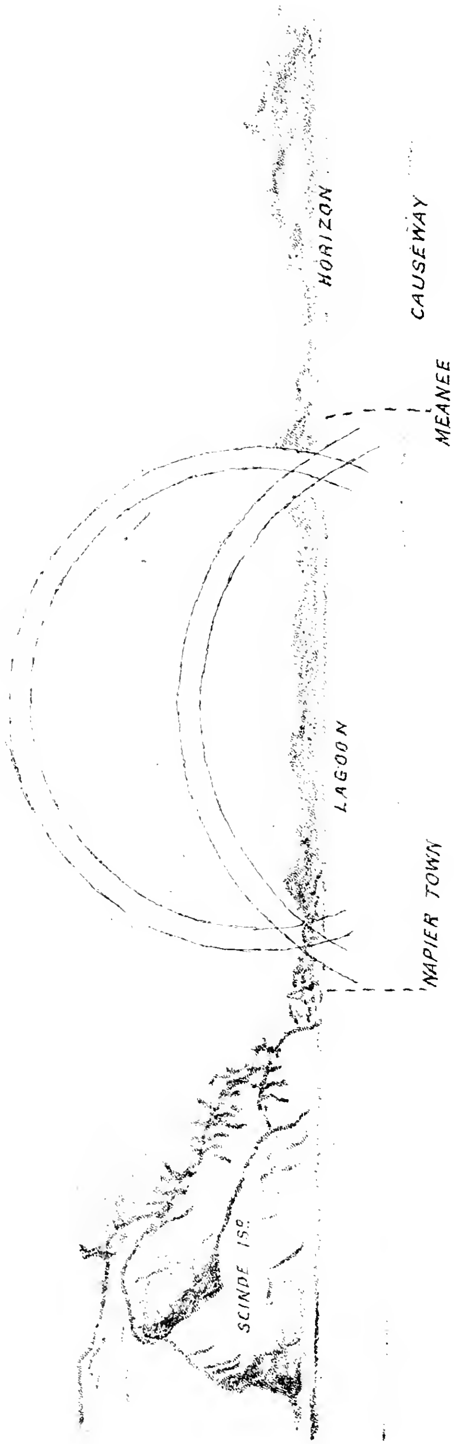
A slight consideration of the subject will show that the distance of the centres of the two arcs will depend on the height of the sun above the horizon, and the consequent angular distance between the centre of the sun and that of his virtual image, the latter being apparently as much below the horizon as the sun is above it. Near the times of sunrise and sunset they will be very near each other, and more distant as the sun is higher in the heavens. When the sun is above 42° in height the vertex of the true bow will be below the horizon, and the nadir (and consequently the whole) of the false bow above it. The true bow will not be seen at all; the other will form a complete circle (all conditions being supposed favourable) in the heavens.

It is, however, evident that men may have eyes and not use them; hence only the general non-observance of such (shall I say?) common things. I have never heard of such a circular bow being seen, but hope that on some fine showery day in summer I may see it yet.

When, however, we consider that reflection is less perfect in proportion as rays strike the reflecting surface more directly, or at a greater angle, we must not expect in any circular bow from the reflected sun to see anything like the brilliancy of that described when the sun's rays fall very obliquely on the water. This also may be a reason why such phenomena have been hitherto overlooked.

Note.—Since writing the above I have seen Major-General Schaw's paper in the "Transactions,"* in which a somewhat similar phenomenon is fully explained. As, however, confirmation by actual observation is always valuable, and the present instance differed in some details from that observed by Halley, who does not appear to have noticed the crossing of the ends of the two bows—also in his case there was a secondary bow as well as the two primaries—I think it worth recording. It will be observed that I saw no secondary bow;

* Trans. N.Z. Inst., vol. xxv., p. 450.



INNER HARBOUR NAPIER

To illustrate Mr. Hardings paper on Rainbows

F.H.T. del.

but why? The sun was quite low enough for it. That the rain-sheet was high enough is evident from the fact that the bow was formed by the reflected sun. I am quite unable to answer this.

From almost the same point of view, and one week afterwards, I had the pleasure of seeing an instance of a reflected bow in the lagoon fronting (east) the Taradale Road. Both bow and (apparent) reflection were remarkably perfect. I did not notice that the ends of the two arcs did not correspond. There was, however, a blank space of some 6° between them. The appearance of the reflection was that of a very perfect bow.

EXPLANATION OF PLATE LIV.

On the left hand is Scinde Island; on the right, trees, &c., fronting and hiding the Township of Meanee, the spectator being on the causeway between the bridges on the Taradale Road. Back of the spectator is the inner harbour of Napier, and in front the double rainbow, springing from and crossing each other at the ends of a single chord well above the horizontal line.

ART. LVI.—"*More Last Words*": *being an Appendix to several Papers read here during Past Sessions on the Volcanic Mountain-range of Tongariro and Ruapehu, with its adjoining District.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 10th July, 1893.*]

——profert de thesauro suo nova et vetera.
MAGISTER.

A MONTH back I felt not a little surprised and grieved (in common with many others) at a statement that appeared in our local morning paper respecting Mr. William Collie, an unassuming, truthful, toiling, steady photographic artist, who formerly (twenty years ago) carried on his profession here in Napier. It was stated that "a camera, &c., had been lately found on the high slopes of the burning mountain Ngauruhoe, which from appearances looked as if the artist had been scared at the rumbling of the volcano, dropped his instrument, and fled."

Apart from the irrationality of the notice as to the "appearances," &c., of the long-lost "camera," now found after fifteen years' exposure to the elements on the barren stony mountain—alike to summers' suns and winters' frosts in that elevated region—was the undeserved innuendo—ugly joke, or worse—on Mr. Collie.

At the time of my reading that statement I was absent from town on duty in the interior; but, as I had known Mr. Collie pretty well, had often admired his large photographic landscape-views of distant and strange places—only obtained through much toil and difficulty, hardship and danger—and frequently had conversations with him in his studio, even concerning that, his last and unfortunate visit to Tongariro, in which he met with his great loss (for he had sought counsel from me on his return to Napier respecting the Maori raid made upon him, and his consequent injury and damage), I was determined to have justice—fair-play—done him. At such times, a quaint distich from Goethe's "Faust," where, in the inimitable scene on the Brocken (blasted mountain-top), in the Walpurgis-night, Mephistopheles accosts one of the old witches riding on a sow, saying,—

> Honour to whom honour is due;
> Here, mother Baubo, is honour to you,—

would continually revolve in my mind, causing me even to repeat it over and over, although forty years had elapsed since I last read it in Goethe's work—(possibly this happened through the association of corresponding ideas—connecting what I had been just reading and what I had heard from Mr. Collie with my own trying experiences in that locality forty-five years back)—and I concluded that Mr. Collie should have due honour done him for his courageous and loving artist-visits to Tongariro. For, in those days, and situated as he was—a stranger with limited means and few friends in this (then) small town—it was a very different thing to carry out such a visit over an unknown and trackless country (much less a repeated one, and after receiving maltreatment from resident Maoris, and enduring severe losses) from what it is now in these modern days—with roads, coaches, inns, store-shops, settlers' houses, and horses; the Maoris themselves there residing no longer enemies, but much more civilised and quiet, and enjoying "piping times of peace."

And here I should briefly state that I would have written a letter to the editor of that morning paper already mentioned on my return to Napier, but an acquaintaince of Mr. Collie, residing at Waipawa, took the matter briefly up in a communication of his to that same paper, which I was glad to see; and soon after a full, plain, and interesting account of what had really taken place at that time of Maori disturbance at Tongariro, written by Mr. Collie's travelling companion on that occasion (Mr. F. E. Lys), appeared in the columns of the same paper,* which, as far as that subject was concerned, seemed to be quite sufficient.

Subsequently, however, on my remembering a few nice botanical specimens collected at Tongariro by Mr. Collie, and given by him to me (some of them—*Dracophyllum rubrum*, *Pimelea stylosa*, and *Thelymitra nervosa*—being novelties, were described by me† and exhibited here before this society in 1887); and also in looking over my album and noticing therein some of the fine photographic views taken by him of Tongariro and Ruapehu; and, further, on my referring to Mr. Hill's paper, read here before you, containing a full account of his visit to those mountains in 1889‡ (including copious interesting extracts from the accounts of the early visits made to those mountains by Messrs. Bidwill and Dyson some fifty years before), and finding that Mr. Hill, not knowing of Mr. Collie's visits thither, had made no mention of them, although he had slightly noticed other visits made afterwards, as if these were really the first in succession after those of Messrs. Bidwill and Dyson,—I determined on writing a short paper—a *résumé* of Mr. Collie's repeated visits to that locality: especially, too, as he had done what no one else has done, either before or since—descended into the crater of Tongariro and spent a night within it.

But before that I take up with Mr. Collie's visits, I think I should also mention a still earlier one, performed by Dr. (now Sir James) Hector, to Tongariro in the year 1867, about ten years before the first visit of Mr. Collie, as this also seems to have been unknown to Mr. Hill.§

I quote from the published proceedings of the Wellington Philosophical Society: "Dr. Hector gave an account of his own ascent of Tongariro on the 23rd November, 1867, and explained that the active steam-eruptions on the side of the

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* A copy of Mr. Lys's letter I shall give at the end of this paper, for I consider it well worth being recorded, if only to preserve another instance of the Maori treatment the early settlers and artists (true lovers of nature) had to put up with.

† In Trans. N.Z. Inst., vol. xx., p. 200, *et seq.* And here I may mention that among that small lot of dried plants was a specimen of the common red poppy of our British cornfields (*Papaver rhœas*), which astonished me; the only specimen I have ever seen in New Zealand. In that same paper several of Mr. Hill's plants from that locality were also described.

‡ In Trans. N.Z. Inst., vol. xxiv., p. 603.

§ I may also briefly notice, in a note, that another ascent of Tongariro was made by Mr. Lys in 1881, when he conducted an American tourist, Mr. M———, to the top of the mountain. Being there overtaken by a snowstorm, they were obliged to pass the night on the summit, but not within the crater. The tourist, however, in an account which he published in a Sydney newspaper, on his arriving there, stated that his night on the volcano was passed *within* the crater.

mountain were due to the percolation from a cold lake on the summit, a sketch of which he exhibited. Dr. Hector then gave a list of plants differing from alpine-plants in the South Island, and exhibited on the screen with the lantern views both Ruapehu and Tongariro."—(Trans. N.Z. Inst., vol. xii., p. 423.)

Mr. Collie's first* visit thither was in May, 1878, and his second in December of that same year (these two dates I obtain from his own paper "On Volcanoes and Geysers in New Zealand," read by Dr. Hector before the Wellington Philosophical Society in June, 1879); but he was still there in January, 1879, as I gather from a date written by himself on a photographic view of Ngauruhoe. On each of his visits he spent several days on the mountain and in its neighbourhood.

In that short paper of his is his description of the crater, of his descending into it, and of his passing a night within it—all interesting and very plain, short, and terse; perhaps the only fault to be found with it is its extreme brevity. That, however, will enable me the better to quote it verbatim here (seeing such a daring feat is all but unknown), while it serves to contribute an additional item (combined with the still earlier ascent made by Dr. Hector) towards the completion of the longer and more particularly scientific account of the mountain by Mr. Hill.

"*Tongariro* (*Ngauruhoe*).—When the writer visited the crater of Tongariro in May of last year (1878) there was a cone on the north-west side of it. This cone was about 120ft. wide at the top, and was closed at the bottom, as if the volcano had not been in action for a considerable time. Upon the writer's climbing the mountain (a feat always attended with difficulty and risk) and descending into the crater in December following, he found that the above cone had completely vanished, and that along the greater part of the north side of the crater another cone, about 500ft. wide at the top, had been violently thrown up. In the interior of this cone, at the bottom, there were two openings opposite each other, out of which sulphurous steam was blown in considerable quantities. The outside of the cone was of loose material, as might be expected from its recent deposition, and was composed of stones, pumice, cinders, and *débris* of the mountain.

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* Yet on one of his large photographic views of Ngauruhoe is an inscription, by himself, that it was taken in "1874." This seems strange; and Mr. Lys (to whom I have submitted it) assures me it must have been an error for 1878, as Mr. Collie had not been there before this dae. The large views of Rotorua and the hot springs there, immediately peceding in the same album, are all dated "1874," which, if written at the same time, might have easily led to the error in the last figure.

"It is thus evident that this volcano is still active, although at uncertain periods. Over the floor of the crater, and up aloft along the sides, as well as outside the mountain, sulphur-steam was issuing in all directions, tinging the orifice with yellow crystals of sulphur. The whole crater of Tongariro might be 1,500ft. wide. The loose burnt sides overhanging the floor are gradually falling down, altering the configuration of the summit of the mountain. Upon the floor of the crater there were several thick patches of hardened snow, and at the north side under the cliffs a large wreath of snow, melting from the heat beneath, formed a singular-looking cavern with a scalloped roof as of white marble. The writer spent a night inside the crater, and found the air intensely cold till the sun rose high enough in the morning to shine into the crater. Astronomers in scanning the volcanoes of the moon have noticed about the middle of the floor of certain craters a small cone, giving rise to speculation about its cause. Does not Tongariro afford explanation—that, as the volcanic forces exhaust themselves, they give vent to their expiring forces by a small cone?"

And this daring action of Mr. Collie's is capped by another, as I view it—that is, his spending a month or so on the barren and volcanic ever-burning White Island, in the Bay of Plenty, in pursuit of his beloved science. Perhaps some of my hearers have not only heard of that exploit, but may also have seen those photographic views which he took while there, some of them highly suitable for illustrating Doré's Dante's "Inferno," and that from truly natural scenes. I may mention, for the information of those who may not have heard of it, that when Mr. Collie visited that island in 1877, by a vessel trading between this port and Auckland, it was stipulated that he was to be called for on her return voyage to Napier; but this could not be done owing to the state of wind and weather—the island also being several miles out of the common course; and so, instead of being there for only a few days, he and his companion (the same young man who subsequently accompanied him to Tongariro, Mr. F. E. Lys) were prisoners for nearly a month. Fortunately they had taken the precaution to carry a month's provisions with them from Napier, and also water in kegs, as there was none on the islet save what might be found in shallow holes in the rocks after rain. When they were rescued their stock of water was nearly exhausted, and, although they had fishing-lines and hooks with them, yet, from the depth of water immediately around the island being very great ("out of soundings," according to the Admiralty survey), they certainly had no prospect of ever catching any fish.

There being no vegetation on the island, except a little scrub at the high and inaccessible north end, and the whole soil being so largely impregnated with sulphur that on a lighted match being thrown on the ground it caught fire immediately, their time there must have been the very opposite of pleasant. Then, the exposure to the winds and sun was extreme; but the very worst was when the land-winds blew strongly towards them across the flaming sulphur-beds beyond the hot-water lake, covering them with dense clouds of stinking smoke and thick clammy vapour, rendering even breathing difficult, from which there was no escape. The lake, according to survey, contains an area of nearly 16 acres, surrounded on more than three sides by high precipitous cliffs, the two highest peaks being each nearly 900ft. high.*

In that short paper of Mr. Collie's (only two pages) read before the Wellington Philosophical Society he says a little about the volcano in White Island worthy of being quoted here. He commenced it by saying, "In the pleasant, if sometimes arduous, pursuit of art-photography, the writer camped for weeks close to the main volcanoes and geysers of the colony, enjoying excellent opportunities for search into the origin and working of these marvellous and attractive exhibitions of nature's powers. And, viewing the existence, or it might be termed life, of the earth in its present state for at least thousands of years, the question naturally arose to the wayfarer of to-day amongst these interesting scenes, 'Whence the activity which still pours forth the boiling waters of Rotomahana, to run glistening down the silica terraces of their own constant formation?—wherein the force that lights the red fires which burn ever in the crater of White Island?—or what the motive-power that still throws up a cone in the crater of Tongariro (Ngauruhoe)?' The reply from the waters of Rotomahana, from the fires of White Island, and from the cone of Tongariro, was the same—the one word, 'Sulphur.'" And he closes his paper with remarking,—

"*White Island.*—It is generally supposed that the vapours arising from White Island are steam from geysers, whereas sulphurous steam never rises to any height. The main forces of the grand display at the 'Theatre of Nature' upon White Island are burning beds of sulphur, which show their red fires at night across the lake, whilst the fumes rise up into the air in volumes, to spread there at a great height, like a balloon, or

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* See Trans. N.Z. Inst., vol. iii., p. 278, for an interesting scientific paper on the geology, &c., of White Island, with diagrams, by Dr. Hector, who visited it in 1870; and also same work, vol. i., p. 57, for another scientific paper on the island, with map and rough survey of the crater, by Lieutenant R. A. Edwin, R.N., who visited the island on two occasions a few years before.

flow away in a train over the sea before the breeze."—(*L.c.*, pp. 418–420.)

Mr. Collie also took several photographic views of those wonderful natural terraces at the boiling springs, Rotorua, in the year 1874, fortunately before the destruction of their marvellously beautiful symmetry by the great local earthquake or eruption in 1886, and his observations thereon are somewhat remarkable, especially his remark made while contemplating them: "On what a slender thread the beauties of that mountain-side hang!"—words since proved too true. And as his whole brief statement thereon is contained in a few lines, I quote them:—

"*Rotomahana.*—During the writer's stay at the Terraces he was favoured with an exhibition of the subsidence of the waters of Te Tarata into the caverns below; and as the Terraces on that occasion got dry it was noteworthy how brittle the silicious surface became, showing upon what a slender thread the beauties of that mountain-side hang; for, were the flow of the blue waters to stop—as stop it must when the energies of the forces below exhaust themselves—the glory as well as the cause of Rotomahana will disappear." —(*L.c.*, p. 419.)

Furthermore, on again referring to Mr. Hill's paper I find that he mentions very briefly the strange and peculiar high volcanic plateau lying on the eastern side of those mountains. I quote his words:—

"The portion of the plateau running along the eastern side of Ruapehu and Ngauruhoe is known as the Onetapu (sacred sands) or Rangipo (cloudy sky)" (*sic*) "Desert, and it well deserves either name. Some parts of it are swamp, and exceedingly dangerous, whilst the portion not swamp is made up of moving sands, scoria, cinders, clinkers, and tufas; and, although its traditional history is not reassuring, it is a spot well worth the attention of geologists, for some very curious and rare specimens of volcanic rocks are to be found in places left bare by the ever-moving sands."—(Trans. N.Z. Inst., vol. xxiv., p. 606.)

Having myself had on two occasions, in 1847 and 1849 (in performance of duty), to cross that desert (then little known), and on the first time suffered much, and having also obtained from that neighbourhood several new and curious plants, I am desirous of telling you somewhat respecting that first journey of mine, which, I think, may prove both new and interesting; and which, if placed on record, will serve to show in days to come how the early traveller occasionally fared.

I shall quote from my journal, prefacing, however, by stating that I was then on my way from Ahuriri (now Napier) towards finding some little-known Maoris, who were said to be dwelling isolated on the upper banks of the Rangitikei River, near the western flank of the Ruahine Range. I had tried to get to them in 1845, through direct crossing over the range by its eastern side, and, though I had succeeded with some difficulty in gaining the western summits, I was obliged to give it up.

I left Ahuriri on the 9th February, and after a long and weary circuitous kind of march—rendered the more trying from there being no roads, and without a guide, and from our not being able to obtain a supply of Maori food (as potatoes) on the way, it being too early in the season—we arrived at the village of Rotoaira, near Tongariro, on the 18th February; were well received by the Natives, and there we stayed that night.

As this was the last southern village of the Taupo country I endeavoured to get a guide hence to the Patea district, and only after great difficulty succeeded, as the country over which our course lay was rugged and difficult, and there was no regular track hence to the Patea villages; only once a year —or in two or even three years—did a small party of Maoris visit Taupo from Patea; rarely if ever did any go from Taupo to Patea.

Nothing is more surprising to me among the many and great changes which have been effected in this country during the last fifty or fifty-five years than this of common fearless communication between the Maori villages and tribes, which formerly did not exist—not even between what are now considered (even by the natives themselves) as neighbouring villages. I could not, however, help fearing that, just as on former occasions so now, our "guide" would prove to be of little real service.

"19th.—We rose early and crossed the head of one of the main branches of the Waikato River (which is the outlet of Rotoaira Lake) at 5.30. Winding round the immediate base of Tongariro Mountain, over undulating ground, we halted at 7.30 to breakfast by the side of a mountain-stream of very cold and pure water, which ran bounding and sparkling in the sun among the rocks. Breakfast over we recommenced our journey, and travelled steadily on. During the former part of this day I met with several botanical novelties—*e.g.*, a very handsome full-flowered *Cyathodes* (*C. colensoi*, Hook.), a low bushy shrub of depressed growth, some plants bearing white and some red berries in profusion: this will become a garden flower. The abnormal prostrate species of pines (*Dacrydium laxifolium* and *Podocarpus nivalis*) were also here, in many places completely matting the surface; also, two or three species (or varieties) of *Gaultheria*—one, in particular, bearing plenty of good edible fruit. Another was very curious, and interested me much; it was plentiful, and grew prostrate, having a racemose inflorescence and baccate calyx, which gave it a singular appearance, as if double-fruited: this is, I think, var. ε of Sir J. Hooker's *G. rupestris*. A distinct species of *Epacris* (*E. alpina*) was also here, but, unfortunately, it was not fully in flower. In damp spots (but only in two places) two curious species of *Drosera* were found—*D. binata* (remarkably fine), and the much rarer one, *D. arcturi*, a plant of the Australian and Tasmanian mountains—the only time I ever met with this latter species; together with a rather scarce orchideous plant, *Prasophyllum nudum;* and in the thickets adjoining, by the sides of the mountain-streams, *Phyllocladus alpinus* and several species (or varieties) of *Aristotelia* with small leaves were noticed. A peculiar-looking small restiaceous plant, a species of *Calorophus*, was also obtained here in a boggy spot. I had found a similar plant several years before in bogs at Whangarei, and near Cape Maria Van Diemen, but in each locality only a little of it. Of the cyperaceous order, I collected two species of *Schœnus* (*S. concinna* and *S. parviflorus*), *Carpha alpina*, *Isolepis aucklandica*, and also several species of *Carex*, among them being a British species, *C. stellulata*. In dry gravelly spots I also detected *Asperula perpusilla* (which I had last year discovered in similar situations at the base of Tararua Mountain-range, in Palliser Bay), and the moss-like tufted *Raoulia australis* was not infrequent. Many beautiful plants of the lichen order I also met with. Prominent among them were several species of *Cladonia*, particularly *CC. capitellata*, *aggregata*, *retipora*, and *cornucopioides*, this last strongly reminding me of the pretty (never-to-be-forgotten) British species *C. bellidioides*, which at first I supposed it to be, from its bright vermilion-red globular tubercles springing from the edges of its tiny cups. *C. retipora*, often found in large tufts in undisturbed spots, is one of the most elegant of lichens; its regular reticulated open structure is wonderful. A few curious fungi new to me I also obtained; and in a still-water bend in a streamlet I came upon a large mass of that peculiar fresh-water alga, *Batrachospermum moniliforme*—the only place I ever found it in New Zealand.

"At 3 p.m. we crossed the sandy desert called Te Onetapu—a most desolate and weird-looking spot, about two miles wide where we crossed it—a fit place for Macbeth's witches, or Faustus's Brocken scene. About it, too, the old Maoris have many peculiar stories and superstitious fears, some of which I have no doubt are agglutinated around a nucleus of reality. Here and there burnt logs lay, scattered and embedded in the volcanic sand, as if where a fiery eruption from the neighbouring volcano had issued forth in times long past upon the then living forest. I noticed also that much of these anciently-charred logs and pieces wore a highly-polished and semi-glazed appearance, as if occasioned by the ever-drifting sharp sand. I was so struck with the peculiar exterior of some of the half-burnt timber, apparently so aged—or of old time—and yet retaining all its vessels and ducts, that I collected a few specimens, and subsequently sent them to England for high microscopical examination. On the edges of this lonely barren desert a lovely *Gentiana* flourished in all its undisturbed beauty—probably *G. pleurogynoides* (another fine garden-flower); also *Celmisia spectabilis*, most luxuriant in gloriously-fine tufts or tussocks; and with it grew a much smaller and different-looking species of *Celmisia (C. glandulosa)*, for the first time here found, and both species tolerably plentiful. Several times during this day were those exquisitely pathetic words of the poet Gray, so highly suitable to the place and scene, feelingly uttered by me:—

> "Full many a flower is born to blush unseen,
> And waste its sweetness on the *desert* air.

Very curious also was the formation, or, more correctly speaking, the state in which the old land was left in many spots on the west side of this desert. Table-topped mounds, from 6ft. to 10ft. high, having perpendicular cliffy sides, each containing only a few perches of land, and rising like little islets separated from each other by the barren white sandy arms of the desert, were common. These mounds, or islets, abounded in a peculiar vegetation, which I greatly wished to know more of; but, alas! I was sadly pressed for time, and I was already more than prudently overloaded for the unknown mountain-journey before me. It was difficult, too, to climb up on them, although I did manage to get on two. Here I obtained an elegant dwarf *Dacrydium* (a "pine" tree, allied to the large Rimu = *D. cupressinum*), rooting up a few old trees of 1ft. or 18in. high, in full fruit, for specimens—reminding me of the quaint yet symmetrical little trees so greatly prized by the Chinese for their gardens. Rain overtook us shortly after our crossing the desert, which we were sorry for, but there was no help for it, there being no kind of shelter nor water at hand; so we travelled on in the pelting rain, which was from the south and in our faces, getting wet, weary, and dispirited, eagerly looking out for a fit halting-place, but finding none. To make matters worse, our guide more than once told us he was "all at sea" as to the proper course, because the thick rain hid the hills on all sides (and everything else) from his view, so that he could not see the landmarks. We kept on, on, on, however, till 7 p.m. (dark), when, finding water, we were obliged to halt in a narrow deep gully by the side of a *Fagus* wood, where everything around for miles of fern and scrub had been very lately burnt off. We had been travelling through this "black country" for more than an hour, in hopes of seeing its end, but in vain. Here, where we were, we could not find a level spot on which to put up our tent, so, in the darkness and the rain, we were obliged to dig away with our axes on the steep side of the hill before we could set it up. That night was a terrible one of wind and rain, insomuch that we expected every moment to be smothered in our half-pitched tent. Few of us slept that night.

"20th.—Our most wretched night was followed by a dirty, lowering morning, with furious wind and heavy rain: it was also bitterly cold. We were here caught in a southerly gale in one of the worst spots possible in the whole North Island of New Zealand, and we could not help ourselves. To retrace our steps and go back to Taupo (over Te Onetapu Desert) our guide flatly refused, and my natives joined him, he saying that high open desert-sand was now covered with snow, and that from the falling snow and sleet he could not tell the course—which, perhaps, was really the case. From him we had the story of seventy men having been once lost at one time in attempting to cross that place in snowy weather. Murmurs, loud and deep, throughout this long and dreary day reached my ears,—of my having been the means of bringing on this weather through my uprooting some small trees (*Dacrydiums*), and my crossing the "sacred" desert without first observing certain superstitious ceremonies, and my sacrilegiously eating some *Gaultheria* berries while crossing it, which the guide had detected, &c. The worst to me was—(1) That I could not get anything whatever to lay on the wet mud floor of my tent (nor fern, nor grass, nor leafy shrubs were there to be found; all had been destroyed by fire, the very lower branches of the *Fagus* trees in the wood before us having been scorched); (2) that we had scarcely anything to eat; (3) that my specimens were becoming spoiled, which caused me to fret pretty considerably; and (4) that, at the rate it was then raining, when the gale should abate the rivers we should have to cross would be unfordable for some days. As the day began, so it closed—no change whatever in the weather, save that even about us, at our considerably lower altitude, the rain was changed to sleet and snow.

"I shudder *now*, while writing this, in thinking of that wretched time, though more than forty-six years have since passed.

"Often enough did those highly-suitable words of my favourite old poet, Ossian, cross my memory: 'It is night; I am alone, forlorn on the hill of storms. The wind is heard on the mountains; the torrent pours down the rocks. No hut receives me from the rain; forlorn on the hill of winds'—(' Songs of Selma')—their suitability being so much the more increased through the superstitious talk and fears of some of my natives, who insisted on it that the sounds they heard between the fitful ravings of the blast among the trees were not merely those of the trees creaking, and of the denizens of the forest—parrots, owls, and wood-hens—but of the justly irate *patupaiarehe* (wood-nymphs or fairies), or of the ghosts of the dead—just, indeed, as Ossian has it; and Schiller laments in ' Wallenstein,'—

> "Alas! the old fabled existences are no more;
> The fascinating race has emigrated.*

"21st (Sunday).—Another wet and uncomfortable day. The wind, however, had lessened a little, and we could manage to make up a fire, which we could not do yesterday. Not really knowing how far we were from help, I could only allow two teacups of rice for all my natives (six in number) for breakfast, and two also for dinner; and for supper *one* cup of rice was all that could be spared, which, with a few scraps of bacon fat and a little salt, made a mess of pottage! At consultation this evening we agreed to start early this morning. I privately requested Paora† and two other of my natives from Hawke's Bay whom I could trust to keep a good watch over our Taupo guide during the night, lest he should give us the slip, a trick I had been served more than once in former travelling. Indeed, to prevent this on this occasion I had determined, if needs be, to bind him till morning.

"22nd.—Up early this morning, and left our wretched encampment at 6 o'clock. The frost was heavy, and it was bitterly cold, insomuch that we could scarcely fold up the tent. Unfortunately, however, the ice on the many pools and streamlets we had to cross after gaining the brow of our hill was not thick enough to bear one's weight, and so we were obliged to go through it. Crash! souse into the cold water, of which my poor companions with their naked feet loudly complained. Here, in one of these watery hollows, and partly submerged, grew a little shrubby plant which I had not before seen, and never again found. It proved to be a new species of *Logania* (*L. depressa*). It cost me a good wetting and cold shivering to get specimens. It was nearly 9.30 before we halted to breakfast, which we did on the banks of the River

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* Die alten Fabelwesen sind nicht mehr,
Das reizende Geschlecht ist ausgewandert.
SCHILLER: "Wallenstein."

† This man (Paul), then one of my baggage-bearers, a fine, tall, stalwart, and useful Christian native, is the same as Paora Kaiwhata, a chief of note, well known to Hawke's Bay settlers, who died a few months ago.

Moawhango (now a swollen rapid), where we roasted our roast—a few potatoes which we had carefully reserved—my natives having then said they could travel better on roasted potatoes than on rice. We travelled on pretty steadily all this long day until 8 p.m. without halting, when we threw ourselves down among the fern quite exhausted and spiritless, not knowing how much farther we had to go before we should reach this long-looked-for Patea. Our guide, who had been lagging behind, although he had no load to carry, had sunk down some time before, declaring he could go no further, being faint through hunger; so, taking from him the course we had to steer (as far as he knew), we left him, believing that a good nap would refresh him. After a while we arose from our fern couch hunger-impelled, and, having broken off the tops of the branches of the large many-headed cabbage-trees (*Cordyline australis*), which grew close by, and which the light of the rising moon revealed, we made a fire, and roasted the stalks of the young leaves, which, though both tough and bitter, served to allay our pangs. The *Cordyline* trees of these parts are the largest I have ever seen. They are not only high and many-branched, but bulky also in the trunk.* The whole route this day was very hilly and broken, with occasional heavy entangled virgin forests without the least vestige of any track, we having been obliged to keep much on the higher ground so as to avoid the streams in the valleys, which were overflowing, rapid, and dangerous. During this long day's march I subsisted on a *raw* potato, which I kept nibbling, and a few *Gaultheria* berries; in addition thereto following out the Maori plan of 'hauling in the slack,' in nautical language, or, in other words, of tightening up my travelling-belt, which I have always found in times of severe hunger to be of great service, although it makes it dangerous for stooping low. That night we all slept as we were in the fern around the fire.

"23rd.—Very early this morning our 'guide,' following our track, came up to us before we were well awake, and, finding from him we were at last really near the Patea villages, I, after he had rested awhile and eaten some roasted cabbage-tree leaf-stalks, sent him on to the nearest village to inform the natives of our arrival and of our hungry state. A long night's sound sleep had done him a deal of good, he appearing a different man altogether, although he had had nothing to eat, and had passed the night in the open without a fire; tobacco, also, at that period not being in use. At 6 a.m. we also managed to hobble after him, stiff enough, following his

* I afterwards measured one in which a native of Patea had made a house or room, and fitted it with a door, to keep his tools, baskets, &c., in. I went into it, and stood upright in it. The tree was living, and healthy. I took down its exact girth—20ft. 2in.

track, and by 8 we were loudly welcomed into a little plantation village, where we found a feast awaiting us, in baskets of smoking-hot cooked potatoes, to which we all did justice."

I will only add that on the day before I collected several new and interesting plants, which with all those others named were described and published, with drawings, by Sir W. J. Hooker in his "Icones Plantarum," and by Sir J. D. Hooker in his "Handbook of the New Zealand Flora."

Appendix.

Copy of the Letter written by Mr. Lys to the Editor of the *Hawke's Bay Herald*, Napier, with reference to Mr. Collie's Ascent of Ngauruhoe, and the Loss of his Camera there.

Sir,—Having noticed several allusions to a camera belonging to Mr. Collie having been found at Ngauruhoe, and two of your correspondents having mentioned my name in connection therewith, I beg to supply you with the true facts of the case.

As near as I can recollect, it was in 1877 that Mr. Collie and myself started for Ngauruhoe, intending to thoroughly photograph the mountain and vicinity, not making any secret of our intentions, as, although we knew that the volcano was *tapu*,* we believed we should meet with no opposition. But on arriving at Erehwon, Mr. Birch's homestead, we were met by a Maori, who bore a letter from the chiefs of the district warning us to go back, as we would not be permitted to take any photographs of the sacred mountain, which was strictly *tapu*. It was but a short time since they had stripped Mr. Conolly, and we came to the conclusion that we would return to Napier, and try again in the following autumn; which we did, taking every precaution to keep our intentions secret, and we succeeded in reaching our goal without the natives being anything the wiser. Mr. Collie and myself for three weeks camped at the base of Ngauruhoe, taking views of the mountain and surrounding scenery. We had taken part of our gear, including the camera, up into the crater, intending to follow next day with the balance of our necessaries; but next morning whilst having our breakfast we were surprised by a party of six natives, who manifested great curiosity as to our reasons for being there, and also as to how we had found our way there. I should tell you that we were prepared for our visitors, in that we had our pictures "planted," and also the bulk of our goods were in another camp, and our money had also been sent away to Mr. Birch's, in Patea; but we were expecting a man to arrive every day with the horses for us to depart when we should have got our views of the crater. The

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* Placed under ceremonial restrictions, rigidly preserved.

Maoris talked of taking us to the king, of killing us, and various pleasant alternatives, but agreed at last that in consideration of a sum of £20 they would overlook the sacrilege done and allow us to depart with our baggage. We drew out an agreement to that effect, which we signed; and then they wanted cash down, which we had taken care was out of our power to comply with by having no money with us. Eventually it was agreed that we should try to get it from Mr. Birch. We were going to get it, leaving our baggage as security—a by-no-means inconsiderable quantity, as we were using the wet process, making a load for two pack-horses. I went with three of the Maoris that afternoon up to our second camp, and showed them our gear, my fellow-prisoner (Mr. Collie) being guarded by the other natives. We arrived at their camp after dark that evening, the said camp being in the bush between Ngauruhoe and Ruapehu, and consisting of a large fire, with boughs of trees thrown on the ground for bedding. It was a novel yet not unpleasant experience for me, as it was a glorious night in May, with the moon at the full. The snow-covered mountain in front of us presented a sight worth going a long distance to see. In the morning, after some breakfast, consisting of *weka** and potatoes, and some tall talk on both sides, Mr. Collie proceeded to Mamoenui, an outstation or shepherd's hut belonging to Mr. Studholme, on the edge of the desert, some twenty miles from our dusky captors, and there we waited for our horses, as we had to leave our camp on foot. Our horses arrived next day, and the man who brought them and myself started for Ngauruhoe as soon as it was dusk, on foot, intending to make a dash up the mountain for the camera and pictures, which, as I have said, had been hidden; but the fates were against us, as there came on a heavy gale from the south, and no man could have ascended the mountain in safety. However, I got our plates, although the Maoris had removed all the rest of the gear; and the following summer we ascended the mountain and found that our camera had been destroyed by eruptions of the volcano and the weather combined. That is the truth about Mr. Collie's camera; and I can say that neither of us was inclined to run from noises or shadows, as we passed a night in the crater on our second trip.

Apologizing for trespassing on your space,—I am, &c.,

F. E. LYS.

Hastings, 3rd June, 1893.

In addition to the foregoing account I may add (having recently had an interesting interview with Mr. Lys) that those

* Wood-hen, probably *Ocydromus greyi*.

Maoris did not get their ransom of £20, Mr. Collie and Mr. Lys having managed to leave very early the next morning for Napier; consequently they took possession of all they found at the camp where they had discovered the two Europeans.—W.C.

Art. LVII.—*Notes and Observations on M. A. de Quatrefages' Paper "On Moas and Moa-hunters," republished in Vol. XXV., Transactions New Zealand Institute.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Wellington Philosophical Society, 13th December, 1893.*]

Every kind of evidence is made to tell by writers who have a theory to defend. Max Müller: "The Gifford Lectures," 1891, p. 428.

It very frequently happens that he who defends the truth does not gain the victory, since the hearers are either prejudiced, or have no great interest in the better cause. Clement: "Recognitions," lib. ii., c. 5. (a.d. 300).

A generous friendship no cold medium knows,
Burns with one love, with one resentment glows.
Pope: "Iliad," book ix., l. 275.

It was with no small amount of surprise that I saw in vol. xxv., Trans. N.Z. Inst. (lately to hand), that old and long paper of M. A. de Quatrefages on the Moa (*Dinornis* species) again served up, and that, too, in a brand-new translation. That paper having already appeared in full in an English translation,* in such a respectable, old-established, and well-known first-class scientific serial as "The Annals and Magazine of Natural History" nearly ten years ago, surely there was no necessity for (I might truly enough say, no benefit to arise from) it being republished in the Transactions, especially as it contains many errors which, possibly, were not fully known to the writer at the time, but which are almost sure to accompany all such heterogeneous and voluminous compilations, particularly when strung together by one who does not fairly grasp his subject; and still more so when he has a former and pet theory, or "fad," of his own to supplement and defend. And, as the one eminent man against whom that paper is particularly levelled is no longer among us to reply to it—which, however, I well knew he fully intended to do—and as I am in full possession of

* Which, moreover, was highly eulogized by Mr. Maskell as being a "good translation," in his paper on it: "Review of a Paper on the Moa by M. A. de Quatrefages," read before the Wellington Philosophical Society, 3rd September, 1884. (Trans. N.Z. Inst., vol. xvii, p. 448.)

this knowledge, as I shall show, I deem it a duty incumbent on me to write this paper on behalf of my deceased friend, to do his memory scant justice in this matter. Indeed, in my adducing his own *ipsissima verba* on this subject, it may be said of him, as of others before him, "*per illam defunctus adhuc loquitur.*"

And here I cannot refrain from observing that this fresh and uncalled-for move seems somewhat ungenerous on the part of its promoters, as the gist of M. de Quatrefages' paper was well known to be levelled against Sir Julius von Haast, now no longer among us—a man who had so faithfully and zealously served science, even beyond his natural powers; and so, like many others who have preceded him, in New Zealand and in the South Pacific, given his life to her cause and to the colony.

The late Sir Julius von Haast and myself had long been correspondents on very friendly terms, and in the early part of the year 1885 he wrote to me respecting this very paper of M. de Quatrefages', then lately republished in its English translation in the August and September numbers (1884) of the serial mentioned,* informing me of it, and asking me to assist him in his replying to it, which I promised to do. Unfortunately, this was not carried out, through Sir Julius being appointed the Commissioner for the New Zealand Exhibition in London, and consequently having to leave New Zealand soon after, for which duty, too, he had to make extensive preparation prior to his leaving New Zealand; and then his sudden premature death at Christchurch so very soon after his return to the colony.† I shall give verbatim copies of the notes and memoranda that passed between us, so far as they relate to this subject. Fortunately I kept copies of my replies to him:—

Christchurch, 23rd March, 1885.

MY DEAR MR. COLENSO,—

. . . As I told you, Professor Quatrefages rather handles me roughly about the Moa age. However, as I know I am on the right track, I intend to answer his paper fully; but, in order to do so, I want the help of my friends. Enclosed I send you a few questions, to which I wish an answer at your earliest convenience. It is only to strengthen my hands—to show that all are not unanimous in believing that the Moa became only extinct in the last hundred years, as I told you verbally. . . .

Ever faithfully yours,
JULIUS VON HAAST.

The questions referred to:—

1. Do you know any reliable Maori traditions about the Moa?
2. Do not all, or at least some, of these traditions appear to have

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* I cannot understand how this paper, then first published in an English translation, could be known to Mr. Maskell so early as 3rd September in that same year.

† Returned to the colony 17th July, 1887, and died on the 16th August.

been brought by the Hawaiki immigrants from their former home, as, for instance, the accounts of the great lizard (crocodile?)?

3. If the traditions of the *Moa* are applicable to New Zealand, *when*, according to them, became the Moa extinct?

4. Are there any reliable traditions that when the immigration or immigrations from Hawaiki took place another autochthonous population was inhabiting New Zealand?

5. To what race did it belong?

6. Had the Hawaiki immigrants, or their predecessors, a frugivorous dog? When did it become extinct or alter its habits? Are there any traditions about it?

7. Are there any traditions when greenstone was first used by the natives? JULIUS VON HAAST.

Christchurch, 19th March, 1885.

Napier, 31st March, 1885.

MY DEAR PROFESSOR VON HAAST,—

Thanks for your kind note of the 23rd inst. . . . I have endeavoured to answer your questions, but, I fear, not satisfactorily, either to you or to myself; but if you will patiently look into those old papers of mine, as noted, you will, I think, gain some information.

I feel at times not a little vexed with the powers that be, when I reflect how much, how greatly, I have been hindered and thwarted in my two principal works—the Maori lexicon, and my papers on old Maori lore and matters. They (or their successors) will be also vexed *hereafter*, but that is no solace to me. They ought to have given every encouragement, but . . .

I am, my dear Professor, yours faithfully,

W. COLENSO.

P.S.—I may also add, and that for *two* reasons, that the thought has crossed my mind that you had forgotten (?) what I had written on the Moa in the paper referred to: perhaps, when you had looked at it, you supposed it to be only my old *original paper*, reprinted from "The Annals of Natural History," with which it does begin, but a great deal of freshly-obtained information was added. My *two* reasons are: Buller made a *similar* mistake last year, in his presidential address at Wellington, mainly, too, on the Maoris, when he said that "no one had yet written a paper on the subject of their poetry," &c. I was ashamed on reading this, and pointed out to him my long paper on that subject, with translations of songs, &c., in vol. xiii., Transactions. In reply, Buller said he had "quite overlooked it." (2.) When Remenyi was with me last Sunday we were on this subject (Maori poetry), and I lent him that volume to read the said paper, and my so doing has brought Buller's omission fresh to memory; hence also this.—W. C.

1st April, 1885.

Answers to Professor Von Haast's questions *re* the Moa, &c.:

1. What I had gleaned I gave in my paper on the Moa, Trans. N.Z. Inst., vol. xii., pp. 80 *et seq.*

2. No; I don't believe in that myth of Hawaiki immigration as containing anything real (material, objective)—*i.e.*, appertaining to the Sandwich or to any other islands. (See legend of a saurian *pet*, Trans. N.Z. Inst., vol. xi., p. 100.)

3. See answer to question No. 1.

4. I don't believe in that *objective* migration; there are *such* stories, however, *re* autochthons—strange, quaint, simple, and contradictory—showing their antiquity, but of no value [save to show their utter ignorance].

5. This question cannot be answered in one word or sentence, as you

would like, simply because all New Zealand, from the very night of their history, was occupied tribally—that is, as deadly foes—after the manner of Cain and Abel; the tribes, too, being numerous, and often changing their names, and becoming extinct through warfare.

6. I scarcely clearly understand this. (1.) I don't believe in that *objective* Hawaiki; yet a tradition says a dog came with them, and swam to shore before their canoe touched land, through *smelling a dead whale* stranded on the shore (Trans. N.Z. Inst., vol. x., p. 154). (2.) The ancient Maori dog was certainly *not* frugivorous in a country *sans* fruit; rather *omnivorous* (see my paper on their dog, Transactions, vol. x., pp. 139–150). It was pretty numerous in Cook's time, and after, as I have shown. Cook's people bought them for food, being a domestic animal, and never too plentiful owing to the great demand for it—for its flesh and hairy skin—for feasts and for chiefs' garments; and always following the fate of its masters in their frequent wars, it gradually became lost; partly, too, owing to the early introduction of the foreign breeds of dogs, which became more and more requisite to enable the Maoris to catch their wild pigs for barter, &c. There are traditions about the dog, some queer and strange (vol. x., p. 154).

7. There are also traditions about the greenstone and its early use, but very short and casual (*e.g.*, see Trans. N.Z. Inst., vol. xii., pp. 80, 81).

Christchurch, 11th April, 1885.

MY DEAR MR. COLENSO,—

Your welcome letter of the 31st and 1st April came to hand, together with the answers to my questions, for which my best thanks. This, together with your papers, will help me a great deal. I would at once have sent you the two numbers with Quatrefages' papers, but they were out. I have sent them with this mail, together with Buller's pamphlet, in which the tradition about the pet Moa is given. You will see that he makes light of it. Now, will you do me this great kindness, and read Quatrefages' paper carefully, and give me some notes on it; also mark with pencil numbers where you wish to draw my attention. Any point you can throw light on is of great value to me in my answer. Please show the paper also to our mutual friend Locke, with my kindest greetings, and ask him to give me *his* views upon the same, as well as on Buller's. The pet Moa must have been *very small* or it could not have been retained by a man with a broken leg. Nobody regrets more than I do that by stupidity and want of interest your valuable labours upon the Maoris have been retarded; but I have still great hopes that you will take them up again with great vigour. What I have seen of you has shown me that there is still any amount of vitality and "go" in you, and so I have not yet given up all hopes. I have, unfortunately, no specimen of *Hookeria flexicollis*, or I would send it with great pleasure.

Ever faithfully yours,

JULIUS VON HAAST.

P.S.—The pamphlet sent was also very welcome. However, I have not yet found the time to read it *con amore*, as the lectures have just begun, and I have my hands full with work.

This last letter was followed by a telegram:—

Christchurch, 18th May.

Please return books. Urgently wanted.

JULIUS VON HAAST.

Napier, 18th May, 1885.

MY DEAR PROFESSOR VON HAAST,—

Your telegram of this morning, requesting *instant* return of books you kindly lent me, I have received, and respond at once. I would that I had got it on Saturday morning last, then your books could have gone by mail-steamer; now, I suppose, they must crawl thither by overland mail to Wellington.

I regret to say that I have *not yet thoroughly* read Quatrefages, while Buller's pamphlet I have not looked into. When your packet of books arrived here, about one month back, I was absent in the Seventy-mile Bush, whence I have only *recently* returned to Napier. Your kind letter was sent thither to me, but not the books; and, as you did not say in it that you wanted the books returned early—but, on the contrary, that "your lectures had just begun, and your hands were full of work," and that I was "to lend the books to our mutual friend Locke" (who is still absent at Gisborne, and expected here, I believe, next Saturday),—I was in no hurry, having, too, *lots* to do after my month's absence in the bush.

However, I have detected two or three small things which I note. There are more, no doubt. I do not admire Quatrefages' style; he, too, evidently fully believes in the legendary migration (indeed, like others, *gives the islands whence they came*), and therefore does all he can in support of that story. One thing, however: I notice that Quatrefages *never once* refers, or in any way alludes, to my *second* and exhaustive paper on the Moa (in Trans. N.Z. Inst., vol. xii.), while he does to others (*e.g.*, Travers's, Stack's, and John White's) whose erroneous statements I had in that paper refuted. He also (in a note, p. 168) calls the attention of writers and authors to my *later* papers in vols. xiii. and xiv. Transactions, but *that one volume he entirely overlooks;* can it be designedly, or had he not got a copy of that volume to refer to? He also, I think, ignores my paper on the New Zealand dog (vol. x., Transactions), where, too, he would have found something—or *all that is known*—respecting that animal. Another thing that Quatrefages has done (which I greatly dislike) is the taking-up with everything—every strange story, *no matter by whom written or stated*—by "the man in the street," or (as I told M. Bastian when here) "by a mere low billiard-room marker—a fellow of only a short time in the country"—and then putting all together as of *equal authority!* hence I withheld mine.

I regret you must have your books right off. I shall write to London by this week's San Francisco mail for copies of Quatrefages' paper. As I said to you before, look closely into my papers on the Moa (*second* part), the dog, &c., &c. Even the stories (legends) will yield you much. In vol. xi., pp. 95–100, you will have a full account of the monster *pet* saurian, while another worthy had a pet whale on which he rode through the deep; others, too, performed similar feats on albatroses; why not a legendary pet Moa? In haste I close. Beware of trusting to second-rate authorities in Maori matters.

Believe me, ever yours faithfully,

W. Colenso.

[Enclosure.]

Brief and rough memoranda and notes of remarks (unfinished):—

P. 134. Mr. Travers and J. White: "35 years."—See my paper on Moa, vol. xii., p. 103 *et seq.*

P. 134. Maning's "proverb." Never heard it. *Greatly doubt it.* "*Ngoikae*" no known Maori word.

P. 134. "Two against two, like the Moas." (J. White again.) See p. 95, *l.c.*

"Tautauamoa—a dispute about a piece of land (*moa* = bed) in a cultivation; a quarrel between a few of the same tribe or village; a private quarrel." Nearly all this paragraph of M. Quatrefages' is most strange to me.

P. 160. (Speaking of *me*). "I find no one but Mr. Colenso who *has accepted* [*sic*] this doctrine as absolute."

Compare with p. 161 (speaking of *you*): "In his 'Geology of Province of Canterbury' *he formally adopts* Mr. Colenso's views."

P. 161. Mr. Stack and his Moa-*feathers*. So Mr. Locke, and so J. White (all nursery tales). See pp. 82, 98, 99, *l.c.*, where I worked out Mr. Locke's relation.

P. 162. "Hair purely Melanesian." *What?*

P. 164. "*Dog brown* or *yellowish* colour, with *long* ears," &c. Our earliest voyagers say, "Black, and also white, and particoloured, with straight prick ears."

P. 164. *Note**. The *whole* of this note is *not in the original Maori text*, as published by Sir G. Grey. I copy correctly that portion:—

"Ka u mai hoki to Porua waka a te Ririno, na, ka patua nga kuri e rua, kotahi i taona, kotahi i haematatia, ko Whakapapatuakura i taona, ko Tangakakariki i haematatia, a ka puareare ka whakaturia nga tuaahu, i whakaturia hoki nga toko o te atua, kia ngarea putia ai, ko te maro o te atua, ka takapauria, ka whakatara te atua ka mea, 'Nau mai e te atua, ekore au e whiti ki rawahi, nau mai ka whiti ai au.' Katahi ka maoa te kuri ra, ka poipoia, ka mama tama i te riri, ka haere ka whakaturia nga urutoko, Te pou kei runga te pou e Rangi, kei a Atutahimarehua."*

N.B.—*Nothing* said about "*other* dogs," neither of "*spirits*," nor of "gods" (plural); nor of a "*sacrifice*"; nor of "*wearying spirits*"; nor of calling on *them* for some *omen;* and their (the Maoris') call, or word, is simply, "Draw hither, O the demon; I cannot cross over to t'other side; draw hither [and] I shall cross over," instead of the long sentence (of six lines), and nothing more implied. And such is not infrequently the case in that translation—*passim*, the plain, good Maori is often added to, dressed, and garnished.

P. 164. "Moreover," &c. *Flavour* of flesh of dogs *far-fetched*.

P. 167. J. White's (!) and Mr. Travers's story of the origin of the name of a hill on the East Coast, from a chief receiving a kick from a Moa; and M. Quatrefages naturally remarks, "We see how all these popular reminiscences agree." (*Bien bon!*) This strongly reminds me of Taylor's (and others') mistakes *re* Tongariro, Puareinga, Rangitoto, &c., &c.; but J. Wh. and T. *forgot* (?) to say that such was in the *olden* time, and that, on his being kicked down the hill by the Moa, his foot striking a rock split it asunder, and hence the outlet of the present river through it. (*Jam satis.*) For the "kick" and its probable origin, see Trans., vol. xii., p. 103.

P. 168. *Re* "mists of hills and fat of moas" and M. Quatrefages' *long* note thereon! J. White's *usual* magnifying and embellishing. *First* paragraph, all from the *short*, common, ancient saying, vol. xii., pp. 84, 85. N.B.—Sir D. McLean's testimony thereto, after long and *general* inquiry throughout the Island extending throughout years, which he kindly undertook for me.

In a week after my last letter to Professor Von Haast I received the following telegram from him, sent from Wellington:—

Rev. W. Colenso, Napier. 26th May, 1885.

Thanks for notes. Will return Buller and Quatrefages in a fortnight.

JULIUS VON HAAST.

MY DEAR DR. VON HAAST,— Napier, 5th June, 1885.

. . . *Imprimis:* I wished to say, at once, Don't send those books here to me, but, as Locke is going to Wellington (to the Parliament), let *him* see them first. I have talked with Locke about both dog and

* Copied in *full* from Grey's P.M., that you may get it rendered by Rev. Mr. Stack, there with you.

Moa, and he thinks (with me) that you would find *all that we know* in my two papers in Transactions.

I find that you are going to England anon. I wish to ask, if I send you a few Moa-bones whether you would name them for me. I have not many, and, with the exception of *one* bird, all single bones. I would not send you *all*—you are far too busy—but only a few, and in good condition—say, of three or four species; and perhaps those (3) of one leg of another from Poverty Bay. Of course, I pay all expenses up and down.

Believe me, yours very truly,
W. Colenso.

My dear Mr. Colenso,— Christchurch, 9th June, 1885.

Since I have accepted the Commissionership of the London Exhibition I have been several times to Wellington making the necessary arrangements. Now everything is settled, and the circulars are going all over New Zealand. I was much obliged to you for returning me the two books. Quatrefages was wanted by the secretary, but I can soon get it back, and shall, according to your wish, first send it to our mutual friend Locke. I need scarcely assure you that I am very grateful to you for the most interesting notes and hints you have given me, which, no doubt, will materially assist me in my task to give Quatrefages the proper answer.

I hope you will allow me to take the bronze bell with me for exhibition to the London [Exhibition (word omitted in note)], because I am sure it will create a great deal of interest, and of course I shall take the greatest care of it.

Concerning your Moa-bones, please send me the whole lot; I shall name them for you with the greatest pleasure, and, if you like, make up your collection with that; you have at least the principal species all represented.

Ever faithfully yours,
Julius von Haast.

My dear Dr. Von Haast,— Napier, 6th August, 1885.

. . . In your note you say, for me to send on my (few) Moa-bones to you to be named. I thank you for this; but *may I do so* now, and to Christchurch, or are you too busy? A single word by "wire" will do.

Then, you ask for the bronze bell to take to your Exhibition. Would not a cast serve? Dr. Hector got several made, and he kindly sent us one here for our Museum. I mention this, as Dr. Hector positively refused to run the risk of taking it to the Melbourne Exhibition, saying, "It ought not to go out of the colony." . . . I suppose you have *seen* Locke, and perhaps given him the "Annals" containing Quatrefages' paper.

Believe me, yours faithfully,
W. Colenso.

Dr. Von Haast's reply, dated "Christchurch, 14th August," referred wholly to specimens for the London Exhibition, merely adding at the close, "Locke has got the 'Annals' now." To that letter I replied on the 28th August. In *his* following and *last* letter Professor Von Haast mainly writes on the specimens of Moa-bones I had sent him, and that on his returning them to me. I omit all that, and merely copy from his letter what he says about his preparations for leaving New Zealand, and also concerning the antique bronze bell, this article having been frequently mentioned in our former letters.

Canterbury Museum, Christchurch,
MY DEAR MR. COLENSO,— 12th October, 1885.

Your welcome letter of the 28th August came to hand in due time. I think I wrote to you that the box with the Moa bones had arrived, but I have been so overwhelmed with work that I have hitherto not found the time, but will now in the first free moment proceed at once to business. I have examined your bones at various opportunities and found them extremely difficult, as I have no material from the North Island for comparison, and Owen having only described but one type-specimen of each of his so-called species; consequently I only can give you my own personal views. . . . [Here follow his descriptions, &c., of the bones.] As our court will be so crowded with industrial exhibits, my space for other scientific things will be much curtailed. Moreover, I do not like to take the responsibility about the bronze bell; but I should like the early prints, and some specimen sheets of the Maori dictionary. I hope and trust you will enjoy good health, so that this grand work will be finished by you in comfort. Your case with the Moa-bones will be returned by the first steamer.

Yours faithfully,
JULIUS VON HAAST.

The sequel to my self-imposed task and long paper is soon told. In due time I received from London the copy of M. De Quatrefages' paper, but on its arrival, Dr. Von Haast being in England, and I otherwise engaged, I did not again take it up, and so it has been down to the present day, for I had written largely and (as I thought) exhaustively on the Moa in my paper in vol. xii., Transactions, and, having done so, I had done with it. Further, I awaited the return of Sir Julius von Haast, and then when he did return to Christchurch he so shortly after unexpectedly died.

Before, however, I quit this subject (of the Moa), as I am never likely to write it over again, and as I have shown how translations from Maori have been amplified, and more than once mentioned Mr. John White and his manner of florid translating Maori into English, I would leave on record a notable instance of his dealing in this important matter of the earliest and only mention of the Moa in Maori legendary narrations.

In my paper on the Moa (*l.c.*, Transactions, vol. xii.) I had particularly referred to the short ancient legend of Ngahue, and the casual mention there of the Moa in the original Maori,* and the grave omission of the main (?) portion of it relative to *the Moa in the English* translation.† I give in a note below the simple Maori sentence containing these words in English.‡

* Grey's "Mythology and Traditions of New-Zealanders," 1st ed., p. 68; 2nd ed., part ii., p. 70.

† 1st ed., p. 133; 2nd ed., part ii., p. 82.

‡ "A, haere ana" (a Ngahue), "noho rawa atu i Arahura, ka tuturu te noho i reira, katahi ka kowhakina mai e ia tetehi wahi o taua ika, ka mauria atu e ia ka hoki atu ka tae a Ngahue ki te Wairere ka patua te Moa, ka haere Tauranga, Whangaparaoa, ka hoki ki Hawaiki, ka korero kua kite ia i te whenua tona *kai* he pounamu, he Moa."

"Ngahue proceeded onwards, dwelt far off at Arahura, fixing his abode there (or, *stronger still*, permanently dwelling there). He broke off a portion of that fish (greenstone), and, carrying it with him, returned. Ngahue arriving at Te Wairere killed (or beat, or struck) the Moa; then (he) went (to) Tauranga (to) Whangaparaoa (and) returned to Hawaiki, and told he had seen the land whose riches (chief productions, *or* principal things) were greenstone and Moa."

I now give John White's rendering of that same story*:—

"Ngahue, at Te Wairere, *saw the bird* Moa, and killed *one*, and went back to Hawaiki and told the inhabitants of that land that he had discovered a country without human inhabitants, but where there was greenstone to be found."

And yet again (another version): "Ngahue returned to Arahura, where he *found* the *bird* Moa near the Wairere waterfall, and killed one and carried it in a *taha* or *ipu* (calabash), and went back to Hawaiki, and informed the people of that land of a fine land called Aotearoa which he had discovered."

And these two versions of that same story J. White gives as from two tribes—Ngatiawa and Ngatihau. Note the differences; premising that Grey's Maori version was old and early (*before* 1854), and, as Sir George says in his preface, obtained from the best Maori authorities.

In Grey's English translation little notice is taken of the Moa (just as in the original Maori); even its "killing" is omitted, although the *only* instance of the Moa being mentioned in any old story or legend: in J. White's (1887, nearly forty years after) the peculiar amplification—(*a*) the words "*saw* the *bird* Moa, and killed *one*"; and, again, (*b*) "*found* the *bird* Moa, and killed *one*, and carried it off in a *calabash*," &c.

It may be observed, "But J. White's English rendering is that of the Maori relations from two tribes" (pp. 170, 171, part ii., *l.c.*). Yes; but note in that of Ngatiawa:—

1. "Ka kite" (a Ngahue) "i te Wairere, i reira te manu nei te Moa e tu ana ka patua e Ngahue," &c. = Ngahue *saw* (or visited) Te Wairere (some high cliff), and *there a single Moa standing*. How closely this relation resembles that statement of the East Cape Maoris to me (January, 1838), of the *one Moa standing on the top of the mountain Whakapunake*; and

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* "Ancient History of the Maori," vol. ii., p. 187. As I have not yet read (nor even looked into) this work of J. White, now extended to six volumes—save only this *second* volume, and that by chance—I should perhaps briefly state how I came to look into *this volume*: through John White having kindly presented me this copy of vol. ii., on account of his republishing in it two of my old historical Maori legends (pp. 167 and 173), which he acknowledges in the preface. There may be more respecting this same very old story of Ngahue in the other volumes.

also that of the West Coast Maoris to Dieffenbach (1841), of *the one Moa on Mount Egmont.**

2. And so in that of Ngatihau, with the addition that the Moa (flesh, I suppose) was collected into a calabash by Ngahue (evidently knowing nothing of the *size* of the Moa).

3. And in both traditions the word "manu = bird" is given, a *modern* addition, which is not in the older one of Grey's. The syntax of these two Maori statements is not that of an old Maori, but of a *pakeha* = foreigner, stranger, and I believe to be John White's own peculiar diction.

4. Be that as it may, two things are clear—(1) The casual brief notice of the Moa as a thing of no importance in the *older* Maori version; and (2) the growth of the legend in the two *later* Maori versions of the same story.

5. And then the *period* (*before* the so-called migration from Hawaiki) and also the *place* where the Moa was killed (in the South Island) are the same in all three versions, from which (their united narration) we may clearly gather—(1) the great antiquity of the story, and (2) the *one* solitary mountain Moa being only then met with in the South Island together with the greenstone; although Ngahue had also travelled largely in the North one, both in going and in returning.

Again, note the peculiar use of this word "*kai*" in the older version quoted. (See note, p. 505.)

In a paper read before the Hawke's Bay Philosophical Institute† in July, 1883, in giving several meanings of the word "*kai*," I have among them the following:—

"A very old meaning of '*kai*' as a noun is movable property, possessions, goods, treasures, chattels—valuables in the estimation of the ancient Maoris" (*l.c.*, p. 97). And here we have a good example of it.

In comparing the two translations of M. de Quatrefages' paper I find very little difference between them; only to this modern one there is a long concluding narration tacked on and made a postscript to the older paper, written in May, 1889, and supplied, as M. Quatrefages states, by Sir Walter Buller, who had sent him a copy of the *New Zealand Times* of November, 1888, containing that peculiar story of comparatively modern Moa-hunting communicated by Colonel McDonnell. Strange that only such additional information ("fresh evidence," as it is called) should have become known to M. de Quatrefages after all those years, and just as strange that Sir Walter Buller should not have known of any other.

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* *Vide* Trans. N.Z. Inst., vol. xii., p. 102.

† Entitled "Three Literary Papers." A copy I had sent to Professor J. von Haast with my letter of 31st March.

My task is done. I did not intend to write another line on this subject of the Moa age, but in this same volume (xxv.), in the Proceedings of the Wellington Philosophical Society, are many observations made at different meetings of the Society by the members present on this theme. Some of them I am really sorry to find recorded there, because they are merely the old, old stories and tales which have long ago been answered, and shown to be untenable, and refuted, and therefore such should not be again resurrected. Indeed, in so doing, the truth—the "true facts"—will never be arrived at; and that true and proper remark of Max Müller (in his late lectures at Glasgow, as brought forward by me in a paper in this same volume, p. 496) is very applicable here: "What is of immense importance in all scientific discussions is the spirit of truth. To make light of a fact that has been established, to ignore intentionally an argument which we cannot refute, to throw out guesses which we know we cannot prove—nay, which we do not even attempt to prove—is simply wrong, and poisons the air in which true science can breathe and live" ("Gifford Lectures," 1891, p. 81). And as I have read of those remarks having been made before (both in the back volumes of Transactions as well as in the Wellington papers of the day), I would, as a member of the Society, beg to be permitted to call the attention of some of our prominent speakers at those meetings to what they have said on this subject.

Mr. Travers, for instance, says, "We could not judge of this matter from the Maoris of the present day, *but fifty years ago they were familiar with the existence of this bird*" (*l.c.*, p. 531). Now, it seems very hard that such a statement (oft repeated too) should pass unnoticed. It was in January, 1838, that I myself first moved in this matter (as I have fully and clearly shown in my long paper in vol. xii., Transactions), and I left no stone unturned to glean something tangible about it—in travelling throughout much of the North Island, from Poverty Bay to Cape Maria Van Diemen (a zigzag course to *all* Maori villages as ordered), during which I now and then fell in with chiefs who had seen Cook and also been on board of his ship, which would take back to another fifty years; by friends and acquaintances among Europeans settled and trading in various parts; by rewards; by young Maori chiefs returning to their homes and tribes from our head mission-station in the Bay of Islands; by letters to our Maori Christian teachers and catechists—and the result was Nil. And there were others succeeding me, fifty years ago, who also travelled much throughout this North Island (Dr. Dieffenbach, for instance), and their united report is exactly the same—NIL. Why, then (may I not ask Mr. Travers) are we not believed? Why every year repeatedly bring up that old, old, and wretched remark, "that fifty years ago the Maoris were familiar with the existence of this bird," when the very ancient legend of Ngahue alone (above related) goes far to prove its incorrectness? (I feel this the more in its coming from Mr. Travers, who professionally knows well the difference between true and false facts, and how easy it is to adduce charges, however insignificant and erroneous, when defendant is out of Court.)

And just so, again, with Mr. Maskell. I really feel ashamed when I read (both on these and on former occasions) his illogical remarks, his strong affirmations, respecting not only the Moa age, but also the Maori legends and the very language itself, of all which, I beg to tell him, he really knows nothing. Surely Mr. Maskell must know full well the difference between legends and legends! Indeed, he says he does; and that, "whilst he thought little of Maori legends, he did value European traditions"—no doubt!—"and he well remembered hearing the late Sir F. Weld state often that when he started from Nelson, somewhere about 1848, to make the first journey overland to what is now Canterbury, the Maoris warned him to be very careful of the large birds which he would meet with in the mountains, and which would kick him to death if they could. That was a tradition worth any number of Maori legends" (*l.c.*, p. 531; and again repeated p. 535). Now, I have already, nearly twenty years ago, shown the probable origin of much of that talk*—at all events, of its modern and foreign embellishments. But, I would ask, where is the "European tradition" here? Is not the simple relation by Sir F. Weld of what the Maoris had told him *their legend?* And where is the radical difference between this legend of theirs and that given by them to Dr. Dieffenbach on the same subject nearly ten years before?—namely, "The Maoris could not understand what induced me to seek to ascend Mount Egmont; they tried much to dissuade me from the attempt, by saying that the mountain was *tapu*—that there were *ngarara* (crocodiles) on it, which would undoubtedly eat me. The mysterious bird 'Moa' (of which I shall say more hereafter) was also said to exist there. But I answered that I was not afraid of these creatures of their lively imagination" (vol. i., p. 140).

No one would stand up more strongly for the true position of an expert in his own peculiar line as a successful describer of *Coccididæ* (and of Mr. Maskell *in that capacity* we have good reason to be proud); but what would Mr. Maskell say,

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* Trans. N.Z. Inst., vol. xii., p. 103.

or think (say) of me, were I, on any occasion when one of his favourite papers was being read, to speak of such in his *own* way, using his *own* language which he so frequently uses towards *us*—myself and other Maori philologists—who, if not equally experts, must certainly be allowed to know something more than Mr. Maskell of those Maori matters, to which we have given many years of time and research and study? I confess to feeling both ashamed and sorry when I read Mr. Maskell's statement *re* this paper of M. de Quatrefages (bearing in mind, as I have shown, the grave omission of many *true facts* from its pages), who said that "he was proud of having been the first to bring that paper under the notice of this colony several years ago in the pages of the 'New Zealand Journal of Science,'"* and now, with all its errors, omissions, and suppressions, actually bringing it forward again.

I trust that both Mr. Travers and Mr. Maskell, for whom I have great respect, will forgive me in my thus writing warmly on a matter in which I am so deeply interested, as, from my age, &c., I may never write again. The old Latin proverb is applicable here both to them and to me—"*Ne sutor ultra crepidam*": may we all be enabled to observe it.

And here I would communicate the very excellent and apposite remarks lately made by Professor Rudolph Virchow, in his Croonian lecture delivered before the Royal Society: "Who of us is not in need of friendly encouragement in the changing events of life? True happiness is not based on the appreciation of others, but on the consciousness of one's own honest labour. How otherwise should we preserve the hope of progress and of final victory in face of the attacks of opponents and the insults which are spared to nobody who comes before the public? He who during a long and busy life is exposed to public opinion certainly learns to bear unjust criticism with equanimity, but this comes only through the confidence that his cause is just, and that some day it must triumph. Such is our hope in our wrestlings for progress in science and art. . . . Happy is he who has courage enough to keep up or regain his relations with other men, and to take part in the common work. Thrice happy is he who does not lack in this work the flattering commendation of esteemed colleagues."†

In fine, the prolific root or cause of error with M. de Quatrefages, and with most of those who have written or spoken on this matter of the Moa—*i.e.*, of the Moa *age*—arises from their believing in the myth of Hawaiki and the migration therefrom, and in fixing that period at 500 years ago. To

* Trans. N.Z. Inst., vol. xxv., p. 531.

† Proceedings Royal Society, vol. liii., p. 114: March, 1893.

me, having long and carefully considered the whole matter in its various phases and bearings, and having no pet theory of my own to support or vamp up, both are alike preposterous and void of true literal foundation. At the same time, there is concealed within them a deep esoteric meaning hidden and masked; not dissimilar, however, to, and possibly more reasonable than, what has obtained among other ancient and highly-civilised people concerning their origins. Much as Max Müller has truly and eloquently expressed it: "Language threw its web of metaphors around the truths of which it spoke, and by a natural mistake men came to take the metaphors for facts."* But on this deep recondite subject I cannot at present enter.

Lastly, I may observe that, in my long and exhaustive article on the Moa (so often referred to by me in this paper), I concluded it with the words of the celebrated Roman historian Tacitus, when writing on the *Phœnix*, a bird of great antiquity, which had given him, and other philosophers before him, an immense amount of labour. Tacitus, after recounting the many old stories respecting it, including recent tales, says, "The accounts of antiquity concerning this bird are enveloped in doubt and obscurity. . . . These accounts are not entitled to unqualified credit, and their uncertainty is increased by the admixture of matter palpably fabulous; but that this bird has been at some time seen in Eygpt is not questioned."† That conclusion, made nearly 2,000 years ago, still recommends itself to us as a fair and a rational one. And yet I find, on lately reading in an ancient Roman author of note contemporary with Tacitus, just the very opposite remarks and conclusions respecting this same fabulous bird. And as such may be little known to this audience, the work containing it being scarce, and the subject somewhat analogous to this one of the extinct Moa and its age, I will briefly quote it:—

"There is a certain bird called a *Phœnix*. Of this there is never but one at a time, and that lives 500 years. And when the time of its dissolution draws near that it must die, it makes itself a nest of frankincense and myrrh and other spices, into which, when its time is fulfilled, it enters and dies; but its flesh putrifying breeds a certain worm, which, being nourished with the juice of the dead bird, brings forth feathers; and when it is grown to a perfect state it takes up the nest in which the bones of its parent lie and carries it from Arabia into Egypt, to a city called Heliopolis; and, flying in open day in the sight of all men, lays it upon the

* "Science of Thought," p. 328.

† Trans. N.Z. Inst., vol. xii., p. 101; "Annals," lib. vi., c. 28.

altar of the sun, and so returns from whence it came. The priests then search into the records of the time, and find that it returned precisely at the end of 500 years." And then the author goes on to say, "Let us consider this wonderful type (or sign) of the Resurrection, when even by a bird the Lord of all shows us his power to fulfil his promise," &c.* Thus, again, proving to a demonstration how easy it is to swallow everything related, however strange, as veritable facts, and so jump to the desired conclusion.

Of course, my only reason for bringing these two notions together here is to show the very great disparity of opinion then existing respecting the *Phœnix*, much the same as now, unfortunately, appertain to the Moa age.

P.S.—Since closing my paper I have received a copy of the "Report of the Fourth Meeting of the Australasian Association for the Advancement of Science" (just published), and I find in the address of the Rev. Lorrimer Fison, M.A., the president of the anthropological section, such very appropriate statements—the very counterpart of my own thoughts and ideas—that I hesitate not to copy a portion of them. The president, too, evidently writes as a practical man well acquainted with his subject.

" . . . In these investigations"—anthropological—"two things mainly are required: first, a patient continuance in the collecting of facts; and secondly, the faculty of seeing in them what is seen by the natives themselves. We must ever remember that our mind-world is very different from theirs. . . . As to the former of these two requisites, one's natural tendency, especially in the beginning of the work, is to form a theory as soon as one has got hold of a fact; and as to the latter, we are too apt to look at the facts in savagery from the mental standpoint of the civilised man. Both of these are extremely mischievous. They lead investigators into fatal mistakes, and bring upon them much painful experience, for the pang attending the extraction of an aching double-tooth is sweetest bliss when compared with the tearing up by the roots of a cherished theory. I speak feelingly here, because I can hold myself up as an awful warning against theory-making."—[An instance given.]—"Even more mischievous is the habit of looking at the facts in savagery from our own standpoint. Some of our modern anthropologists' books are full of errors arising from this evil habit—errors which are 'gross and palpable' to any one who has lived long among savages, and taken the pains to learn to see with their eyes. 'You can feel the mistakes with a stick,' said a good Lutheran missionary (one of Mr. Howitt's correspond-

* Clement, *Ep. ad Corinth.*, c. xxv.

ents) who had been reading the statements about the Australian blacks in a work which is generally considered to be of great authority, and has passed through many editions. To get at the real meaning of the facts we must learn to see in them what the savage sees, and in order to do this we must get out of our own mind-world and into his. We must unlearn before we can begin to learn. It is the lack of this which makes the evidence—or, rather, the opinions—of the mere passing traveller so extremely untrustworthy. As long as he confines himself to telling what he has actually seen, his statements, if he be a truthful man, are of value; but as soon as he begins to talk about what is *in* the facts, in nine cases out of ten he is sure to go astray.

"The best way of getting at the meaning of the facts is to go and live with the natives long enough to learn their language, and to thoroughly gain their confidence—say, from ten to twenty years; but, as this is impossible to all but a very few, the next best way is to get information from the men who are living among them."—(*L.c.*, pp. 150, 151.)

Art. LVIII.—*A Maori Pa at Lake Te Anau.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 12th June, 1893.*]

As I am unaware that any record has been made showing that in comparatively recent times certain Maoris were living on the eastern shores of this lake, and knowing that any signs of Maori habits or customs in the olden time are increasing in value as time rolls on, no matter how seemingly trivial these signs may be, I will attempt a description of what I saw at the latter end of the year 1859, or early in 1860—after a lapse of thirty-three years, or thereabouts.

When visiting my friend, the late Donald Hankinson, Esq., who then had a large cattle-station between the Mararoa River and Lake Te Anau, he took me to the shore of this magnificent lake, the eastern boundary of which consists of rolling downs, at that time covered with fern, and in one place a large flat close to the lake densely covered by manuka scrub, in which already a small herd of his cattle had become feral, taking to this cover immediately a horseman came in view. Mr. Hankinson told me of the remains of an old Maori village on the south side of the Upukarora River at the junction of the lake, but said that a fire had of late years passed over it and left little to be seen. I expressed a wish to see the place, and he at once guided me there.

The signs of habitation consisted of charred posts, the uprights or supports of several whares; in one or two places the battens and thatch of a roof lay on the ground, having partly escaped the burning. Several pieces of a broad flat board, some 2½in. thick, were near by, and may have been part of a canoe. It was pierced by holes in several places, some square in shape, others circular, and one large square hole about 3in. in diameter, which might have been a place to step a mast. Of the remains of tools was one small iron adze, which had been so much sharpened that all the steeling was ground away. From the eye of this adze it was evident that its smallness was not owing altogether to frequent sharpenings, but that it originally was of a small make. For chisels were half a dozen large spike-nails, bevelled on one edge only; and some very curious remains of knives were lying about. My first opinion was that they had been made from old hoop-iron, partly from their decayed appearance, and also from the peculiar way in which they had been fitted into handles, of which latter remained no vestige. The blades were either filed away or otherwise sharpened to a flat four-sided apex at the proximate end, which had then been driven into a hole in the handle; the outer end was rounded like a dinner-knife. They were large and clumsy, and gave the idea of a primitive make. In reference to these knives, I seem to have somewhere read an account of travels among the islands, where this entry is made: "The cooper was set to work to make knives from hoop-iron, to barter with the natives." Perhaps these were of such make, and given to those Maoris by the people of some "whaler" many years ago. Of the use of spike-nails as chisels we have Captain Cook's evidence that the Maori had found them of more utility than their former implements of stone or bone. In Cook's First Voyage, he says of the Maoris near Cape Campbell, "They came on board with very little invitation, and their behaviour was courteous and friendly. . . We soon perceived that our guests had heard of us, for as soon as they came on board they asked for *whou* [*whao*], the name by which nails were known among the people with whom we had trafficked; but though they had heard of nails it was plain they had seen none, for when nails were given them they asked Tupia* what they were. The term *whou*, indeed, conveyed to them the idea not of their quality but only of their use, for it is the same by which they distinguish a tool, commonly made of bone, which they use both as an auger and

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* A native of Tahiti, who acted as interpreter between Cook and the Maoris, the Tahitian and Maori languages being cognate.

chisel. . . . However, their knowing that we had *whou* to sell was a proof that their connections extended as far north as Cape Kidnappers, which was distant no less than forty-five leagues, for that was the southernmost place on this side the coast (east) where we had any traffic with the natives." Cape Campbell is the other side of Cook Strait, being the north-east cape of the South Island, whereas the Kidnappers is on the east coast of the North Island.

This treasure trove of the old Maori village had most likely been left hidden in one of the thatched roofs, and the burning had caused them to fall to the ground, where they remained, as I saw them. At one spot seemed to be a workshop for making stone implements, as there were numerous scales of a peculiar light greenstone, clouded as it were with a glassy look—not the genuine greenstone, for this was brittle, and inclined to fall into useless flakes; yet seemingly it had been put to some use by these people, probably for want of a better material.

Who the inhabitants of this pa were I have no knowledge, or why they should, presumably, have left the coast where fish and mutton-birds were in plenty and come some eighty miles to this inland sea, unless it was for a change of fare, such as large eels, flappers (young ducks), kiwi, weka, kakapo (night-parrot, *po* = night); and in this district was obtained one of the few living specimens of that rare bird the *Notornis*, of which neither I nor my friends the Hankinsons ever saw a sign when residing in these parts. Two specimens of *Notornis* were found here some years after we left—a live bird and the skeleton of another. Possibly these people of the pa were natives from Riverton, who came up the Waiau River in the summer time, returning to the coast for the winter season. That they trafficked with the "old whalers" these remains of iron tools give evidence.

I should suppose that Maoris were living in this lake-coast village some fifty years ago (yet there is no reason why the time may not extend to eighty years), which would give seventeen years previous to my visit to the remains. The buildings would remain most probably intact, being well thatched, till the white pioneer settlers set fire to the surrounding country, and so destroyed this relic of the past.

In 1859, and ten years subsequently, no Maoris came inland to either Lakes Te Anau or Wakatipu, and I never saw sign of their previous occupation other than as mentioned above.

Art. LIX.—*Note on the supposed Fire-drill found in the Cave at Moa-bone Point, Sumner.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 4th October, 1893.*]

In the list of objects found in the Moa-bone Point Cave Sir J. von Haast has recorded "apparatus for lighting fire by circular motion, made of pukatea (*Atherosperma novæ-zealandiæ*)."* Now, it is well known that the Maoris, like all the other Polynesians, used to obtain fire by rubbing a pointed piece of wood longitudinally on another flat piece, a method employed, I believe, by no other race of men. The fire-drill —which was used throughout America, in Africa, in the Indian Archipelago, and even in Australia—was quite unknown to the Maoris and to the Polynesians; consequently Sir Julius von Haast's statement that the moa-hunters of the Sumner Cave used it is of great importance, although he does not seem to have recognised its bearing on the origin of the moa-hunters, for he makes no other allusion to it.

This so-called fire-drill is in the Canterbury Museum, and I cannot understand what induced Dr. Haast to give it such a name. Neither of the two pieces of wood shows any signs of charring—as the rubbing-sticks do—so that the idea that they formed a fire-drill must have been inferred from their shape.

The supposed drill is about 6in. long, the handle portion squared, and about $\frac{1}{3}$in. thick on each side. Towards the other end it expands to more than $\frac{1}{2}$in. in breadth, but remaining $\frac{1}{3}$in. in thickness. At one corner of the expanded end there is a conical point which forms the "drill." The squared handle, and the point not being in the centre, are both against the supposition that the instrument was intended to be used with circular motion, and it is much more probable that the stick was intended for rubbing.

The other piece of wood is flat, rather more than $\frac{1}{2}$in. broad, by $\frac{1}{4}$in. thick, and is now about $2\frac{1}{2}$in. long; but, as it has been broken at both ends, it may have been much longer. In the middle line, and at about one-third the length from one end, a roughly-circular hole has been cut completely through

* Haast: "Researches in Sumner Moa-cave," Trans. N.Z. Inst., vol. vii., p. 83.

the wood. This hole has been cut with a blunt instrument, and not drilled. The inside is quite rough, and no attempt has been made to smooth it. I cannot think that the hole would have been cut through the wood if it had been meant to catch the dust rubbed off by a fire-drill; and unless this were done no fire would be obtained. It seems to me that this piece of wood is part of a whare, and that the hole is simply for a flax lashing. However this may be, I am quite confident that neither of these pieces of wood was meant for a fire-drill, and that the rubbing apparatus found in the same cave was the only means by which the moa-hunters obtained fire.

ART. LX.—*The Disposal of Sewage by Application to the Soil (Sewage Farming).*

By Dr. CHAPPLE.

[*Read before the Wellington Philosophical Society, 28th June, 1893.*]

No subject in preventive medicine has attracted more attention or excited greater interest of recent years than the efficient disposal of sewage. And such a statement in the domain of science embodies the promise of great developments —developments which have been abundantly realised—in this important branch of public hygiene. Facts and experiences have been accumulated from the numerous disposal-works in England and Scotland, and theories have been elaborated in laboratories, schools, and congresses, all tending to place the whole subject on a sound scientific basis.

The purification of sewage by the soil is a chemico-biological process; the working of a sewage farm, a sanito-agricultural process.

The term "soil" in its widest sense includes the superficial layer of the earth's surface, and its properties, of course, vary vastly. But all soils are common in this: that they contain air, bacteria, and organic matter in varying proportions. Air is most abundant in loose sand and friable loam, while organic matter and bacteria are to be found most largely in rich loamy soil. The bacteria of the soil are most numerous near the surface, and exist in diminishing numbers to a depth of 3ft. or 4ft. Their constant function under ordinary circumstances is to disintegrate the particles of soil and of organic material for the supply of plants with nutriment. These miniature tillers of the soil require an abundance of both air and organic matter; and, granted these, there is practically no limit to the activity of their processes, nor to the amount of noxious organic matter they can dispose of, converting it into harmless innocuous compounds. These useful little organisms exert a powerful influence in nature, the magnitude of which is seldom realised. They have a wonderful power of adaptability, and can modify their constitution to suit the circumstances, becoming, like most living things, educated to their environments. This will be exemplified later.

Sewage, the other factor in the chemico-biological process I am about to describe, delivered at an outfall after flowing a considerable distance in a closed channel, consists of nitrogenous compounds, chiefly in solution, the solids, for the most part, being suspended in finely-divided particles; but sewage contains also within itself, potentially, the power of its own destruction. Countless myriads of the bacteria of decomposition carry on their disintegrating processes, and all that is required to complete the chemico-biological change initiated by the vital process is a plenteous supply of the ever-obliging oxygen of the air, readily accessible.

We have, then, on the one hand soil—a medium containing in its interstices oxygen as air, and myriads of bacteria, whose favourite diet is dead animal or nitrogenous matter; and on the other hand the water of an abundant water-carriage system—a medium containing this very dead nitrogenous material, with an equal number of greedy bacteria. The oxygen and bacteria in the soil and the nitrogen and bacteria in the sewage are the factors which, when brought together under suitable circumstances, bring about a transformation of the most impure liquids into a pure and sparkling water that the most fastidious could drink of and commend, soluble mineral constituents, known generally as nitrates and nitrites, only being present—the chemical indication that the change known as oxidation or nitrification has been complete.

To illustrate, corroborate, and amplify this, let me describe an experiment conducted in the laboratory: A long glass cylinder is filled with pure sand. There are few or no bacteria and little or no organic matter, but because of the looseness of the sand-particles there is abundance of oxygen as air—about 50 per cent. A small pipe leads a supply of very impure water on to the surface of the sand in this artificial filter, while a tap at the bottom of the cylinder allows the filtrate to be caught and examined.

The first of the fluid filtering through is found to be almost entirely as impure as that distributed on the surface of the sand, only some of the coarser particles being retained. The bacteria are as numerous, the amount of putrescible nitrogenous compounds and ammonia is the same, and there is an absence of nitrates and nitrites, this absence, as I have already said, being the chemical indication that no oxidation or nitrification has taken place in the passage of the fluid through the sand. But let the process of filtration continue for twenty-four hours and another sample be examined, a marked improvement in the filtered fluid is at once noticed, and chemical and biological examination show that the putrescible nitrogen and ammonia are diminished, and the bacteria are fewer in number, while the nitrates and nitrites are largely increased. This improvement keeps going on till the fluid passing through the sand is as absolutely pure and sparkling as the finest spring water. Chemically tested it reveals absolute freedom from all organic matter and ammonia, with the presence of a considerable amount of the innocent mineral compounds nitrates and nitrites. Tested biologically there is a complete absence of bacteria; in short, this water is purer than most drinking-water, and no one would hesitate to drink of and appreciate it. This mysterious and marvellous conversion of the foulest liquid into the purest water will continue for many days, but gradually the affluent will lose its purity, and in time will become as noxious as the original fluid, and get extremely foul. But if now the flow of the impure liquid on the surface of the sand be stopped for twenty-four hours, and then resumed, the affluent will again become pure as before. If, further, this cessation of the flow is permitted upon alternate days, or upon one day out of three, by other cylinders being placed beside the original one, the purification of the foul liquid experimented with may go on indefinitely without any renewal of the sand or impairment of its efficiency. This process of purification is known as "intermittent downward filtration."

If the experiment I have just described be extended by planting in the surface of the sand various garden-plants they will, of course, grow luxuriantly, provided other conditions of warmth and light be attended to, and the nitrates and nitrites hitherto present in the filtrates will diminish and almost entirely disappear, the water issuing from the tap being pure and sparkling as before, differing only in being free from its mineral compounds. This process of purification extended to agricultural land is known as "broad irrigation," or "sewage farming."

If the chemical and vital processes which have taken place in the sand be examined more closely they will be found to depend upon the presence and labours of the minute bacteria before referred to. The particles of sand get coated with a slimy material secreted by the bacteria themselves, and in this they live in countless myriads, taking from the organic nitrogenous matter in solution as it slowly trickles past them the elements they require for the support of their tiny bodies. The other elements of the organic compounds are thus let loose, and are seized by the oxygen of the air between the particles of sand, forming the mineral compounds already referred to as nitrates and nitrites.

The presence of oxygen in the air-spaces of the sand is thus essential to the chemical change; but the constant saturation in the first experiment described prevents the renewal of the air-supply, and the success of the purification process is thus frustrated. Hence the necessity for intermittency in the application of the liquid to be purified. When the flow is stopped the contained fluid drains off, and air, bearing its bounteous supply of oxygen, again fills the spaces. The new compounds formed by this chemical process (oxidation or nitrification, as it is called) are the nitrates and nitrites, which, being soluble, are carried on with the water, providing there are no plants to feed upon them. But nitrates constitute the best and most easily-assimilated food for plants; and as the chemico-biological process I have described takes place most largely near the surface, where the bacteria are most numerous, it is apparent that the most favourable conditions for the growth of plants are here to be found. The assimilation of the nitrates and nitrites by the plants in the above experiment, illustrative of broad irrigation, explains their absence from the effluent water.

These principles applied to the disposal of sewage by application to the soil constitute the scientific basis of sewage farming. But a sewage farm, to be successful, must effectually dispose of sewage as sewage by converting the solids into plants, and the liquids into pure water, without nuisance or injury to health. Now, can this be done? The experience of years rings out a chorus of emphatic affirmation. If the laws arising out of chemico-biological experiments be conformed to in the management of a sewage farm the solids can be converted into the finest plants and the liquids into the purest water without the slightest nuisance or injury to health. Dr. Cornill tells us that he drank freely of the limpid streamlets of the Berlin Sewage Farm. Many sewage farms are favourite Sunday resorts, and strangers are frequently surprised to be told, while they admire the luxuriant vegetation, and breathe the pure air, that they are on one of the walks in the middle of a sewage farm.

But though this brilliant consummation can be attained, and is being attained in some of the most populous towns in different parts of the world, it is not an easy nor an inexpensive matter. Conditions must be favourable to the working of a sewage farm. Land must be available at an elevation sufficient to permit of underdrainage if the soil is retentive of moisture. Underdrainage by laying porous pipes at a depth of about 6ft. is an important because it is an expensive matter. A loose friable surface-soil, with a subsoil of coarse gravel, can be worked without underdrainage, as in Croydon. But whenever the soil for a considerable depth is favourable to the retention of water underdrainage is necessary, for it must be remembered that sewage must pass through, not over, the soil in order to fulfil sanitary requirements. Many farms have no underdrainage, and in some, with very impervious clayey subsoil, the managers are content to allow the sewage to flow over the land, finding that after about a mile of flow it is comparatively pure, and the amount of water small in quantity. But though underdrainage is necessary to allow of the rapid relief of the land from moisture, and the consequent aëration of the soil, it is found that, except in rainy weather, there is not much flow in the affluent drain-pipes, sometimes the whole quantity of water passing upwards through the vegetation of the farm by evaporation.

Pure sandy soil is an extremely suitable one for sewage farming, and the most luxuriant crops are very soon produced, while the cost of levelling and draining is usually less than for most others. A gentle slope is necessary for the purpose of irrigation, while what is known as the "ridge and furrow" system is adopted for the growth of vegetables, and a system of gentle slopes, with grips, for the growth of grass-crops. Vegetables are planted on the tops of the ridges, and the furrows convey the sewage at a slow pace. The area required where the dry-weather flow varies from 20 to 40 gallons per head is 1 acre for every hundred of the population. If "intermittent downward filtration" alone be adopted for the disposal of sewage, 1 acre for every thousand of the population is sufficient.

It is advisable, whenever much rain-water is admitted to the sewers, to have a small area of well-prepared filter-beds, for downward filtration in wet weather, for the disposal of any excess of sewage, or when it is not required for the purposes of irrigation.

In a properly-laid-out farm tanks receive the sewage at the outfall when it issues from the main sewer, and here the larger solids are retained and collected and dug into the soil with town ashes and refuse, making a very superior and profitable manure. A main open carrier, formed generally of concrete or of split pipes, conveys the sewage from the tanks through the centre of the farm. Grips in the land, or on the tops of ridges, strike out at right-angles from this main carrier, and opposite these grips stoppers are placed by the workmen every now and then, causing an overflow of the sewage, and its distribution over the land. This is done intermittently, and, as a rule, the irrigation of growing crops is avoided; but as the primary object of a sewage farm is to dispose of the sewage, and not to grow crops, whenever it is necessary for such disposal the sewage is turned on to the crops, in spite of the wholesale destruction often caused by such a procedure. This unfortunate necessity in the name and for the sake of health is the consideration which determines the management of a sewage farm.

It has been shown repeatedly that tenants will not dispose of sewage to the ruin of their crops, and the responsibility of efficient management has therefore devolved entirely upon the Board of Works or local sanitary authority. But small areas can be let to market-gardeners, the local Board agreeing to supply sewage upon demand; or the whole farm may be let if the stipulation be made that the whole of the sewage is to be disposed of without nuisance or injury to health.

The amount of farm produce raised upon sewage farms is sometimes phenomenal. On the Craigentinny Meadows (originally drifting sea-sand), irrigated by the sewage of Edinburgh, from 50 to 70 tons of grass per acre are raised, yielding thus about £36 per acre. Rye-grass is about the most abundant crop grown, as this grass has a wonderful power of absorbing sewage, and five and seven cuttings are taken off each acre annually, yielding in all from 30 to 50 tons per acre. The Sewage of Towns Commission concluded that experience had shown that, with the application of 5,000 tons of sewage per acre per annum to meadow-lands, an average of 1,000 gallons of milk had been produced from the cattle fed upon the produce; and, further, that an average gross return of £30 to £35 per acre per annum in milk, at 8d. per gallon, might be expected. Dr. Corfield quotes evidence to show that land which "formerly let at from £2 to £6 per Scotch acre is now let annually at from £30 to £40, and that poor sandy land on the seashore, which might be worth 2s. 6d. per acre, lets at an annual rent of from £15 to £20."

These figures might at first sight lead one to suppose that the profits arising from sewage farming must be considerable; but it is not so. The amount of capital absorbed in the acquisition of land, and in its preparation, the number of hands required to do the work, and the constant risk of rainy weather, with its accompanying losses, all tend to make sewage farming a hazardous undertaking from a financial standpoint.

The following table gives some of the information I have been able to collect in reference to the initial outlay, the expenditure, and the incomes of sewage farms:—

Name.	Cost of Laying out.	Interest on Outlay.	Farm Ex-penses.	Farm Income.	Loss.	Gain.
	£	£	£	£	£	£
Beddington (1887, 1888, 1889)	18,000*	5,486	4,226	4,504	..	722
Doncaster (1886)	4,000	160	2,602	2,567	35	..
Birmingham (1888)	394,643†	13,812	23,560	20,416	3,144	..
Leamington (3 years)	..	..	..	..	..	675
Pulman ..	..	..	..	..	..	1,000
Adelaide ..	..	..	..	..	..	..
Birmingham (1890?)	..	..	34,548	20,533	14,015	..
Berlin (1890) ..	1,149,206	..	86,570	95,027	..	8,457

Speaking generally, sewage farming does not pay as an agricultural enterprise, and authorities are unanimous in the opinion that if the farming operations clear expenses, or yield a small profit, this is all any local body is justified in expecting, and this only when the local conditions are favourable. In estimating the profit and loss of sewage farms, rent, in the shape of interest upon the capital outlay, must be left out of account. If this item be taken into the estimate the figures show an enormous loss in the working of most sewage farms.

Dr. Corfield, in his work on the treatment and utilisation of sewage, comes to the following conclusions in reference to broad irrigation: "(1.) That by careful and well-conducted sewage irrigation (especially if combined with a filtration area) the purification of the whole liquid refuse of a town is practically perfect, and has been insured in cases where it was not at all the object of the agriculturist; and that it is the only process known by which that purification can be effected on a large or small scale. (2.) That perfectly worthless land—blowing sea-sand, for instance—can be made in this way to support large and valuable crops. (3.) That the quantity per acre of all crops obtained from even the best land is enormously increased. (4.) That it reduces to a great extent, or renders entirely unnecessary, the usual amount of artificial manures of all kinds by supplying a manure especially adapted, from its complex constitution, for the nourishment of crops; supplying it moreover in a state of solution—that is to say, in the most readily-absorbable condition; and supplying at the same time that most necessary aid to vegetation—water, which often converts what would otherwise have been

* 525 acres. † *Plus* cost of land.

a heavy loss into a handsome profit. (5.) That by it the farmer is rendered entirely independent of drought; so that he can be practically certain of his crops, and, moreover, be able to transplant them as much as he pleases. (6.) That when circumstances are favourable it has been found to pay, and when its management is more thoroughly understood it will doubtless in many instances be found to be a source of income to the towns. Where the circumstances are *not* so favourable it will yet prove to be the most satisfactory way to get rid of the nuisance, although it may not entirely pay its expenses."

Nothing is more thoroughly established in regard to this subject than the entire absence of anything like nuisance, or injury to the health of those on or in the immediate vicinity of sewage farms. The only semblance of nuisance that ever exists on a well-managed farm is at the outfall, and this is reduced to a minimum by prompt and effective treatment, and, at worst, the odour is no more offensive than that noticeable in the vicinity of any of our present sewer outfalls into the harbour. The bounteous production of ozone by the luxuriant vegetation of the farm corrects any tendency to the rise of miasmata from the soil, and actually purifies the air to a degree beyond that of the towns themselves. Dr. Cresswell says of the Norwood farm at Croydon: "As for effluvia, I will not say there does not exist any, but it is so seldom perceptible that a house built within 200 or 300 yards would command the same rent as if half a mile off." Dr. Carpenter says that hundreds of persons exercise and recreate in the sewage farms of the Croydon Local Board of Health, and that visitors express surprise at the absence of everything offensive to sight and smell. The travelling correspondent to the Melbourne *Age*, in describing the sewage farms at Croydon, says, "It is only fair to admit that the health of the people who live upon the farm (seventy-two in number) is very good, and the only place where any unpleasant odour is traceable is at the sieves where the solid matter is arrested, an operation which takes place some distance away, and at the spot where the crude sewage is distributed over the first field." Mr. Stayton, in his report to the New South Wales Government, says of the Berlin Sewage Farm, "The health of the labourers on the farms is very good, and the death-rate was only 11 per 1,000 during the last year; and it is rather a remarkable fact that, although there was a severe epidemic of typhoid during the first months of 1888 in this city, yet no case of disease occurred on any of the farms."

Evidence is abundant and emphatic in declaring that the purest and healthiest mode of sewage disposal is by broad irrigation, and this method can be adopted in the immediate vicinity of populous and favourite suburbs without nuisance or injury or depreciation in the value of property. The germs of disease liable to be carried in sewage are effectively disposed of by the bacteria of the soil; and it is remarkable that many infectious diseases which exist in the towns are conspicuously absent from the farms supplied by the town-sewage.

Generally speaking, the advantages of sewage farming are: (1.) The general wealth is increased by the increased production. (2.) Employment is given to many workmen. (3.) Sewage, as sewage, is absolutely and completely annihilated. (4.) Nature is imitated in the method of disposal, and the utmost use is made of waste products.

In determining whether the sewage disposal of Wellington should be by broad irrigation these general advantages of course apply, and local advantages also exist in the suitability of available land in the vicinity of the already-determined outfall; but the conditions unfavourable to sewage farming are numerous:—

1. The isthmus suggested as the site for a farm is exposed to the severe southerly winds and salt spray.

2. The amount of water to be disposed of is much greater than is found to be convenient on most sewage farms—50 gallons per head of the population is the dry-weather estimate for Wellington. The average applied to sewage farms is about 30 gallons, while in Berlin, where the best results are obtained, the dry-weather flow in twenty-four hours is only 21 gallons per head of the population.

3. The average annual rainfall here, according to a return prepared by Mr. Gore, is about 51in., and, as provision is made for the reception of a large amount of rainfall by the sewers, it is evident that in rainy weather an enormous quantity of sewage will have to be disposed of. The average rainfall of Berlin is 23in.

To justify the establishment of a sewage farm upon the isthmus, the following questions must be decided in the affirmative:—

1. Can a sufficient area of suitable land be bought, levelled, underdrained, and thoroughly prepared for farming at a cost not exceeding that required to extend the outfall to any other suitable place?

2. Would crops and stock be likely to thrive, in spite of the exposure to wind and spray arising from the situation?

3. Would the cost of labour, and the demand for farm and dairy produce, justify the expectation that financial results would compare favourably with those of other typical sewage farms?

4. Would the danger of deposit on the land, or of tearing up, in times of heavy rainfall, be of no serious importance?

In conclusion, it must be admitted that the question of disposal in Wellington is purely a matter of cost. From a sanitary point of view either broad irrigation or direct discharge into Cook Strait will abundantly satisfy the requirements of public health, and no sentimentalism such as is indulged in by Victor Hugo, in deploring the sin of casting human refuse into the sea, should be allowed to weigh in favour of a sewage farm if it cannot show a reasonable prospect of affording an adequate return.

We have listened to this eloquent writer, who warns us that nations are pouring their substances drop by drop into the sea; but we have also listened to Malthus, who warns us that population is increasing so fast that we shall soon be packed like sardines in a tin; and to Sir James Hector, who maintains that we are exporting our wealth in the shape of flesh and bones to other lands; and to astronomers, who declare that we are dropping inch by inch into the sun. We believe that this is all quite true, but cherish in our souls the thought that all these things are in the wisdom of creation so designed that when all nature's storehouses are exhausted, and we are struggling for foothold on some rocky shore, in a moment, in the twinkling of an eye, we shall fizzle in the sun.

Art. LXI.—*Tuberculosis in Man and Animals.*

By Dr. Chapple.

[*Read before the Wellington Philosophical Society, 11th October, 1893.*]

The most distinctive feature in the practice of modern medicine is the public demand for, and the profession's willingness to impart, instruction in the nature and causes of disease. This is the natural outcome of the rise and progress of preventive medicine—a science pre-eminently the people's, for only when its truths are understood and appreciated by the public will the good fruits of this beneficent science be fully manifested. The practice of one hundred years ago was almost exclusively curative; but more real good has accrued to humanity, more disease has been controlled, and more happiness promoted by preventive measures in State medicine, and prophylactic treatment in practice, than has resulted from the cures of a century.

Of all the diseases which come within the province of preventive medicine none bulks so largely in national importance as tuberculosis. Tuberculous diseases are the scourge of the British Isles, where scarcely a family is to be found that has not suffered directly or indirectly from this insidious foe. All civilised countries in temperate regions are afflicted by its ravages. It attacks its victims in the bloom of youth or in the flower of manhood, while those who are marked for its prey often show a clearness of intellect, a vivacity of character, and a loftiness of conduct much above the normal, making this disease responsible for the aphorism that "the good die young."

Since Koch's discovery in 1882 of the bacillus of tubercle a complete revolution has taken place in our knowledge of tuberculosis. It is now held to be, and treated as, an infectious preventible disease, whose manifestations vary with — (1) the animal attacked, (2) the organ attacked, (3) the degree of infection.

The cause of the disease is a minute vegetable organism belonging to the *Schizomycetes*, and known as the *Bacillus tuberculosis*. It is rod-shaped, $\frac{1}{7000}$in. in length, and developes by the formation of spores. It flourishes best in dead or partially devitalised animal tissue, but when the disease is prevalent it abounds almost everywhere. The expectoration of a tuberculous man or animal contains millions of these organisms and their spores. After drying on pavements, floors, walls, or grass, the germs are carried about in the air, which is inhaled by others, or the grass may be eaten by stock previously free from infection. The presence of this minute organism in any of the body-tissues then constitutes tuberculosis; its absence makes the existence of the disease impossible; and it is this organism that has to be reckoned with in all public-health measures for the control of consumption. Rest, warmth, moisture, and nutriment are required in partially devitalised, non-resistent, or weakened animal tissue, to allow of a nidus being formed for the development of the bacillus. These conditions are found in the tops of the lungs of young people who restrain the functional activity of these areas by cramping the chest, especially if there is a constitutional weakness of the lung-tissue due to the disease having existed in the parents. In this sense only, it might here be remarked, is tubercular disease hereditary; the constitutional or tissue weakness is transmitted, and these weakened body-tissues become an easy prey to the invading bacillus. There is no direct transmission, though there may be maternal infection, and the child die in infancy.

The conditions necessary to successful invasion (rest, weakened tissue, &c.) are also present in the brain membranes of some young and weakly students—here tubercular meningitis arises; or in the knees of housemaids or men used to scrubbing floors—here "housemaid's knee," or "white swelling," arises; or the glands of the neck may be the seat of infection, or the bones of the spine, or the hip-joint, constituting the conditions known generally as spinal disease and hip disease respectively; or the lungs, the intestines, or the neck-glands in cattle may be affected, constituting bovine tuberculosis. In short, any part of the human body, or of the body of an ox, may become invaded by the bacillus of tubercle; and the want of uniformity in the nomenclature of the disease is due to the fact that the names were given before the true nature of the affection was understood.

It is not necessary to make reference to the destructive processes that go on after the invasion of the body-tissues by the bacillus of tubercle, as the purpose of this paper is to deal with the subject in its public-health aspect; and the points of importance in this connection are—(1) That tuberculosis is a germ disease; (2) that it exists in man and in some of the animals he uses for food; (3) that it is infectious, being communicable from man to man and animal to man; (4) that, being infectious, it is preventible; (5) and, being preventible, it comes within the province of State medicine.

First, then, tuberculosis is infectious; but the infection is not virulent, the vitality of the bacillus is low, and the conditions necessary to successful invasion are numerous; while the power of immunity, or resistance to infection, is an increasing factor in healthy individuals. But, apart from the bacterial nature of the disease, and the truth of the statement that diseases of germ origin are all more or less infectious, instances of direct infection are constantly under notice. Individuals in the same house are infected by each other; successive families following one another as tenants of the same house have fallen victims to the disease; and such houses have been known to be infected for generations. Respired air, or air vitiated by germs from dried expectoration, is the medium by which infection is conveyed in such places. The air in hospitals for consumptives has been found to contain the tubercle bacillus, and to have the power of inoculating nutritive media, from which the disease has been produced experimentally.

The milk and flesh of affected cattle form another, and perhaps the most important, medium by which the disease is communicated to man. That these tissues contain the bacilli of tuberculosis has been frequently demonstrated, and the disease has been produced experimentally through their agency.

The question of the degree of infective power of the tissues of an animal with only a local tuberculosis—for instance, diseased glands—is still unsettled, and forms the subject of a Royal Commission of the House of Commons now investigating the matter; but the Public Health Acts in England and Scotland assume that where a local tuberculous centre exists any and all of the body-tissues are infective. Of these tissues milk is by far the most dangerous, for it is used in the raw state, and most largely by children, who are susceptible to the disease in all its forms; and the frequency with which tuberculous symptoms manifest themselves soon after weaning has been urged as evidence of infection by milk.

It is certain, and is universally admitted, that a large amount of tuberculous disease is communicated to children by infected meat and milk, and the Health Acts of Britain are built upon this knowledge. Quite recently a butcher in the South of England was fined £30 and £7 costs for exposing meat from a diseased beast for sale. The penalties for this offence under all up-to-date Health Acts are very severe, and rightly so, for no one knows better than a butcher when he is dealing with infected meat, for every slaughter is a *post-mortem* examination, and every butcher is, or ought to be, familiar with the indications of disease.

So well recognised in Britain is the infectiousness of tuberculosis that at the annual Congress of the British Institute of Public Health, held in Edinburgh last month, Dr. G. E. Squire, of London, read a paper entitled "Should Pulmonary Consumption be included in the Notification Act?" in which he urged that this step is necessary to control the spread of this disease, and was supported in his contention by many distinguished health officers.

Amongst cattle themselves grass very readily gets infected by expectoration, discharge, and excreta, and the communicability amongst stock is very marked, and manifest to all breeders. About two years ago, when spending a short holiday in Taranaki, I was induced by my friend Mr. York, of the *Hawera Star*, to examine several young cattle said to be "wasters"—a name given by the farmers to those animals that, for no obvious reason, suddenly began to waste away, and to eventually die. There was absolutely no evidence of disease upon a casual examination of three two-year olds I specially examined; they simply looked ill-fed and half-starved. I was assured that they had come from good paddocks, that their fellows were sleek and fat, and that from past experience these young beasts were doomed to waste away and die. A butcher dissected up these animals for me, and I found that, though all the other organs were apparently healthy, the intestines, on being opened, were studded with small tuberculous ulcers throughout. This cleared up the mystery of these "wasters." Young stock feeding on infected grass developed intestinal tuberculosis, nutrition was interfered with; the disease once established was practically incurable, and the unfortunate animals, after living long enough to spread the infection widely, gradually sank and died. Upon the suggestion of Mr. York I delivered a lecture at Hawera upon the nature and preventive treatment of tuberculosis, and was told subsequently that within a fortnight fifty head of suspected stock were killed by the owners themselves.

From a return* very kindly prepared for me by Mr. Von Dadelszen, showing the relative mortality from tuberculous diseases in New Zealand for the years 1882 and 1892, I find that while, on the whole, the amount of disease has decreased, the deaths from tuberculosis in Taranaki and Hawke's Bay have increased. In Wellington, Nelson, Westland, and Otago the mortality has remained about the same; while in Auckland, Marlborough, and Canterbury it has considerably abated.

* MORTALITY IN NEW ZEALAND FROM TUBERCULAR DISEASES.

Provincial Districts.	1882.			1892.				
	Mean European Population.	Number of Deaths from Tubercular Diseases.a	Proportion per 10,000 of Population.	Mean European Population.	Number of Deaths from Tubercular Diseases.a	Proportion per 10,000 of Population.	Phthisis.	Other Tubercular Diseases.
Auckland ..	103,500	161	15·56	136,407	172	12·61	10	2·6
Taranaki ..	15,599	14	8·97	22,757	23	10·11	8	2·1
Hawke's Bay ..	18,023	14	7·77	29,370	33	11·24	9·5	1·7
Wellington ..	63,826	66	10·34	100,490	104	10·35	6·9	3·4
Marlborough ..	9,698	14	14·44	13,144	13	9·89	5	4·8
Nelson	26,834	25	9·32	35,562	34	9·56	8·4	1·1
Westland ..	15,732	17	10·81	16,054	17	10·59	10	0·59
Canterbury ..	116,787	150	12·84	131,499	137	10·42	7·7	2·7
Otago	139,058	150	10·79	156,663	167	10·66	7·5	3·1
Chatham Islands ..	252	..	..	280	..	..	..	..
Kermadec Islands ..	..	..	..	19	..	..	..	..
Total ..	509,309	611	12·00	642,245	700	10·90	8·1	..

a Includes tabes mesenterica, tubercular peritonitis, tubercular meningitis, acute hydrocephalus, phthisis, scrofula, and other forms of tuberculosis.

ENGLAND AND WALES.

Rate per 10,000 from tubercular diseases	28·9
Phthisis only	21·2
Other forms	7·7

This disease, then, can only be controlled by preventive measures, and these may be divided into individual prevention and State prevention. Under individual prevention such precautions should be taken as the destruction of all sputa by burning, the comparative isolation of phthisical patients, the thorough purification of apartments used by such, the boiling of suspected milk, and the thorough cooking of suspected meat. The natural resistance of the body-tissues of all young and growing people should be increased by chest exercises, such as singing, rowing, and varied gymnastics; while hygienic laws should be thoroughly and consistently taught in all schools, and be allowed to replace much of the rubbish now crammed into young heads.

State legislation can and should be made a most important factor in the control of this much-dreaded disease. State enactments for the prevention of disease are amongst the proudest advances in modern legislation, and the Public Health Act of London, 1891, is a triumphant monument to the life and labours of members of a noble profession, and to wise and philanthropic legislators, who have eagerly seized upon their scientific discoveries and embodied them in humane enactments for the diminution of suffering, the promotion of happiness, and the public good. When we think of what medical science has done for London alone we wonder at the few there are who give her thanks. She has given to the lowly habitations of this great city the light of the sun and the pure air of heaven; she has led sparkling water from the hillsides to the meanest homes; she has pulled down the hovels of the poor and built them palaces; she has cleansed her streets and put guardians in her gates; she has banished typhus, controlled small-pox and cholera, and poured the balm of Gilead into a million wounds; she has saved the health and life of countless numbers, and exceeded every other humane factor in her contribution to the cup of human happiness. And all this through the agency of public-health legislation.

But very much still remains to be done, and could more readily be accomplished if there were a closer bond of unity between medical science and legislation; and the want of this is not the fault of the former, for science prays and beseeches long and patiently before her haughty sister will condescend to listen.

Perhaps in no part of the world is public health so well and extensively administered as in England and Scotland; and there is now a well-founded and growing demand for a Government Department of Public Health, with a Minister at its head. At no distant date the Mother-country will have accomplished this great reform. Our New Zealand Government boasts that it leads the world in Liberal legislation, but it is far behind other countries in the matter of State medicine.

Nothing but legislative interference—compulsory, not permissive legislation, which is a farce—will protect the public of New Zealand from the danger that exists from the alarming amount of tuberculosis at present to be found amongst stock. And more especially is this an urgent question for Wellington, which gets some, at least, of its beef and butter from the most infected districts in the colony. And the legislative remedy is not a difficult nor a complex problem: the establishment of public abattoirs, the licensing and thorough inspection of all dairies, with adequate penalties for offences against the Act, would satisfy the demands of public health, as it does in other parts better off than ourselves for hygienic laws; and it will not redound to the credit of our legislators if, in the face of an abundant knowledge on the subject, the health and life of the people are not protected by useful legislation in this direction.

The London Model Abattoir Society has done much to popularise the public slaughter-house system; and its reports, gathered from the experience of about fifty towns in England and Wales, clearly show that the abattoir system is the only means by which the sale of diseased meat can be absolutely controlled. By this system a public slaughter-house is established on the outskirts of the city by either the municipality or a private company. The buildings generally consist of sale-yards and slaughter-yards, conveniently arranged and paved throughout, with every provision for the humane treatment of the animals to be slaughtered. In the best managed provision is made for the immediate boiling, preparation, or disposal of all readily decomposable material, and an abundant supply of water at high pressure insures thorough cleanliness throughout. It is at these abattoirs only that thorough inspection can be practised, and this is done by competent meat-inspectors, who either stamp or certify to the wholesomeness of the meat sent to the retailers, and it is made a punishable offence for any meat to be conveyed or exposed for sale within the municipality that has not been certified to. A small fee is charged for the use of these abattoirs, and as a rule they clear expenses—some pay well, and very few indeed are worked at a loss.

The advantages of the abattoir system are: (1.) It is the gateway through which all animal food must pass to the consumer, and at which it must receive the certificate of a qualified meat-inspector. (2.) Efficient inspection of a large number of private slaughter-yards, scattered round the town, is costly and practically impossible. (3.) Provision can more easily be made for roofed sheds, paved floors, water-flushes, ample feeding, and humane treatment generally. (4.) Weight and time are economized, as the abattoir can be situated at some convenient place, and driving be saved. (5.) Nuisance can be effectually prevented. (6.) Consumers have a guarantee that they are being supplied with only sound and healthy meat.

In conclusion, it must be urged that the State has a twofold duty in the domain of hygiene—a duty to itself and a duty to its subjects individually. Health is wealth to the State, as to the individual, and every day's sickness is a national loss. It is wise for the State to invite and encourage a healthy immigrant, but it is equally wise, and infinitely more humane, to restore a sick man to health, while it combines these qualities with that of commendable forethought if it prevents a man from contracting disease.

But it is the bounden duty of the State to have a watchful care over the health of its subjects for the sake of humanity and posterity, as well as for the sake of present policy; and it is not too bold to say that a few wise laws, based on modern hygiene, and enacted by our next Parliament, would save many valuable lives, and promote a degree of health and happiness that would remain an abiding blessing.

ART. LXII.—*Old Maori Civilisation.*

By E. TREGEAR.

[*Read before the Wellington Philosophical Society, 9th August, 1893.*]

IT seems a touching sight to reflecting persons when they see the children playing their simple games on green mounds and barrows which hold the dust of a past race. When the small, ignorant fingers are toying with fragments of pottery, relics of some funeral urn deposited with grief and pious care ages ago, we fully realise how pathetic the incident is; how full of sadness in regard to the short period of man's abode on earth; how full of hope as it pourtrays the race-life ever proceeding, as the children of our children's children will be playing, full of vivid life, in places where we are forgotten. When we behold such a scene we realise all that it means; but there are other tokens of vanished life around us which we do not recognise—old customs and survivals with which we play as the children play, unconsciously and without recognition. They are not so palpable as the pieces of pottery—they need cleansing from the dust and dirt of centuries; but they may be as truly relics of the past—message-bearing relics—as the fragment of clay cylinder or the stone arrow-head.

It is probably a general, and it is certainly a convenient, way of observing the customs, language, &c., of an uncivilised people to regard them as being the possessions of a primitive people; to look upon the wild strangers not only as savages, but as being the descendants of savages. On the Asiatic and African Continents such conclusions have been in some cases counterchecked by that which ancient history has told us, but, in regard to races of which little is known, the common method of regarding them is as barbarians, root and branch. This easy way of dismissing the subject is the method of the child with the fragments of ancient pottery, not caring for the maker because unconscious that centuries ago such a person existed; but for those who possess the spirit of inquiry and who will take the trouble rewards of discovery are surely waiting. If I assert that the language, customs, and traditions of the Polynesian Maoris have internal and almost unmistakable evidence that the forefathers of these Maoris once knew a higher culture than they possessed at the time of their discovery by Cook, I touch upon a field of inquiry which can be searched in many different directions, and which invites many workers, whose varieties of disposition and attainment will assist each other.

It would take up far too much space for a paper of this kind if I should descant on the examples of decadence which history presents to us. We have seen that sovereign cities like Nineveh, Babylon, Carthage, Tyre, Palmyra, and Thebes can pass away utterly from the active life of the world; while others, like Athens, Rome, Byzantium, and Alexandria, have been peopled by men little fitted to represent the fame of earth's dead masters. To-day we may pass among the Arabs as among the South Sea Islanders,* and, asking the names of the builders of what are now gigantic ruins, be answered, "These were built by the gods, or by the evil spirits, in old time." We even find that in Malacca the descendants of the Portuguese conquerors have fallen lower than the wild tribes around them, and have become bookless, letterless, nameless, immoral savages. How this decadence is wrought is not always easy to trace—probably in no two cases are the causes precisely the same; but the result is the same—forgetfulness and intellectual paralysis.

If we narrow down the inquiry to the case of the Polynesian Islanders, and admit for a moment, as a hypothesis, that it is possible that they once knew a higher civilisation, it

* In the New Hebrides, Ponape, &c.

is pertinent to ask, "What caused forgetfulness?" It probably arose from emigration, and the result was worked out in two different ways. If a body of explorers, seeking new abodes, sets out among strange people armed for war, unless the expedition finds a higher civilisation than it left behind, or is constantly renewed by accessions in numbers from the parent country, the issue is almost certain to be degeneracy in culture. If we picture such an expedition starting, we see many armed men, few women (if any), few priests or other representatives of learning, and only such animals and such stores of food as can be most compactly stowed. Such a party emigrating into unknown seas has little chance of return; those who survive will take wives of the women of the country they colonise; hard work and hard fighting are their lot, and the finer, softer things of life are forgotten. Such we may imagine to have been the case with the New Zealand Maoris: in a variable climate, and in a land where animal food was scarce, sustenance would have to be wrung from earth and sea only by the incessant efforts of "the strong man armed." In Eastern Polynesia and the islands lying nearer the tropics a different cause for deterioration presents itself. In lands where the work of a single day can provide food for a year, where the warm sun tempts to repose, and nature basks in prodigal luxuriance of vegetation, toil of any kind seems out of place, and laziness becomes one of the first duties of man. In this land of the lotus-eaters arts and artifices are forgotten, the calabash replaces the earthen vessel, the girdle of leaves becomes the successor of the woven garment, the bamboo knife is easier to procure than the blade, the metal of which must be smelted from the scarce and heavy ore.

This is, of course, a mere hypothesis; we see the islanders in their girdles of leaves, with their calabashes and their bamboo knives; we have no circumstantial evidence to show that they adopted these to the neglect of materials requiring more labour or skilled direction in manufacture. But there may be evidence which is not circumstantial, yet convincing; and a convergence of many lines may indicate a point as certainly as one line leading directly to the object. That in the case of the Maoris we find a possibility of rapid forgetfulness and deterioration is shown historically in their having forgotten the use of the double canoe within the present century, a thing hardly to be believed had we not the best evidence on the subject. If so useful, roomy, seaworthy a vessel as the double canoe (or even the outrigged canoe) can pass from memory in so short a time, we can easily understand how, in the thousands of years which lie behind us, the Maori could forget arts, appliances, and culture which did not seem absolutely necessary for "the survival of the fittest" under adverse conditions. Amongst the lost arts which I believe their language and myths indicate is that of communication in a written language; and it is to this branch of inquiry that I shall confine myself in the present instance.*

If we look at the tattooing of a Maori as a mere piece of ornamentation, I think we are regarding it as the child does the fragment of the cinerary urn. Some patterns of tattooing have undoubtedly become mere ornament, but I trust to be able to show a convergence of lines of evidence that will prove that such was not the original intention of tattooing as understood by the South-Sea Islander. Tattooing, as is well known, is almost a world-wide practice: it was used by our own ancestors up to the time of the Conquest, and in our army and navy is still a common custom. It differs according to the race, but it is divisible into two classes as to manner: the method by scar-making, and the pattern by puncture. The scar tattoo is generally used by savages—Africans, Papuans, Australians, Negritos, &c.; the punctured patterns by Japanese, Malays, Nagas, and Pacific Islanders. In some of the Polynesian Islands the tattoo is obviously copied from natural objects; thus, we are told that navigators found the Easter Islanders tattooed with figures of hogs, although the hog had become extinct locally years before. Even in New Zealand it is said that fern-leaves tattooed upon the back have been seen, although this must be a very rare case, as I have never been able to find any person but one who has seen such ornamentation.† The common tattoo in New Zealand is highly conventional, and each part of the decoration is named and fixed. We see some faces with less tattooing than others, but, if the work has been properly done, it is all part of a constant scheme, and the only difference is in the stage arrived at when the work was discontinued. It has been said, however, that it was possible to know the tattooing of one face from that of another; if that is the truth, the tattooing

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* Note from Anthro. Soc. Jour., Nov., 1891, p. 176, Professor F. Max Müller's address as President to the Anthro. Sec., British Association, Cardiff, Aug., 1891:—

"Here, too, Bunsen's words have become so strikingly true that I may be allowed to quote them: 'The savage is justly disclaimed as the prototype of natural, original man; for linguistic inquiry shows that the languages of savages are degraded and decaying fragments of nobler formations.'"

He quotes Herbert Spencer ("Open Court," No. 205, p. 2896) thus: "There are sundry reasons for suspecting that existing men of the lowest type forming social groups of the simplest kind do not exemplify men as they originally were; probably most of them, if not all, had ancestors in a higher state."

† Among the illustrations prepared for the "Ancient History of the Maori," by the late John White, may be seen such tattooing.

cannot have been on the conventional pattern, for one perfect *moko* is the exact likeness and copy of another. This refers only to the particular tattooing, in spirals, &c., with which we are generally acquainted; the face of a chief pourtrayed by Cook gives an entirely different set of markings; and, again, the *mokokuri* pictured by White* shows a series of short straight lines, arranged in sets of threes, which are alternately horizontal and vertical. The difference between the decorations of one set of Pacific Islanders and the next, and even the different systems in vogue among the Maoris themselves, show that tattooing has probably had some common source, but has been so affected by an immense interval of time, and by the isolation of those practising it, that it is almost impossible to find out what the original form was. However, its form matters little compared with its signification, and I trust to be able to prove that its significance is unmistakable.

I have, in a former paper (Trans. N.Z. Inst., vol. xx., p. 361), called attention to the fact that the common word for tattooing had meanings leading to the conjecture that tattooing was once a form of writing; and I have now to strengthen that conjecture by showing that every word used by the Polynesians for tattooing points backward to the same conclusion.

When Cook returned to Britain from the South Seas he enriched our language with a new word, or what was said to be a new word in European speech, viz., "*tattow*," as applied to a pattern punctured on the skin. The word is Tahitian, and should be written *tatau*. It is a form of the word *tau*, and is one of the most common and widely spread of Polynesian vocables. Besides its general meaning, "to puncture markings on the skin," † it appears also to apply to trading and numerical calculations. In Maori, it means "to count"; in Moriori, "to calculate"; in Samoan, "to count, to buy, to barter"; in Tahitian, "to count or number"; in Tongan, "to trade"; in Niue, "to count, to buy"; in Marquesan, "to count"; in Mangarevan, "to be counted," &c.‡

These words so widely distributed show at once that the tattoo was not a mere ornament; it was something that was of use in buying and selling—some mode in which accounts

* Frontispiece, vol. i., "Ancient History of the Maori." See also Trans. N.Z. Inst., vol. xx., p. 353.

† Tahitian, *tatau;* Tongan, *tatatau;* Rarotongan, *tatatatau;* Paumotuan, *tatau;* Futuna, *tatau*, &c., all meaning "to tattoo."

‡ Maori, *tatau*, to count. Moriori, *tau*, to calculate. Samoan, *tau*, to count, to buy or sell; *fa'a-tau*, to buy, to sell, to count. Tahitian, *tatau*, counting, numbering. Tongan, *faka-tau*, to trade. Niue, *totou*, to count; *faka-tau*, to buy. Marquesan, *tatau*, to count. Mangarevan, *tatau*, to be counted. Hawaiian, *kakau-kaha*, to print, or mark the skin. Outside Polynesia proper, *c.f.*, Matu, *tawar*, to chaffer. Macassar, *tawara*, to haggle. Nala (New Guinea), *tava-tava*, to buy.

could be kept. Had the meanings been confined to this sense they might have alluded to the very rudest methods of numbering—to the mere tally-stick cut with notches, or to some simple arrangement of the kind for pricking off or dotting down numbers. There is, however, still another set of meanings for *tatau* which implies a great deal more than this. The word means, in Maori, "to imitate, to copy, to search, to examine"; in Samoan, "to be alike, to equal, right, proper, fit, to read"; in Tongan, "resemblance, equal, similar, to criticize, to remark upon"; in Tahitian, "to invocate, to address in prayer"; in Marquesan, "to recite, to relate"; in Paumotuan, "to describe"; in Hawaiian, "to give publicity to a thing, to publish, to proclaim, the government of an island, clear, explicit in expression, to explain, to take counsel, to resolve in one's mind, to put down for remembrance, a writing-down of the names of those who have to pay tribute, to describe, to mark out, to promulgate as a law, to print or paint on native cloth as in former times, to dot, to write, to set down words on paper."*

It seems to me to be certain that the word in most common use for tattooing, even if its use for counting or trading was the marking of tally-sticks, must have meant infinitely more before it could be used as signifying "to publish, to proclaim, to set down for remembrance, to describe, to print or paint on cloth as in former times." Compounds also of *tau* point in this direction, such as *matau*, which everywhere means "to know, to consider, to mark attentively," and show that it was an intellectual effort which the *tatau* was calling forth. Had we but this word *tau* alone to depend on, the inference would be very strong that tattooing was once something very different from the representations of hogs or fern-leaves, or from the conventional curves of our Maori pattern.†

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* Maori, *whaka-tau*, to search, to examine, to imitate, to copy. Samoan, *tatau*, to be alike, equal, right, proper, fit; *fai-tau*, to read. Tongan, *tatau*, resemblance, similar, equal, to criticize, to remark upon. Tahitian, *tau*, to invocate, to address in prayer. Marquesan, *tatau*, to recite, to relate. Paumotuan, *tatau*, to describe. In Hawaiian, *kau* (*k* for *t* in this dialect), to dot, to write, to set down words on paper, to give publicity to a thing, to promulgate as a law; *kaulana*, to be famous, fame, report, the government of an island; *hoo-kaulana*, to publish, to spread abroad as a report; *kakau*, a writing, to write, to make letters, to print or paint on *kapa* (native cloth, *tapa*) as in former times, to put down for remembrance, a writing-down the names of those who have to pay tribute, to describe, to mark out; *kaukau*, clear, explicit in expression, to explain, to take counsel, to resolve in one's mind; *kakakau*, to write as a law.

† Although in most Polynesian dialects *tatau* is used for marking the skin, in New Zealand the word used with this meaning is *ta*. (See Rarotongan, *tatatatau*, to tattoo.) It is probable that the word is originally Asiatic, since we have—Malay, *chachah*, to tattoo, and *tau*, to know; in Javanese, *chachah*, to count, to enumerate.

We will now take up another word. Many of us have admired the beautiful carvings which adorn the canoes, houses, food-stores, &c., of the Maoris. They have been executed with rude tools, and appear grotesque in their primitive conception, but they are nevertheless possessed of a beauty of their own, not to be judged by the rules of Greek art, but to be regarded with admiration for their symmetry and bold intricacy of execution.

This carved work is called by the Maoris *whaka-iro,* a word which appears on the surface to have its radical meaning in *iro,* "a worm, or maggot"; *whaka-iro* would thus seem to mean "causing to appear worm-eaten." Whether this is the original meaning we will inquire.

Although *whaka-iro* is now applied to carved work, we find that in old times it had a different meaning. In an ancient legend, to be found in Grey's "Polynesian Mythology" (edition 1885, p. 112), we are told that when Ngatoro-i-rangi by his incantations raised the great tempest causing the mountainous sea in which Manaia and his army were drowned, the body of Manaia was washed ashore and was recognised by the tattoo-marks on one of his arms. The word for "tattoo" here used is *whaka-iro.** Let us trace it comparatively. We have in Maori (besides *whaka-iro*) *whaka-iro-iro,* "striped, variegated"; *wheiro,* "to be seen, to be understood"; *whairo,* "dimly seen, imperfectly understood." The corresponding words in Polynesian mean—in Samoan, "to show, to make known, a mark or sign, to mark, to distinguish"; in Hawaiian, "to predict, to guess, to tell beforehand"; in Tongan, "to show, to find, to discern, knowledge, understanding, a sign, a mark, to discover, to reveal, to promise, to call to mind, to signify"; in Mangarevan the words mean "a sign, to mark"; in Mangaian, "to mark, to take notice"; in Paumotuan, "to mark, to stamp, to signal, a signal"; in Aniwan, "to know, to teach"; in Niue, "to know, to recognise, to find, to discourse, to make known, to explore." In Futuna (Horne's Island), we also find that the god Ailoilo was the deity who stood at the gate of heaven to note all who passed in.†

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* The word is also thus used in the legend of Tu-heitia. (See White's "Ancient History of the Maori," vol. iv., p. 59, English, and p. 49, Maori part.)

† Samoan, *fa'a-ilo,* to make known, to show; *fa'a-iloga,* a mark or sign, to mark or distinguish. Hawaian, *hoo-iloilo* and *ho-iloilo,* to predict, to guess, to tell beforehand. Tongan, *ilo,* to know, to find, to discern, knowledge, understanding; *iloilo,* prudent; *iloga,* a sign, a mark; *faka-ilo,* to discover, to reveal, to promise; *faka-iloilo,* to distinguish, to know, to call to mind; *faka-iloga,* a sign, a mark, a proof, to signify. Tahitian, *tairo,* to mark, to point out; *tairoiro,* a soothsayer, to predict. Mangarevan, *aka-iroga,* a sign, to mark. Mangaian, *tairo,* to mark, to

Here we have a word which, although used in New Zealand for "carved work," once meant "to make known by a mark or sign, to reveal, wisdom, knowledge, to teach, to predict, to foretell," &c. If we consider that it could not possibly have always been restricted to signify either wood-carving or the twisting of worms in decayed wood we have a clear example of decadence, and this view is borne out by a very remarkable coincidence. In an erudite paper by Professor Lacouperie on the pre-Chinese languages,* we find that he has written as follows concerning one of the aboriginal tribes of China, dispossessed through the conquest of their country by the immigration of the present inhabitants: "The Li are reputed to have known the art of writing, which they seem to have forgotten. Captain J. Calder has found near Yu-lin-kan some characters scrawled on the walls of a temple, which I think may have belonged to the writing of Tsiampa. We know that several migrations from the latter country took place in the tenth century. In some parts of the island the Li women carry a piece of lacquered wood, on which are written several lines of a ballad; the writing, however, is like the wriggling of worms, and cannot be deciphered." We have then, in this extract, a record of a parallel case to that of our own Maori word *whakairo*. I think that, if it is a similar case, it is a very pathetic cause for reflection. Here is an expression which signifies to make marks or signs which others can understand, and regard as the vehicle of wisdom and knowledge, by which they teach, communicate, and know beforehand; plainly, it is an inscribed character. Then it becomes used to signify making marks on the skin by which persons may be known or recognised; then, as the characters lose their interpreters, the word implies "dimly seen, imperfectly understood." At last, the significance of the marks is quite lost, intelligence has gone out of them, and the word becomes merely a name for carved wood, or for the twisting of worms in rotten wood. Surely, a sad and pitiful history of a vanished culture and a lost civilisation.

We now come to some curious words, of which the meanings are obscure, but which are full of interest. The Maori word *ta*, "to tattoo," is in its most common sense used as "to strike with a stick"; and as the tattooing-chisel (*uhi*) is tapped lightly but firmly in order to drive the points of the instru-

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take notice. Aniwan, *iro*, to know; *faka-iro*, to teach. Paumotuan, *tairo*, to mark, to stamp; *faka-iro*, to signal, a signal. Moriori, *hoko-airo*, to carve (in wood, &c.). Niue, *ilo*, to know; *iloilo*, wisdom, knowledge. Futuna, *iloiloa*, to know, to recognise, to find, to discover; *faka-ilo*, to make known, to show, to announce, to learn, to explain. For the god Ailoilo, see Journal Polynesian Society, vol. i., p. 44.

* "Transactions of the Philological Society," London, 1885–87, p. 464.

ment through the skin we see the connection between the senses of "tapping" and "tattooing." We have also a word in Maori, *paki*, "to slap," and we find that in Paumotuan the word means not only "to chastise," but "to tattoo, tattooing, to describe, to write." In Tahiti this word signifies "to mark the skin with the tattoo, to write, to recite a tale"; in Futuna, "to chisel, to print, to engrave"; in Hawaiian, "to smite with the hand, to stamp, to print, a printing as native cloth is printed, to strike a tax, to stir up one's feelings, to make a solemn promise, a vow, a line, a cluster, tied up, bound together, writing arranged in a row or line."* So that here, too, we have the word used for tattooing and writing, referring to the making of promises, describing, reciting, &c. The Maori word *tongi* means "a point, a dot or speck." In Samoan it means "to carve, to engrave, the dot of an *i*, to mark off a portion of the tattoo, to appoint or decree the amount of a fine, the payment for labour or produce, to give a payment." In Niue it means "to pay"; in Tongan, "to engrave, to carve, payment, wages, exchange"; in Futuna, "to peck as a fowl, to engrave, to make a mark, to exchange."† Again, we have a word which, signifying "to engrave, to tattoo," also means "to decree, to give payment, wages, exchange," just as the words we have previously examined have done. There is no possible connection between "a dot, to peck as a fowl," &c., and the meaning of "a decree, payment, trade," &c., except the bond shown by engraving in some literary character, pecked out, so as to be understood by those decreeing, paying, or trading.

Before leaving the subject of *tongi*, "the dot or speck pecked out," it will be well to consider the Paumotuan *tito*, "to peck." In Mangarevan this word means "to peck, a point, a dot"; in Marquesan, "joined, united, put close together"; in Hawaiian, "a small dot, point, or speck, a spot on the skin, the figure marked on the skin by tattooing, spotted, striped."

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* Maori, *paki*, to slap, to strike together. Paumotuan, *papaki*, to chastise, to punish, to tattoo, tattooing, to write, to describe. Tahitian, *papai*, to strike, to beat, to mark the skin with the *tatau*, to write, to recite a tale. Futuna, *paki*, to print, to engrave, to chisel. Hawaiian, *pai*, to smite with the hand, to strike a tax, to stamp, to print, a printing as *kapa* (native cloth) is printed, to stir up one's feelings, to make a solemn promise, a row, a line, a cluster (as in the Maori *tautau*, a string, a cluster), tied up, bound together; *paipai*, to peel off as bark.

† Maori, *tongi*, a point, a dot, a speck. Samoan, *togi*, to engrave, to carve, the dot of an *i*, to peck as a fowl; *totogi*, to peck, to appoint or decree the amount of a fine, the payment for labour or produce, to give a payment; *togi-togi*, to carve a stick, to mark off a part of the tattooing. Niue, *totogi*, to pay. Tongan, *togi*, to carve, carved work, to engrave; *totogi*, to nibble as a fish, payment, wages, fee, reward; *fetogi*, exchange. Futuna, *togi*, to engrave, to make a mark, to peck; *togia*, to exchange.

So by this it would seem that the *tito* was not only tattooing, but that it was in stripes or dots united closely together. The corresponding Maori word has none of these meanings; it is boldly "to compose a romance, to invent a fable." If there is any connection between the Maori and the other Polynesian meanings of *tito*, it must signify that rows of pecked-out dots or stripes were used in which to compose or preserve a narrative or fable, unless the allusion is to the lost art of writing as being itself a fable or romance of times passed out of mind.

We have seen that *tongi* and *tito* mean to peck or dot in stripes. Let us examine the Maori word (*tuhi*) now used for writing as we understand it. The modern word for printing is *ta*, once used for tattooing (so well has the genius of the language preserved the faithful unconscious record), but the word for handwriting is *tuhi*. *Tuhi* properly means "to stain, to paint, to delineate, to point out"; also, "part of the tattooing on the face."* In Samoan it means "striped, to mark native cloth, to point out as a road." In Tongan it signifies "striped"; in Marquesan, "to point out with the finger"; in Mangaian, "marked, inscribed"; in Futuna, "to point out, to make known." In Hawaiian we again come upon the more refined meanings, "to show, to point out, to teach, to give an appellation, to reproach with a reminder of some former delinquency, to think, to imagine."†

It is hard to see how such meanings as "to teach, to think, to imagine, to remind of some former delinquency," can be connected with tattooing and striped native cloth unless the stripes were lines of writing appealing to the intelligence.

I have only one more word to bring to your notice, and I was led to the discovery of its connection with this subject only because I have devoted some time lately to the study of Paumotuan. It is the Maori word *nakonako*, signifying "recollection, anxious thought." The Paumotuan form gives the following meanings: "Like that, thus, a spot, a stain, striped, variegated,‡ to tattoo, tattooing, to write." The Tahitian means "the markings on the skin" (*tatau*). The Hawaiian signifies "a slight ripple on the water, the ridges of

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* It may be connected with *tui*, to prick.

† Maori, *tuhi*, to write, to sketch, to delineate, to paint, to stain, to point out, to indicate, part of the tattooing on the face. Samoan, *tusi*, to mark native cloth, to write, to point out as a road; *tusitusi*, striped. Tongan, *tuhituhi*, striped. Marquesan, *tuhi*, to point out the way with the finger. Mangaian, *tui*, marked, inscribed. (Also compare Melanesian-Futuna, *tatusi*, paint; Malay, *tulis*, to draw, to paint; Javanese, *tulis*, painting, writing.)

‡ Just as we saw that *whaka-iroiro* meant "variegated."

twilled cloth, writing so thick that the paper seems black, dimly lighted, to look earnestly at, to think deeply, to seize hold of as the mind." This word *nako*, meaning at once "tattooing" and "to think deeply," is most interesting in its principal compound *manako*. We find that in Polynesian *manako* means "thought, idea, conception, to exercise anxious thought" (the Maori *nakonako*, which we referred to above), "to muse, to reflect, to call to mind something known before, memory, imagination, fancy."* If the idea of being "tattooed, striped, rippled, lined, so that the paper appears black," passes into the concepts of "thought, idea, calling to mind something known before," then this word *nako* agrees with and confirms the words previously examined as to the connection between the meanings of "carving, stamping, engraving, pecking dots, making stripes, printing native-cloth," and the use of the same expressions for "thinking, teaching, making decrees, publishing information, buying, trading," &c., which only the conception of the tattoo as a thing to be read and understood makes plain, and otherwise is perfectly incomprehensible.

I have now quoted the whole of the Polynesian words which are used for tattooing,† and each one of them shows this recondite signification, this secondary sense, lurking behind the modern meaning. No representation of hogs, or fern-leaves, or spirals could possibly have led to the abstract conceptions attached to the tattooing-words; and therefore we may conclude that it was in no spirit of mere ornamentation that the ancestor of the Maori invented the tattoo. If, afterwards, the Maori allowed the art of communicating intelligence from one to another by means of letters to die away, his forefathers nevertheless understood by "engraving" a great deal more than to regard it as only the carving of a gable, or the twisting of worms in rotten wood.

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* Just as *tau* means "to tattoo," and *matau* "to know," so does *nako* mean "to tattoo," and *manako* "to reflect, to think upon."

† That is, for tattooing in its general sense; the tattoo on the different parts of the face and body are all named, but they are local only; the patterns differ in the different Island groups.

Art. LXIII.—*Skeleton revealed by Dew.*

By Major-General Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 27th July, 1893.*]

The cold nights and fine days which we have experienced lately, with clear skies, and a consequent very copious deposition of dew, have produced a phenomenon which, probably, many may have remarked under varying conditions, and which at first was somewhat puzzling to me. A blank wall of a wooden house is visible from my window. The wall faces west, and is therefore in shade in the morning, and I have observed in it every morning, marked out in clear lines of moisture, the skeleton of the framing of the house —the vertical studs, diagonal braces, and floor-line. The effect was evidently due to inequalities of temperature caused by the contact of the various parts of the framework with the outer planks: where these planks were in contact with a part of the framing they were practically thicker, and therefore the surface lost, or acquired, heat more slowly than the unsupported and thinner parts. As the outer surface cooled down at night by radiation, the heat lost would be supplied again from the mass of the framework where the plank was in contact with it; and so these parts would remain warmer than the intervening portions, and on them the dew would therefore not be deposited so soon or so freely as on the intermediate parts. This seemed to me the natural course of events; and yet the effect observed in the morning was just the contrary. The portions attached to the framework were wet, and the intermediate parts dry. Reflection, however, showed that this was quite in accordance with the first impression that inequalities of temperature caused the inequalities of moisture. There can be no doubt that the deposition of dew takes place first on the thin unsupported portions of the wall, but soon the whole surface cools down by radiation below the temperature of the surrounding air, and dew is deposited all over the surface during the night. In the morning, as the air is warmed by the sun, it expands, and its capacity for holding vapour of water increases; it communicates its increased heat to the surface of the wall, and the thin unsupported parts are the soonest to take up the increased temperature, and the dew on those parts is dried off first. The thicker supported parts require a longer time to assimilate their temperature to that of the warmer air, and so continue for some time to retain their deposit of dew, which remains until the whole surface of the wall has taken up the day-temperature of the air.

ART. LXIV.—*On a Remarkable Appearance of Two Triple Bows, seen at Invercargill.*

By Major-General SCHAW, C.B., R.E.

[*Read before the Wellington Philosophical Society, 20th September, 1893.*]

TOWARDS the end of August last a very remarkable and beautiful appearance was witnessed, and carefully recorded by Mr. A. H. Stock, at Invercargill. He was returning home from special work at the bank at eleven o'clock at night when he observed towards the north three consecutive arches of light, the two inner arches coloured, the outer silvery-white. Turning round, he observed a similar appearance in the southern sky, but not so complete as towards the north, as the southern arches faded away and disappeared towards the east. Apparently the two sets of triple arches started from the same point in the west, and if the southern arches had been complete they would have sprung from the same point as the northern arches on the eastern horizon. The colours seen in the inner arches were in the same order, and were chiefly those at the violet end of the spectrum.

The night was frosty, and the sky was clear overhead and towards the west, but there was a thick mist all round the rest of the horizon. The moon was gibbous, shining brightly, and about 5° above the western horizon. The appearance lasted for about fifteen minutes, and for a short time a ray of white light appeared shooting upwards into the sky as a tangent to the western end of the northern white bow.

As far as I am aware there is no record of a similar appearance having been observed before, and its explanation is not easy. Clearly the phenomenon was totally different from a lunar rainbow, which would have been seen opposite to the moon in the east. Neither was the appearance due to aurora, for in these southern latitudes auroral displays are seen towards the south, and the most brilliant appearance in this case was seen towards the north, while it was repeated also towards the south. I think that the key to the solution of the problem is to be found in the observed facts, that it was freezing, and that there was a bank of mist or fog all round the observer, except towards the moon and overhead. It would seem therefore that he was standing, as it were, in a sort of avenue of clear, dry air, bounded to the north and south by walls of frozen mist, and that the moonlight was streaming down this avenue; and by reflections and refractions in the myriads of ice-crystals forming these walls the appearances of the arches were formed. Perspective would narrow the avenue towards the west, where it was open to the light, and also towards the east, where it was closed in, and so the arches would seem to spring from about the same points in the horizon. The order of the colours in the inner and second arches being the same points also to this explanation, as this is also the case in halos. To account more in detail for the mode in which the appearances were produced under this very unusual combination of circumstances we must go back to the more ordinary phenomenon of halos, or circles of coloured and white light seen round the sun or moon when shining through thin frozen clouds.

The basis of the explanation is the fact that ice-crystals are hexagonal prisms, and that when light passes transversely through such a prism it is refracted, producing a spectrum of coloured rays, the mean angle of divergence of the emergent rays (*i.e.*, the emergent angle of the yellow ray) being about 22° from the entering ray, if that entering ray strikes a face at angles between 35° and 55° from the perpendicular to the face. If the crystal be so turned that the entering ray is similarly inclined to the face on the other side of the perpendicular it emerges at the same mean angle of 22° in the opposite direction. As the successive perpendiculars to the faces of the crystal are inclined to one another at angles of 60°, it follows that, in a semi-revolution of a crystal on its major axis, during 100° of the revolution the parallel rays of light will have been refracted at this definite angle of 22° to one side or the other, while 80° will have been non-effective; or, which comes to the same thing, if a multitude of ice-crystals be placed at random in all possible positions in the path of the light, of those through which the light passes transversely, 55·5 per cent. will be effective in refracting the light in all directions, inclined at 22° to the incident ray. Hence, from each unit-volume of crystallized vapour (say, 1 cubic foot, or 1 cubic yard) a series of concentric cones of coloured light issue, the angle at the apex of the cone being always the same. If the light be proceeding from its source to the eye, passing through such a frozen cloud, it is evident that the conditions exist for the formation, in the eye of the observer, of a circular halo around the source of light, whether sun or moon; for such of those cones of coloured light as conform to the surfaces of similar imaginary concentric cones in the opposite direction, having their common apex in the observer's eye, are effective in producing in that eye the sense of concentric coloured rings of light at about 22° from the sun or moon.

Similarly, it may be shown that those ice-crystals which are so placed that the light passes through them obliquely, entering at a side and issuing at an end, or *vice versâ*, also refract the light at a definite angle of about 46°, and thus a second coloured ring outside the first is perceived; and in both, the refraction being produced directly without internal reflection, the colours are arranged in the same sequence, red inside and blue outside.

The third circle of white light sometimes observed outside the other two coloured rings is probably produced by reflections from the surfaces of the ice-crystals without refraction by the light passing through them.

In the bows seen at Invercargill the axes of the cones of coloured or white light producing the appearances were at right-angles to the parallel rays of moonlight—not coincident with them, as in ordinary halos. The phenomenon was therefore, I conceive, caused by reflection previous to refraction—reflection from the inclined surfaces of myriads of ice-crystals, which happened to be in the right position to reflect the incident rays outwards from the walls of frozen mist; their reflected rays passing through other crystals, and being refracted in their transit through them, gave rise to the divergent coloured rays, which produced in the eye of the spectator the arches seen both to the north and to the south. I think that in this way the effect was produced; for, although by an interior reflection in a prism coloured rays would be projected backward towards the source of light, I have not been able to find any position of the prisms that would account for the symmetrical arches on the theory of internal reflection.

The reflection from the outer surfaces of other crystals would doubtless weaken the light; but, as compared with ordinary halos, in which the light which reaches the eye has passed completely through a cloud, and has undergone very numerous reflections and refractions in its transit, the Invercargill appearance would have the advantage that the light would have been reflected and refracted at the outer surface of the cloud, and so would have lost less by absorption and dispersion than in the more ordinary appearance of the circular halo round the sun or moon; and this would be the more true if, as I suppose, the clear avenue in which the spectator stood was V-shaped—wider at the western end towards the moon and narrowing towards the east.

The straight ray of white light tangential to the northern white bow at its west end, which appeared only for a short time, may have been due to a local current of air which turned the majority of the ice-crystals there in a direction which reflected the moonlight; but it is very much more probable that it was the result of some of those intricate effects of refraction and reflection which produce the reversed circles sometimes seen in connection with halos, and those phenomena known as parhelia or paraselenæ, according as they are seen by sunlight or moonlight.

Mr. Stock was very fortunate in having had the opportunity of seeing so unusual and so beautiful an appearance; and the remarkably full and accurate description of the display and of its attending circumstances which he recorded are very much to his credit, and are an example to all observers. Without such a full record it would have been impossible to trace the causes which produced the phenomenon. Whether or not the explanation I have given be quite correct, I am convinced that the cause of the appearance was the moonlight refracted in the ice-crystals, and that the phenomenon was analogous to a halo; although under such peculiar conditions that I confess I should not have *expected* to see it.

Art. LXV.—*Tennyson and Browning: A Retrospect of Victorian Poetry.*

By Professor C. A. M. Pond.

[*Read before the Auckland Institute, 29th May, 1893.*]

It was very soon after the members of the Institute had done me the honour of electing me its President for the current year that I began to be troubled in my mind as to the subject on which I should deliver my presidential address. I understood that I had been elected as, by virtue of my official position in Auckland, in some measure a representative of literature, and it was evident that some phase or aspect of literature must be dealt with in the address given to inaugurate the proceedings of the Institute for the year. But now came the question, What phase or aspect? And that question I found somewhat difficult to answer. A presidential address in an Institute such as this is usually either a retrospect or a summary of the progress of some one branch of knowledge in the years immediately preceding. Now, for many years past the presidential chair of our Institute has been filled by gentlemen who have, either from the theoretical or practical point of view, represented some province of science. And it must be obvious that in this respect the representative of science has the advantage of the representative of literature—the advantage of fact over opinion. In the great and glorious progress of science in this century the most amazing discoveries jostle one another to gain recognition from us, appealing now to our sense of utility in their practical applications, now to our imagination by their sublimity. To the devoted workers of science nothing is too great or too small for their all-embracing scrutiny. Science deals equally with the infinite and the infinitesimal. The composition of far-distant suns and the life-history of the parasite of a parasite are equally the subjects of her investigation, and the results are such as cannot fail to appeal to any man who has a spark of intellect or imagination. A discourse on literature, on the other hand, deals with a subject with which all are more or less familiar, and so loses the advantage of novelty; it does not deal with concrete facts, but rather with opinions about facts, and so, as compared with the directness of science, it is apt to be somewhat vague and intangible; it is subjective rather than objective. To use the language of science, criticism must inevitably be qualitative only, and can never aspire to be quantitative. It can detect the presence of certain elements, but not accurately weigh or measure the proportions in which they exist.

At last it occurred to me, after I had examined and rejected many possible subjects, that in the noble singer whose death at the close of last year was regarded as a national calamity by all the English-speaking peoples I might find the starting-point for the retrospect which I desired. Further consideration led me to hope that by comparing and contrasting Tennyson and Browning I might be able, without making a mere enumeration of Victorian poets, to give a retrospective review of Victorian poetry. The magazines of late have been filled, and overfilled, with what one may call Tennysoniana—anecdotal accounts of the Laureate, written, some by intimate friends, others by Americans who had for once succeeded in intruding on his privacy at Freshwater, or by Englishmen who had once seen him at a railway-station. With these I have no desire to enter into competition. I shall rather aim this evening at examining Tennyson and Browning not as men, but rather as the living embodiments of certain aspects of poetry characteristic of the Victorian era, by discussing their methods, their objects, their ideals, and their views with regard to the great questions which are always present to the mind of man.

I have said the Victorian era of poetry, and I use the term advisedly. For the beginning of the reign of Victoria is practically coincident with the rise of certain tendencies in poetry. It is true that those tendencies have worked themselves out before the conclusion of the reign of the royal lady from whom the period takes its name, but none the less for fifty years were they coextensive with it. To use a paradox, poets are to a great extent at once the creation and the creators of their time, and from either point of view the term Victorian poets is not misapplied.

To appreciate the characteristics of the Victorian poets we must go back to a pre-Victorian period. The eighteenth-century poetry is on the whole vapid and insincere, tainted by an artificial classicism and conventionality. Nothing in English literature is more remarkable than the sudden and vigorous onslaught on this artificiality and insincerity which begins with the closing years of the eighteenth century. There came a return to nature and simplicity; the romantic era dawned once more, and what classic influence was still found was of the spirit and not of the letter. Then came the Lake school, with its great leader, Wordsworth, the contemplative interpreter of the poetry of nature, from whom none of her secrets were hidden; and the mysticism and melody of Coleridge; Scott, with his delight in mediæval chivalry, and that heroic verse that rings like the blare of a trumpet; the sensuous and romantic beauties of Keats; the ethereal raptures of Shelley; the fervid passion of Byron. By 1837 this brilliant band of poets had disappeared. Byron had perished of fever in Greece; Shelley was drowned in Italy; Keats was dead—not, certainly, "killed by the *Quarterly*," according to the not-yet-exploded legend, but carried off by consumption; Scott had overtasked to his death even his magnificent powers; Coleridge, the wreck of his former self, had lived his last few years in an opium dream, and was already dead in 1834. Wordsworth, and Wordsworth alone, remained of a band of poets second in English literature to the Elizabethans only. But Wordsworth's work was done, though even then he had not attained full recognition. The poetry of the time had died away into magazine verse, which was called Byronic, and which, while reflecting his faults and weaknesses, omitted the passion and strength which had raised Byron himself to fame.

The kings of verse were dead. Was there any to succeed them?

In 1827 there had appeared a slight volume of verse entitled "Poems by Two Brothers," graceful and pretty in their way, if somewhat imitative. Very few of the poems contained therein are to be found in any collection of Tennyson's poems—for one of those brothers was Alfred Tennyson, at the age of eighteen—nor did they attract much notice. Soon, in 1830, appeared another volume "Poems, Chiefly Lyrical." Accustomed as we now are to nobler and grander music from the same lyre, such poems as "The Merman" and "The Owl," "Claribel" and "Lilian," may be read by us now without any great enthusiasm. They are evidently over-elaborate, too full of effort, and not devoid of affectation—the poems of a young man gifted with an eye for richness of colour and harmony of detail, but not yet skilled to give adequate expression to that which he saw clearly enough. And yet, slight as they were, they were different from preceding work, and different not in degree but in kind. Whereas the earlier poets of the century had aimed at grand general effects, here was a young poet who aimed first of all at beauty of detail only, who, recognising that poetry was truly an art, was content first to apprentice himself in order to master the technical detail of his craft, and who, as Stedman says, "wrecked himself upon expression for the expression's sake."

It is in the volume published in his twenty-fourth year that young Tennyson seems first definitely to feel his strength, and I do not think it is altogether by accident that in that little volume the first place is given to "The Lady of Shalott." The Lady of Shalott dare not look upon life, but only upon the shadows of life reflected in her magic mirror; and now—

> "I am half-sick of shadows," said
> The Lady of Shalott.

She looks out upon the world as it is, and she dies in consequence. So with the young poet. He has hitherto dallied merely with the shadows of life, with dreams and fancies, which, for all their richness and beauty, were still nothing but dreams. He now looks forth upon the world as it is, and in doing so finds not a curse but a blessing. And if, in the same volume, he describes the land of the lotus-eaters where "slumber is more sweet than toil," it is only resolutely to turn his face from it.

It is not my intention to trace Tennyson's poetic career by the milestones of his successive volumes. The "English Idylls," "The Princess," "In Memoriam"—to my mind his most characteristic work—lead up to his acceptance of the laureateship in 1850. It was then that, at the death of Wordsworth, he received, to use his own words, the

> Laurel, greener from the brows
> Of him that uttered nothing base.

Then, after "Maud," comes the commencement of the "Idylls of the King," that wonderful series of pictures which has been in hand in one way or another more than forty years, which began with the end, was continued with the beginning, and finished with the middle. They are like a series of stained-glass windows in some great cathedral, whose design the artist had in mind from the first; but in his execution he follows no order—he inserts one here and another there—and the people, while admiring the individual windows, are puzzled as to the general design. It is only when transpositions have been made, and the last two or three windows added in their proper places, that it is seen that they are not only beautiful individually, but now form an intelligible and connected series, noble in design, admirable in execution.

The rest of his works may be summed up as efforts, to my mind unavailing, on the part of Tennyson to prove that he possessed that dramatic power which his critics denied him.

The contrast which may be drawn between Browning and Tennyson on almost every point begins almost with their birth. Born as they were within three years of each other, the elder, Tennyson, was born and brought up at a quiet Lincolnshire parsonage. Browning, on the other hand, first saw the light in what was at that time a rural suburb of London—Camberwell—tolerably tranquil itself, but only some four miles distant from "streaming London's central roar." As I have said, the first work really characteristic of Tennyson appeared in his twenty-fourth year. When Browning was of the same age there appeared his "Paracelsus"; and this, his first work, is as entirely characteristic of him as anything that he has written at any time since. For some time his work was cast in a dramatic mould. The somewhat commonplace "Strafford," and that decidedly not commonplace, but chaotic and incomprehensible, "Sordello," were followed by a series of less pretentious dramatic works, many of which are not without their charms. In fact, "Pippa passes" and "Colombe's Birthday" rise to a high level of literary excellence. It was in 1845 that Browning, disappointed with the reception of his dramas, bade farewell, for the time being, to the direct dramatic method. To that method he has never returned.

I said "to the direct dramatic method," for in most of his later work the point of view is that of the dramatist, dealing, however, not with groups but with single figures. Fifty of these portraitures are contained in the "Men and Women"; "Dramatis Personæ" forms an addition, in number considerable but not great in value. It is by no means worth while to enumerate Browning's work after 1860. It contains much that is worthless, much that is singularly great, but nothing new in kind; from the beginning Browning is Browning, the most original and the most unequal of the poets of our century.

From this most inadequate sketch of the rise of the two leaders of the Victorian schools I now pass to that comparison and contrast of their art, their aims, their opinions, and their thoughts from which I hope to bring into prominence those features of Victorian poetry which seem to me most characteristic. More than a sketch I cannot attempt, but I hope that the broad outlines of the sketch will be sufficiently clear.

Assuredly there have never been two contemporary poets whom a critic might more fairly examine by the method of contrast than Tennyson and Browning. Throughout their careers we find the most curious points of likeness and unlikeness. Had some mighty genius, competent for the task, attempted to embody in the characters of two poets two opposite tendencies in art and thought, he might have drawn a Tennyson and a Browning. Like in their unlikeness, unlike in their likeness, the opposition in which they stand seems the work rather of art than of nature.

Examine briefly the career of each of them. Both have lived long, both chose the office and function of the poet above all others, both were poets pure and simple, neither of them writing or publishing a word of prose. And yet the contrasts are greater. Tennyson at once attained a recognition so full, a success so complete, that every successive work which did not surpass its predecessors was regarded as a failure. Browning, long without recognition, struggled to success by a series of failures. Browning began by writing dramas, but abandoned the dramatic method for portraiture. Tennyson began as a lyric and idyllic poet, but ended as a writer of drama. And yet with neither were the dramas written good stage-plays —successful, that is, upon the stage under ordinary conditions, without the glamour of a great name to aid them. For many years no one would have thought of comparing Browning with Tennyson except to the disparagement of the former; but in the last twenty years Browning's audience, "fit though few" at first, has grown rapidly, and, if Tennyson has the larger number on his side, Browning has the finer spirits. Tennyson is admired, Browning worshipped; the followers of the one form a school, of the other a cult. To whom posterity will assign the superiority I do not know, but this I am sure will form part of the verdict: that, if Tennyson was the finer artist, Browning was the more original thinker.

I spoke of Tennyson as the finer artist. We have now to contrast them from the point of view of art. For poetry is an art, not of "sentimental caterwauling" as Huxley once said, but of giving expression, in metrical form, to any thought having relation in any way to man, in such a way as to enhance its beauty. I pointed out a few minutes ago how Tennyson's early work arrested attention because of its artistic beauty of expression. In exquisite finish no poet in any literature has ever surpassed him. As an artist in metre he is supreme; more than that, his supremacy was at once accepted. The insipid sentimentalities of the Byronics disappeared at once, and the minor poets at once began to mould themselves upon Tennyson. Henceforth, with such a master to show them how it should be done, slipshod work was impossible.

If we open a volume of Tennyson, we can hardly help noticing how one form of poem predominates. "English

Idylls and other Poems," "Idylls of the King," actually bear the word "idyll" on their forefront; and others, like "Enoch Arden" and "Aylmer's Field," are not less idyllic in tone. Throughout the greater part of his career Tennyson's most important work has been cast in the form of the idyll. What, then, is an idyll, and what is meant by an idyllic poet?

The word "idyll" in its origin means "picture," and the idyllic style was discovered by Theocritus in the second century B.C. His "idylls" are little pictures of the joys and sorrows of country life, the life of the shepherd, the hunter, the fisherman. The idyll, then, is essentially pictorial and descriptive. It does not confess the deepest secrets of the individual soul like the lyric; nor, on the other hand, does it allow the character to depict itself in action—that is the function of the drama. The idyllic style stands outside that which it pourtrays. The idyllic and the dramatic schools in poetry stand in the same relation as the landscape and portrait schools in painting.

Now, there can be no doubt that in choosing this style Tennyson accurately recognised the limitation of his own powers. It was exactly suited to him in every respect. In thought his master was Wordsworth, in art principally Keats, though at the same time in his art he was eclectic, ranging over all times and all literatures, and selecting with admirable taste that which best suited him. The poetry of passion was for the time exhausted. Tennyson is the poet of repose and restraint, mastering his subject thoroughly and never allowing it to master him. In all his work he shows the perfection of proportion and good taste. With him there is not, as there is, for example, with Byron, any hurried work, any poem begun without any definite idea as to how it is to end. Every piece of work is filed and refiled, polished and repolished, until it stands flawless, smooth to the nail. At the same time this very perfection is a limited perfection. If Tennyson's restraint and repose prevent him from falling below the level, they also prevent him from rising above it. He lacks those glorious spontaneous outbursts which electrify us in Byron. I do not in any way blame Tennyson for not attempting to transcend the limitations imposed on him by temperament. He shows his intense feeling for art in not attempting what lay beyond him. At the same time a distinction must be made. A carved gem may be a more finished work of art than a noble statue, and yet there will remain no question as to which is the grander.

Let us now turn to the other side. I have just shown how Tennyson owed his first successes to his mastery of the technique of his art. In Browning we have a man who from the first was a rebel against form. The limitations imposed by form in which others delighted were to him trammels and fetters. And therefore in his method he has shown himself not merely eccentric—eccentricity might be pardoned—but actually perverse. And this perversity will bring its own reward. To sin against a law of nature means destruction: to sin against a law of art means neglect, and to neglect a large portion of Browning's work is doomed. He possesses a mighty intellect, of a most original cast; he owes allegiance to none, and none can call themselves his sponsors in art. But he lacks that restraint which has made Tennyson's art what it is. He is mastered by his theme, and it runs away with him. In working out that theme, the thought grows and ramifies in his subtle intellect into infinite variety of detail, and not one detail will he spare us. And so he goes on involving one parenthesis in another, until we are wearied by the constant jerking of our attention from its proper track. This is one element in his undoubted obscurity. The other main element is due, I think, to his surprising alertness and quickness of thought. The problem which we might solve in five or six steps he completes in two, and is already off on another train of thought before we quite realise that the first is finished. Thus it is he offends in both ways: he is at times tediously garrulous upon nothings, at other times wearingly compressed and crabbed upon thoughts of the greatest import. Just that sense of proportion which is so eminently characteristic of Tennyson is entirely lacking in Browning. He insists upon neglecting the expression for the thought, not perceiving that it is the expression which gives, as it were, the stamp to the blank gold of the thought, and makes it once for all current coin. And yet he seems to have known this principle, but to have refused to apply it. If only he would have accepted for himself the words he addresses to another!—

> Song's our art:
> Whereas you please to speak these naked thoughts
> Instead of draping them in sights and sounds.
>
> * * * *
>
> But here's your fault: grown men want thought, you think;
> Thought's what they mean by verse, and seek in verse:
> Boys seek for images and melody,
> Men must have reason: so you aim at men
> Quite otherwise!

Thus it is, I think, that Browning is at his best in his smaller pieces, where the theme is naturally limited. Here his fine gifts show themselves to their best effect. And how fine his gifts are! Look at the fun and humour of "The Pied Piper of Hamelin"; or the magnificent stride of "The Ride from Ghent to Aix"; the passionate pathos of "The Lost Leader," or the sweet pathos of "Evelyn Hope." What lyric could be imagined more pure and serene and melodious than the last I have mentioned? This, at all events, is not written in that tooth-splintering jargon which disfigures so much of Browning's work, and of which it might well be said —as De Quincey said of Bowles's verse—that it ought to be boiled before it could be read. I have no hesitation in saying that the seven stanzas of "Evelyn Hope" are worth the whole 11,000 lines of the chaotic "Sordello."

Tennyson, then, is a lyric and idyllic poet, the direct inheritor of Keats and Wordsworth. He proceeds by the pictorial method, making his scenery suggest or support the central idea. Browning is more original: starting for himself, he constitutes himself the poet of the soul of man. He is a psychologist, but working objectively. He has the art of piercing at once to the innermost soul, of arresting the master passions one by one, and forcing them to reveal themselves. Tennyson has to some extent tried the same method; but his "St. Simeon Stylites" and "Ulysses" and "Tithonus" seem to me, fine as they are, but thin analysis compared with Browning's robust and vigorous presentments. And this leads us to consider another ground on which both poets meet—the dramatic.

To my mind, neither of them has been successful in the drama proper. Both have failed, but not for the same reason. How should Tennyson work a real drama? Whence is to come, in his case, the knowledge of that mingling of action and passion which gives dramatic interest? All his years have been passed aloof from the storm and stress of life; his whole nature shrinks from them. His career has been easy and fortunate, his life retired. But a dramatist must know men as they are, not men as they are depicted in books. And therein alone, apart from temperament, Tennyson must have failed as a dramatist. As a matter of fact, he has carried the idyllic method on to the stage, and given us—as Stedman well says—a series of tableaux, or dramatic pictures, instead of dramatic action. His work is pleasant reading for the study, but not really adapted for the stage. The aid of a great actor, the dictates of fashion, the high reputation of the author, may enable his "Cup" or "Becket" to keep the stage for a time; none the less they are intrinsically failures, or, at all events, nothing more than a *succès d'estime*.

Browning, on the other hand, though in some of his finest work he pursues the dramatic method of embodiment of some great passion, which he makes to pourtray itself, yet fails in that portion of his work which is cast in the dramatic mould. He has the necessary knowledge of mankind—not Shakespeare himself had more piercing insight. Wherein, then, does he fail? In two points, as it seems to me: firstly, in that his characters are creations of the intellect, instead of the sympathy of the artist; secondly, in that he cannot stand outside his characters—he cannot represent them objectively. Peasants and kings, old men and maidens, all are animated by Browning, and all, unhappily, are liable to speak Browningese. With Shakespeare, one may say that Hamlet said this or that, or Othello said that, but not that Shakespeare said either; but with Browning, whether the mask be Paracelsus or Pippa, it is Browning speaking through it.

There is one further point in which I desire to oppose Tennyson and Browning. I have discussed their art: now as to the materials of their art—their thought.

It is very evident that this is a question on which a volume of essays might be written. At the same time it is, I think, possible to put the fundamental differences between them into a few words. Tennyson would bring passion in all its forms under the rein of law. Browning would give the rein to passion. The one advocates control, the other free play. Of course, statements like these can be but half-truths only. They need a somewhat longer consideration.

In that volume of poems which I adduced as the first real representation of Tennyson, in the poem of "Œnone," are the following words, which form the keynote of all Tennyson's poetry :—

> Self-reverence, self-knowledge, self-control,
> These three alone lead life to sovereign power:
> Yet not for power—power of herself
> Would come uncalled-for—but to live by law,
> Acting the law we live by without fear;
> And, because right is right, to follow right
> Were wisdom in the scorn of consequence.

That, as I said, seems to me to sum up the whole ethical position of Tennyson—"to live by law." It crops up in various forms throughout the whole of his works. Thus we find it controlling his own art. His poetry is to have some moral restraint, not a merely sensuous passion for beauty—

> —— such as lurks
> In some wild poet, when he works
> Without a conscience or an aim.

"Energy nobly controlled," says Professor Dowden, speaking of Tennyson in this aspect, "energy nobly controlled, an ordered activity, delight his imagination. Violence, extravagance, immoderate force, the swerving from appointed ends, revolt—these are with Mr. Tennyson the supreme manifestations of evil."

Thus it is in religion: to him God is the supreme lawgiver rather than the supreme friend; with ecstasy or mysticism he has no sympathy. When the Holy Grail descends, and the Knights of the Round Table swear to follow it, Arthur, the kingly embodiment of law and order, upbraids them with following "wandering fires." Their vows are sacred, they must go; yet how often now, instead of "laying the sudden heads of violence flat," and splashing "the strong White Horse with his own heathen blood"—

> This chance of noble deeds will come and go
> Unchallenged, while ye follow wandering fires,
> Lost in the quagmire.

It is the same in politics. England, the land of law and order,

> Where freedom slowly broadens down
> From precedent to precedent,

is always contrasted with

> —— the schoolboy heat,
> The blind hysterics of the Celt.

Look, too, at the close of "The Princess." The passage is too long to quote, but the contrast between England and France is even more strongly put. So it is elsewhere. In the "Ode on the Death of the Duke of Wellington" the characteristic of the dead hero especially insisted on is his submission to duty. For him

> The path of duty was the way to glory.

On the other hand, with Browning it is not law but passion and aspiration which are supreme. Life is to have its full and free development. It is the main idea of his first work. Paracelsus aspires to the highest pleasure, the highest knowledge, and fails. But Browning constantly insists that he does not fail. So long as a man does nothing contrary to the law of his nature his failures in lofty aspirations may be and are higher and nobler than a meaner success. This principle is always present with Browning, and it will explain, I think, the difference between the art of Browning and Tennyson. It is now seen to be a fundamental difference of principle. Tennyson, restrained by law, feeling the laws and limitations of his temperament, will do nothing beyond them. Browning, not perhaps less aware of his limitations, will aspire gloriously, even if he fail, for his failure will also be glorious. Better a noble failure than a mean success.

> That low man seeks a little thing to do,
>   Sees it and does it;
> This high man, with a great thing to pursue,
>   Dies ere he knows it.

To aim at a million and miss by a unit is better than to gain a hundred by adding one to one. So it is in art. With Browning,

> He is all fault that hath no fault at all;

and in one of the best of his "Men and Women," Andrea del Sarto, the so-called faultless painter, confesses that his faultlessness is the work of the craftsman rather than of the artist. Rafael's drawing is not so good as his :—

> That arm is wrongly put,—and then again—
> A fault to pardon in the drawing's lines—
> Its body, so to speak ; its soul is right ;
> He means right—that, a child may understand.
> Still, what an arm ! and I could alter it,
> But all the play, the insight, and the stretch
> Out of me, out of me.

One point more and I have done. What is the general tendency of their thought? In answer I should say that both are profoundly optimistic ; both alike believe that mankind is progressing to something nobler. Tennyson, however, while liberal in theory, is, owing to his love for law and order, conservative in practice. He can look forward to the war-drums rolling no longer and the federation of the world, but he does not altogether like the preliminary steps, and is ready to acquiesce in things as they are. Tennyson looks to the progress of society ; Browning, on the other hand, looks for the progress of the individual, through aspiration and free play of passion, until there is accomplished

> ——the ultimate angels' law
> Indulging every instinct of the soul,
> There where law, life, joy, impulse, are one thing.

Such are, in a few words, the views of these great poets upon life. A little examination will show that their views, opposite as they seem, are not so much opposite as complementary. Truth is one, but wears many aspects ; and each of them insists upon truth as he sees it from his own standpoint.

I have throughout dwelt upon the clearly-marked differences between the two men. Let me, in conclusion, point out the curious similarity in the little poems in which each, in extreme old age, contemplates the death that must soon meet him—Tennyson's "Crossing the Bar" and Browning's "Epilogue to Asolando." Each can behold death nobly, tranquilly, serenely. Short as they are I prefer to leave you to read them for yourselves rather than to quote them. When the "clear call" comes for Tennyson there is to be "no sadness of farewell." Browning is even readier for death: in words as noble as have ever been written, he will "greet the unseen with a cheer."

Art. LXVI.—*The Date of the Extinction of the Moa.*

By H. C. Field.

[*Read before the Wellington Philosophical Society, 1st November, 1893.*]

During the discussion which followed the reading of Captain Mair's paper,* on the 5th October, 1892, on this subject, illustrated by translations of Maori traditions respecting the bird, I said that my own impression was that the moa became extinct at widely different dates in the various parts of the colony; that north of Auckland, where the land was narrow and densely peopled, the whole of these birds were soon killed off, so that the missionaries seem to have heard nothing about them (though Mr. Polack, who seems to have seen some of the bones, did so, and in his "New Zealand," published in 1838, expressed his belief, from Maori statements, that some still survived); that when the missionaries visited the east coast of this Island they also saw bones and heard of the bird, though under a different name; and that it was not until the Rev. Richard Taylor came to Wanganui, and found the bones in considerable quantities (particularly at Waingongoro), that the name of "moa" became attached to the bird. I also referred to assertions of these birds being heard or seen by Europeans and Maoris at comparatively recent dates, both in this and the South Island; and in reply to our President, Sir W. Buller, I said that it was a pity that the doubt as to the recent existence of the moa had not been started in the early days of the colony, because forty years ago plenty of evidence could have been got from old Maoris who had hunted and eaten these birds, and were perfectly acquainted with their habits; and I promised to collect any information now available on the subject. I now therefore put before you several pieces of evidence, arranged according to the apparent dates at which the birds referred to in them were alive.

The first is a letter which appeared in the *Wanganui Chronicle* of the 5th October, 1890, arising out of the discovery of some moa-bones near Wanganui having given rise to some local discussion as to the living birds; and, in reply to my inquiry as to the probable date of the feast referred to, Mr. Rees said he did not know exactly, but inferred, from the Maori statements, that it had taken place apparently between the years 1820 and 1830, at Te Heuheu's place, Tokaanu, the southernmost part of Taupo Lake. Te Heuheu and his pa

* See Trans. N.Z. Inst., vol. xxv., p. 534.

were destroyed by a landslip in 1846, while, by Maori accounts, he was still not more than a middle-aged man, which again fixes the date approximately.

TO THE EDITOR.

SIR,— Wanganui, 5th October, 1890.

In about the year 1850, when residing with Mr. Samuel Clarke, at Waipuna, on the Tamaki River, near Panmure, a Maori from Taupo happened to be staying there. This Maori was about forty-five years of age, and a very intelligent specimen of the Maori of those days, but I forget his name. He told Mr. Clarke and me that he was invited amongst his people to a feast at Taupo, at Te Heuheu's place, where there was to be a moa supplied as part of the feast. However, he said that his party did not arrive until the feast was over, but he saw the skin of the moa lying in a large kit in one of the *whares*. He said that the skin was as large as the hide of a big ox, and covered with tufts of hairy feathers, and long hairy-like feathers hung down from the head, with the appearance of horse-hair. He afterwards drew a moa on a slate, describing it as about 14ft. high, and generally standing on one leg, and facing the wind, making springs of 30ft. or more at a time. A kick from the moa, he said, would kill any man. The Maoris caught them with snares made of stout ropes. I am, &c.,

G. C. REES.

The next is part of a letter which appeared in the *New Zealand Herald* of 31st October, 1892, from a gentleman who had written to me to the same effect in the previous August. After mentioning that he had seen in a newspaper a reference to what I had written on the subject, he says,—

In the seventies I was practising as a solicitor in London. Among my clients was a Mr. Robert Clark. The matters in which he required my services necessitated frequent interviews between us, both at my offices and his house, and these interviews led to a most sincere and cordial friendship springing up between us, which was only severed upon my leaving England with my family to come out here. When I first mentioned to my friend my intention to emigrate to New Zealand, he said, "Why, I was there over forty years ago (this was about 1870), and can tell you something about that country"; and he added, "I believe I am the only white man living who has seen a live moa." I need scarcely add how interested and astonished I was, and I asked him to write me his experiences in New Zealand (he passed several years here). At first he was not inclined to take the trouble; but, however, when he found the time draw near when we must bid each other farewell, probably for ever, his kind old heart got the better of him, and he promised me a full account of his rather remarkable life as a parting gift, writing as minute an account as he was able of the moa; and at nearly our last interview he handed me a bundle of manuscript neatly written, and I now extract the following from it regarding that most interesting subject, the moa: "The weather continuing stormy, to pass the time away (until the storm abated, and they could get off in their boats), my mate proposed we should travel inland, taking our muskets, and seeing if we could pick up a few wild birds. We had been out for some time, but nothing whatever showed itself: whilst scrambling amongst bushes and underwood on rather high ground, and looking down to a green patch of about 100ft. long by 40ft. broad—this patch could not have been better kept in order by an experienced gardener—stood an immense black bird of a beautiful form, long legs, long neck, with a rather small head for so large a bird, piercing eyes (rather large ones), a small beak, having from each side red comb, with a very small crest of a comb on the centre of the head; altogether, I should say, in height 12ft. Being only about 100ft. from him, and looking down, as he was below us and therefore foreshortened, he stood still looking at us, as if surprised. My mate said, 'We must have a slap at him, and we will fire together. Are you ready?' 'Yes.' 'Then let fly!' The bird took to his heels towards the end of his pleasure-grounds—the grass-plat—dived down, and entered an open clearance in a thick mass of bushes, no doubt his place of roost. We did all we could to get near him, but the scrub, bushes, and other impediments hindered us so that we had to give it up." From what Mr. Clark says further on, the natives regarded the bird as very uncommon. In conclusion, I may say I feel sure we are very far from knowing all the wonders of this magnificent country yet, and there is a splendid opening for the bold explorer, as I believe other animals exist that are at present unknown to us. I am, &c.,

Mount Roskill. FRED. A. G. COTTERELL.

Mr. Clark's statement would give a date for the existence of the bird corresponding with that mentioned by Mr. Rees, and with that which all the old Maoris hereabouts always named, as that of the extermination of the moas in this part of the colony.

Mr. William Stanley, formerly of Motueka, tells me that, when his family went to reside at that place, there were so many moa-bones in the caves thereabouts that it seemed as if each cave must have been occupied by several birds, either at the same time or in succession, but that, in a few years, these bones all decayed and crumbled away. This would be between the years 1840 and 1850; so that the moas had apparently existed in that part of the colony certainly during the present century.

Mr. Alexander Murray, of Wanganui, states that he came to Wellington in 1841, being at that time a lad of about sixteen years of age. In September, 1842, he and his father were sawing timber for Mr. Gollan, in a gully on the eastern side of Wellington Harbour. There were a number of men (probably twenty or thirty) so engaged, and they lived, some in tents and some in huts, close to where they were working. Early one morning all hands were aroused by a loud roaring cry, evidently close at hand, and some of them turned out to try and ascertain its cause. It was too dark to see anything, but they heard some large object moving off through the bush. When the Maoris were informed of the circumstance they said that the cry must have proceeded from a moa, which they described as a large bird, far taller than a man, and that it had, no doubt, been alarmed by the camp-fire. Mr. Murray says that this was the first time that he ever heard of the existence of such a bird.

During the discussion on Captain Mair's paper, Mr. Maskell spoke of the immense number of moa-bones scattered on the surface of the ground in the South Island when the settlers first arrived there, and their rapid disappearance afterwards. I have heard the same thing from my cousin, Mr. Strickland Field, who went to Canterbury in 1851. He mentions one instance in particular, in 1852 or 1853, when he and his brother found, apparently, the whole of the bones of a medium-sized bird, where it had seemingly lain down and died, beside a large flax-bush, at St. Albans, near Christchurch. I happen to have always grown a few bushes of the very best kind of *Phormium tenax* (that called by the Maoris of this part *tihore wharariki*) for the last forty years, and, as the result of my experience, I can say that the life of a flax-bush does not exceed from twenty to twenty-five years. Long before that time it becomes hollow in the centre, and divides into several smaller bushes, preparatory to dying out altogether. All my original bushes have been dead for many years, and I renew them by planting fresh fans from time to time. The position, therefore, in which these bones were found bears out the opinion formed by my cousins at the time, that from their freshness and soundness the bird could not have been many years dead. My cousins collected the bones and carried them to Christchurch in a sack, which they placed among some shrubs in their father's garden. Six or eight years later, when moa-bones were being sought for as curiosities, they looked for the sack and its contents, and found that the whole had completely rotted away.

I have taken notice of late, and made inquiry from others, as to the time it takes bones of animals to decay and disappear, and I find that it varies greatly according to soil and situation. I am assured that, on the top of a high dry ridge, where there is but little soil, bones will last for twenty or thirty years, while on the flats near my own residence there is no trace of such bones even after five or six years. I find that large bones, like those of a horse or a cow, somewhat shade the ground, promoting the growth of grass, and causing worms and beetles to establish themselves beneath them. From these two causes, and particularly from the burying-operations of the latter, the bones soon sink into the surface and decay, nourishing the grass and being absorbed by it in the process. From the cellular structure of moa-bones, it seems to me that they would decay far faster than those of an ox or horse, so that those seen in Otago and Canterbury in the early days of those settlements must have belonged to birds that had not been very long dead.

In October last I mentioned that I had received information from Major Lockett, an ex-officer of the Imperial Forces, which indicated that the moa still existed, in the Nelson Province, certainly up to 1857 or 1858. On my return to Wanganui I got the Major to give me the following memorandum on the subject. He has told me in conversation that, from his having hunted a good deal in India, he is quite sure that the sounds which he heard were not produced by any quadruped.

MEMORANDUM.

Shortly after the commencement of the Collingwood (Nelson) diggings, I started one evening, rather late in the day, to walk over the range that divides Riwaka from the Takaka. On arriving at the top of the range, I proceeded about half a mile, when I found that it would soon be dark. I determined to camp where I was. I lighted a fire and rolled myself in my blankets, and went to sleep. How long I slept I know not. I was awoke by hearing a most unearthly scream close to me, and apparently some feet from the ground. This noise was followed by a drumming sound—similar to that made by a woodhen, but louder and gruffer. The scream I speak of was more of the nature of a roar, and different from anything I had ever heard. I immediately seized my gun and stood on my feet—when I distinctly heard something walking away. I immediately followed, but as my fire was almost out, and the dark clouds overshadowed the moon, and knowing there was some precipitous ground in the vicinity, I returned to my camping-ground. In about half an hour the noise was repeated, at a distance of 400 or 500 yards. In a few minutes this roar was replied to by a similar one, from the sandy-bay side of the range, distant more than a mile; from what source this noise came I have not the slightest idea. On returning by the same route I stayed with a Mr. Cook, a Riwaka farmer, and mentioned the circumstance to him. He had been for many years residing on this farm, and he informed me that he frequently heard the same roar, and was unable to conjecture what it was. There was a Maori sitting in the room where we were talking, and, having been a whaler for many years, talked English as well as I did. He remarked, "I know what it was—a good many years ago I saw some—it is a large kiwi, as big as this"—standing up and holding his hands aloft. Mr. Cook informed me that this Maori, known as Tommy Brunner, was a thoroughly reliable man, and what he said could be depended upon. This is simply all I know of the matter. I am quite sure it was no four-footed animal, from the height the noise seemed to come.

About twelve months afterwards four English emigrants arrived, wearing the smock-frock then worn by farm-labourers. They proceeded to Golden Gully looking for work, and shortly afterwards went some miles further on—prospecting, I presume. They returned in great alarm one day, stating that they had come suddenly upon an enormous bird standing at the entrance of a cave or hollow on the hillside. They described the bird as standing about 8ft. or 9ft., of a brown colour, with a red mark round the eye. With the greatest difficulty we persuaded them to show us the spot where they said they had seen the bird. A party was formed, and remained and examined the cave and other places for the period of two or three days. A number of caves were found, but not all explored. In conclusion I may state that these countrymen had seen or fancied they had seen something, for they were thoroughly frightened. On inquiry we found they had never heard of a moa; and, judging from their manner and conversation, I do not think they could ever have been twenty miles from their home. They were all large able-bodied men, but thorough country-bumpkins, and quite unable, I should imagine, to invent such a story. And the fear they showed proved that something had frightened them. JOHN LOCKETT.

The Maori, apparently, did not know the bird by the name of "moa"—only as a wingless one, like the kiwi.

I also mentioned that I had been told by a person in Wanganui that his brother-in-law had seen two moas somewhere in the Rangitikei district, and apparently inland of Marton or Hunterville, and that on writing to this man Olsen (one of the Danes who came out with Bishop Monrad) I got more reliable information. His letter is as follows:—

SIR,— Egmont Village, 17th March, 1892.

You must excuse me for not answering your letter before, as it got mislaid. Mr. A. Harrison informed you that I had seen two moas, but it's wrong; it was a friend of mine who saw one. There were twelve or fourteen other men who saw it at the same time, and it frightened the life out of the lot of them. They cleared for their bare lives, so he told me. He said that he was frightened when he saw it come out of the bush and walk across the clearing as well as them. These other men said nothing about it that I know of; as they were up there on the quiet a-prospecting. There was a great depth of snow on the ground at the time: it was coming on winter. This friend of mine his name was Sutherland. He was a man that any one could speak after. How he came to see it—he got some land up there off the Maoris, and was a-going sheep-farming, but he only got one season up there. In the winter he told me there was from 3ft. to 4ft. of snow on the ground, and the wild pigs devoured all the lambs. The locality is about sixty miles up the Rangitikei River, on this side. If I were where he was I could tell you just the place where the bird was seen. After he had seen the bird he came down that sixty miles on purpose to get a rifle and sixty rounds of ammunition. He stayed with me a night or two till he got what he wanted, and then went back. He told me his intention, if ever he saw it again, he was a-going to shoot it. He described the colour and height of the bird well to me at the time. He said it must have stood 16ft. or 17ft. high, and the body a tremendous size. The colour of it was speckle or greyish colour, with a woolly look. He would not forget the colour, as he must have seen it so plain.

Now, that happened just twenty-two years ago this coming winter. You can depend upon this as true to the best of my belief. I have given all the information I can about the moa that I got from the man who told me that he saw it. Now, if you think it worth your while to find Sutherland, he is somewhere in the country, I suppose. It's only twenty-two years since I saw him. I think I have sent you all I know.

I remain, yours respectfully,

To Mr. Field. H. OLSEN.

As I happened to know of this man Sutherland as having resided in the locality described, I made inquiry about him, and learnt that he was dead. I, however, found that he had left a son, whom I saw. The young man told me that he had no recollection of his father having mentioned that he had seen a moa, but that he had repeatedly heard old Maoris speak of them as existing in their younger days, and as having disappeared through the wild pigs destroying their eggs, and the large dogs, introduced by the whalers, having killed the young birds—causes which seem very likely ones to have led to such a result.

The following appeared in the *Wanganui Chronicle* of 17th June, 1893:—

On Tuesday Mr. Drew received a valuable contribution to our local Museum in the shape of the bones of perhaps the most perfect example of a moa yet found in New Zealand. The bones were exposed among the sandhills between the Turakina and Wangaehu Rivers by a late gale, and, having been noticed at once, have been brought to Wanganui in a very perfect condition. Though the skeleton will only stand 4½ft. high, it is evidently that of an adult bird of a small variety of moa. This is proved not only by the hardness of the bones, but by the fact that, along with them, were many fragments of the shell of an egg, which must have been nearly hatched, as there were also bones of the young chick. It would seem as if the bird had been overwhelmed by the drifting sand while sitting on her nest. Even the bones of the head are complete, which is a very unusual circumstance, as from their fragility they usually get broken as soon as exposed to the weather and the trampling of stock. Along with the bones are the harder portions of the windpipe, which, we believe, had never been previously found under similar circumstances, and seem to point unmistakably to the bird having been alive at a comparatively recent date.

There is an inaccuracy in the report, the bones having been found on the other side of the Wanganui River. It is the only instance in which I have known of tracheal rings being found with moa-bones; and fragments of egg-shells are not often met with in this part. Only a few weeks ago the bones of a moa were found in a cave near Eketahuna by a party of roadmen, who divided them among them, instead of having the sense to collect them carefully and offer them for sale to some museum or collector of curiosities, as a perfect skeleton. I believe that, even when found, many skeletons have been destroyed or dispersed, owing to the ignorance of the finders.

I never could understand how the idea that the moa had been extinct for ages had arisen, since it seems to me that all the real evidence on the subject points to their having survived to quite a recent period—if, indeed, there may not be some in existence at the present day.

In a letter which I received from Professor Hutton, in September, 1892, he said that "in 1866 a smart New-Zealander got up a company in London to catch moas on the West Coast." This indicates that at that date there must have been a very strong belief in the survival of the birds in that locality; and I remember Mr. G. Roberts, Government surveyor, telling me of one reported to have been seen there at even a later date, I think by some of his own survey party, on the opposite side of a flooded stream. The birds have been repeatedly reported as having been seen on the West Coast.

I was much struck by Mr. Tregear's paper on this subject in last year's Transactions, because the circumstance mentioned by him seems to me to point in the diametrically opposite direction from that which he appeared to think that it indicated. In my early days I read that the domestic fowl was introduced into the South Sea Islands by the missionaries, and, as I have never met with any statement to the contrary, I believe the information to be correct. If, then, the natives of those islands, on seeing a bird of larger size than the other land-birds with which they were acquainted, and with only imperfect powers of flight, gave it the name of "moa," it seems to me that they must have had, in some way, a tradition of a struthious bird, so called, having formerly existed, either in the islands or in the country from which they themselves had come. I see no reason why all the Europeans (mostly uneducated men), who would not be likely to have heard of the moa, who, from time to time, have asserted that they have seen gigantic birds in the colony, should be set down as liars, or why the Maoris should be credited with having invented yarns about the birds to please us pakehas. If the Maoris never saw the bird, how should they have known that the bones belonged to one, and not to a mammal? and how should they have been able to describe its appearance and habits so correctly? I noticed that several of the traditions quoted by Captain Mair mentioned the birds as living in caves, and having red eyes or heads. The frequency with which the bones have been found in caves might give rise to the former idea, but certainly not to the latter; yet it is corroborated by passages in the letters of Mr. Cotterell and Major Lockett; and in the travels of a Swedish naturalist, named Helmholz, who visited Australia a few years back, I read that the Queensland cassowaries, or some of them, have red heads, and are nocturnal in their habits, hiding themselves in the thickest forests during the day. It is curious that all the Europeans who have reported having seen the birds seem to have spoken of doing so either in the evening or very early morning, and that what appears to have been their cry was also only heard at night.

It was from the Maoris that we learnt that the curious little heaps or groups of quartz pebbles scattered about the country were the crop-stones of the moa. But for the fact that they called these collections of white pebbles *puku moa* (moa's stomachs), and so led us to inquire, I doubt whether the reason of such pebbles being always found in such clusters, and so only, would have been likely to occur even to highly scientific men, though the fact of the stones being so collected had attracted general notice. Forty or forty-five years ago the Wanganui Maoris spoke of the existence of the bird in the vicinity of the Ruahine Range as a certain fact, and some years later a party who had gone up the Oroua River on a prospecting expedition asserted that they had seen a bird answering to the description.

Again, when I mentioned that an old Maori had described the bird to me, fully forty years ago, as fighting by standing on one leg and striking forward with the other, Sir W. Buller said that this was the practice of all the struthious birds; and his words were corroborated last February by Mr. Bramley, the former curator of the Botanical Gardens at Wellington, who told me that he had had his clothes thus torn by a cassowary, which was formerly in the Gardens, when it was being shipped away; but how should a Maori have known of this practice unless acquainted with the bird? There is also a correspondence between the Maori and European statements as to the general colour of the bird, and the hairlike appearance of its plumage, and an agreement, in both cases, with that of cassowaries, which could hardly have arisen except from the narrators having really seen the birds which they professed to describe.

I think it would be well if some member of the Westland branch of the New Zealand Institute would take the trouble to collect the various notices which have been printed from time to time respecting moas being seen on the west coast of the South Island, and any other information on the subject that can now be obtained there; as the subject is an interesting one, though, perhaps, not of any practical value.

Art. LXVII.—*Note on a Curious Maori Flute in the Collection of the late Dr. Shortland.*

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 21st February, 1894.*]

In the collection of Maori things left by the late Dr. Shortland, and now in the possession of Mr. John D. Enys, of Penryn, Cornwall, there is an interesting Maori flute of a kind I have not before seen. It is, so far as I can judge, made out of a very straight branch of tupakihi (*Coriaria sarmentosa*), the pith of which has been removed to form the hollow, the opening at the top being ingeniously closed by letting in a piece of soft wood. It is of the colour of well-seasoned oak, and measures 22·5in. in length, with a maximum width of 1·5in. As might have been expected, it is elaborately carved in its entire length. At the top there is a double-faced Maori head with well-marked *tiwhana*, and with a pair of *paua*-shell eyes so placed as to suit either face. From the open mouth of this uncouth head proceeds the stem of the flute, artistically bounded by a festooned edging in relief, intended, no doubt, to represent the human lips. Halfway down, or about the middle of the flute, there is another precisely similar carving in relief, and another again at the bottom of the instrument; but the last has elevated ears (as if to catch the strains of music), and the mouth is open, the orifice of the flute representing the throat. The entire outer surface of the flute between the heads I have described is very elaborately carved in the neat and regular *whakarauponga* pattern. The blowing-orifice, or mouth of the flute, is placed in a plain circle just below the lips of the top figure. The three other apertures are placed near the bottom of the instrument, the first being just 6in. from its extremity, and the two others at distances of 2in. and 1·5in. apart respectively. It produces a rich note like that of our own flutes, and not the shrill penny-whistle piping of the ordinary Maori *koauau*. I am assured that the tradition in the family is that this is the identical flute on which Tutanekai discoursed his love-song to Hinemoa, the maiden of Rotorua, several hundred years ago. But that seems to me only a pleasant fiction. The comparative newness of its appearance prevents our referring this relic to any remote period, besides which the fine carving is undoubtedly produced by cutting with an iron chisel. It seems to me rather an adaptation of the principle of our own flute than a very ancient form; although, on the other hand, the late Dr. Shortland, who was no mean authority on Maori matters, is said to have believed in its historical authenticity, placing a value of £100 on the relic. It must be remembered, also, that there are other flutes on the true *koauau* pattern, and of admittedly ancient date, claiming the honour in question; notably, the famous human-bone flute, called Te Murirangaranga, presented by the Rotorua tribes to Captain Gilbert Mair after his gallant defence of Ohinemutu, for which he afterwards received the decoration of the New Zealand Cross; and the interesting wooden flute in Sir George Grey's collection, now deposited in the Auckland Art Gallery.

To return, however, to Dr. Shortland's flute, now under notice, I may mention that the cavity, due apparently to the natural hollowness of the wood when deprived of the pith, is exactly three-quarters of an inch in diameter. As already explained, this is hermetically closed at the top; but at the bottom of the instrument there is an artificial constriction, about two inches up, with an orifice in the centre, exactly of the size of the note-holes, or $\frac{3}{16}$in. in diameter. This is very curious and suggestive, reminding one of the peculiar tonsil-like contrivance already described by me in treating of the *pukaea*, or long war-trumpet.*

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* Trans. N.Z. Inst., vol. xxv., p. 527.

Art. LXVIII.—*Note on a Remarkable Maori Implement in the Hunterian Museum at Glasgow.*

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 21st February, 1894.*]

Plate LI.

I was much interested on a recent visit to the Hunterian Museum at Glasgow with the examination of a beautiful specimen of the Maori implement known as the *mira-tuatini*, which has long gone out of use. It was brought from New Zealand by the great circumnavigator Cook, but is not the one figured in the "Voyages." It was purchased, together with some other Maori things, by the late Dr. Hunter at a sale of a portion of Cook's collections which took place in London very many years ago, and in this way passed into the museum which the doctor afterwards founded at Glasgow, and which bears his name.

In Cook's "Second Voyage" (vol. ii., pl. xix., fig. 3) there is an illustration of one of these implements, under the name of a "saw," but it is of a somewhat different pattern, the carving being less elaborate. In the original drawing, which is now in the British Museum, it is called a carving-knife. Mr. T. H. Smith, in his recent lecture at Auckland "On Maori Implements and Weapons,"* states that in former times the *mira-tuatini* was used for cutting up human flesh at cannibal feasts. Its chief interest from an ethnographical point of view is that it appears to supply another link of connection with the South Sea Islanders. Every one is familiar with the little handswords, edged on two sides with a setting of small shark's teeth, from the Kingsmill or Gilbert Islands, and those of a somewhat coarser make from the Hervey Group. The *mira-tuatini* is contrived on the same principle. The Glasgow specimen is in the form of a small fish-slice, measuring 8·75in. in length by 2·25in. in the widest part of the blade, and its somewhat rounded cutting-edge is armed with seven irregular sharks'-teeth, set continuously in a close row, the base of each tooth being neatly let into the woodwork and firmly secured by having the more or less open margin of the weapon bound round with flax fibre. At each end of the blade, if I may so term it, there is a circular *paua*-shell eye, and the intermediate space is filled with perforated carving of an elaborate pattern, and of apparently ancient type, the lines

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* See above, Art. XLIX.

To illustrate Paper by Sir W. Buller.

being involute throughout. At the bottom of the handle there is a sort of shell design—an open volute, forming a knob, covered with the same detailed carving as the blade. Immediately above this terminal scroll-work the handle is perforated to receive a thong or flax-string. The authenticity of this relic is undoubted, and to the eye of the practised expert its genuine Maori character is placed beyond doubt at the first glance. I made a careful pencil-drawing of it at the museum, but Professor Young, the chief curator, has at my request been kind enough since to get it photographed for me, and one of the prints accompanies this note by way of illustration (Plate LI.).

There are four specimens of the *mira-tuatini* in the British Museum collection; one of these is like that figured in Cook's "Voyages," two others are of similar pattern but much coarser make, and the fourth is in the form of a long lancet (measuring about a foot) with four sharks' teeth let in near the extremity, immediately below a *paua*-shell eye.

It is said, with what truth I know not, that the hand-swords from the Gilbert Islands mentioned above are used by the islanders as instruments of torture, or for punishing unfortunate slaves. Even as a fighting weapon, in the hands of a desperate man, I could imagine their inflicting terrible flesh-wounds, especially among combatants whose only livery is nature's skin, and whose conflicts are chiefly hand-to-hand. But, for whatever purpose intended, the arrangement of erect, unevenly-pointed shark's teeth gives a very effectual sawing-edge. May not this have been used by the ancient Maori as an instrument of self-torture? In former times it was the universal practice of Maori mourners for the dead (more especially the women) to cut and gash themselves, so as to induce great physical suffering, sharp shells or the cutting-edge of a splinter of glass-obsidian (*mata-tuhua*) being generally used for that purpose; the more intense the grief for the departed the deeper the cuts. Cook, in his "First Voyage" (vol. ii., p. 290), in giving an account of his first contact with the Maoris, says, "Among the persons of the family there was a woman who had her arms, legs, and thighs frightfully cut in several places, and we were told that she had inflicted these wounds upon herself in token of her grief for the loss of her husband, who had lately been killed and eaten by their enemies, who had come from some place to the eastward which the Indians pointed out." This custom was continued in some parts of the country for years after the introduction of Christianity; and in my boyhood I have seen female mourners with their cheeks, arms, and breasts painfully gashed in short parallel lines, the blood streaming from the wounds and almost covering the body. This hand-instrument would be admirably adapted for such a purpose, and the severity of the cutting could be regulated at will.

Art. LXIX.—*The Story of Papaitonga; or, A Page of Maori History.*

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 21st February, 1894.*]

Sixty miles from Wellington by the Manawatu Railway, and less than two miles to the westward of that line, there is one of the prettiest bits of natural scenery in New Zealand. This is Papaitonga, so called from time immemorial, the name signifying "the beauty of the South." It is a lake of 125 acres in extent, with two exquisite islets covered with bright vegetation. On the north and north-east sides it is enclosed by a beautiful native forest, which presents a thick fringe of tree-ferns and underwood along the water's edge; on the southern side there is open rising ground, with clearings in the forest beyond, showing the snow-covered ranges of the Tararua Mountains; whilst on the low-lying flat to the westward there is an outlet to the sea, about three miles distant, by the Waiwiri Stream. Every part of it is historic ground, Papaitonga having been the scene of one of the most important of ancient Maori fights, and the little island which has given its name to the lake the principal battle-ground. To this day the island is a perfect necropolis of human bones, although concealed and protected by the dense growth of evergreen vegetation that now covers the site of the ancient pa. The original possessors of this picturesque lake—the Muaupoko—after being vanquished by Te Rauparaha and his armed followers, were driven out of the district, but a remnant was afterwards permitted to come back and settle at Horowhenua, a little further to the north, which is still the home of the tribe. At Muhunoa, near the Waiwiri outlet, a small section of the Ngatiraukawa has for more than half a century been located, the principal surviving chief being Waretini Tuainuku, a man of intelligence and excellent character. By a succession of events, to which it is not necessary to refer here, this charming place has come into my possession, and my two sons are living there.

It seems to me of importance that everything relating to the early history of this land of our adoption should be carefully recorded and preserved for the student of the future. As an interesting episode in Maori history, and as forming a supplement to Mr. Travers's valuable paper on "The Life and Times of Te Rauparaha," which appeared in our Transactions,* I have taken down (in Maori) from the lips of the resident chief the following narrative, for this is the story of Papaitonga as told by Waretini Tuainuku :—

"Now, O friend, sit down on this rising ground, here in the sunlight, and let me tell you about Papaitonga, which lies spread out before us. That name was given by the ancient Muaupoko people. The lake was called Waiwiri. The Muaupoko pa was on the Island of Papaitonga. At that time there was no bush on the island, only some karaka-trees which had been planted by the residents close to the water's edge. But the island was completely filled with people, the inhabitants of the pa numbering four hundred twice told. All along the shores of the island, in the shallow places, posts were stuck into the ground, and store-houses erected upon them.

"That other island yonder, the smaller one, was called Papawharangi. It is an artificial one, having been made by human hands in the following manner: First of all poles were driven in to define the extent of the proposed island. Then great lumps of 'negro-head' were brought from the shore and cast into the water within the lines of the poles, and this was continued till a mound was formed level with the surface of the water. Then enormous quantities of *kakahi*-shells from the refuse-heaps were brought over and cast upon the platform of negro-heads; and after this many canoe-loads of soil were thrown on top. Then dry fern, and negro-heads, and all kinds of rubbish were spread over the surface, and lo! there was dry land in the midst of the waters. Upon the island so formed residential whares were erected—four of them. But owing to the encroachments of the water the island has become diminished in extent; formerly it extended out to where you see the raupo now growing. However, if you will take the trouble to look, you will find the boundary-poles still fixed there, with any number of skulls also, and dead men's bones.

"The larger island of Papaitonga yonder was a scene of disaster in very ancient times, as far back as the time of Hingakaha. In that generation this island was visited with an epidemic which was very fatal. It spread all over the coast, and the skulls that are accumulated on Papaitonga show how deadly it was. But in spite of that visitation the people continued to live on the island, even down to the

* Trans. N.Z. Inst., vol. v., p. 19.

coming of Te Rauparaha. At that time the actual residents numbered about six hundred, or perhaps seven hundred. But the people were more or less broken up, some being at Porotawhao, some at Horowhenua, some at Waikawa, and some at Waitaua; so that the actual residents on Papaitonga did not, perhaps, number more than four hundred. But here let me explain to you. This tribe—the Muaupoko—was at that period very much scattered. They were to be found at Manawatu, at Karekare, then lower down at Totara, and lower down again at Porotawhao and at Horowhenua; also at Waiwiri, and, following down the coast, at Ohau, at Waikawa, at Waitohu, at Otaki, at Katihiku, at Waimea, and right down to Waikanae, or even to Porirua on the further side. They were living in detached parties in all these places. When Te Rauparaha came into this district he was allowed to pass down the coast by way of Taranaki unmolested. The Ngatiawa and the Ngatiruanui agreed to let Te Rauparaha pass through in peace. And so he came on till he reached Wanganui, where Turoa was paramount. Turoa wanted to oppose the progress of Te Rauparaha, but he was powerless, because the great tribes of Taranaki had offered no opposition. So he was allowed to pass through Wanganui. Then he came to Horowhenua, and rested awhile. Thence he explored all the coast as far as Waikanae. From there he went on to Porirua, and even to Port Nicholson. Returning from there, he settled on the Island of Kapiti. He came in great force, having with him four hundred followers twice told, some of his people having remained behind at the North. Te Rauparaha's reason for selecting Kapiti as a home for himself and his tribe was because of its security from attack, as it was very unlikely that the tribes would cross the sea to molest him. He also knew that this would afford him a good outlook in case an enemy should be moving about in canoes.

"After he had established himself there, it occurred to Turoa and Paetahi (chiefs of Wanganui) that they might be able to dislodge him, and they conspired with the chiefs of Muaupoko with that purpose. The Muaupoko sent emissaries to Wairarapa, to the Ngatikahungunu, to the Ngatiapa, and to the Rangitane. They all responded, and the people of Wanganui came down to join them. The total number of these forces numbered a thousand twice told. They manned their war-canoes, and made straight for Kapiti. It was now dusk. The Ngatitoa saw them in the distance from Kapiti, but they thought it was only floating timber, for it was then getting dark. When the canoes reached Kapiti the invading force rested on the beach, whilst some remained in the canoes, all waiting for the hour of midnight. Then a dispute arose among the leaders—some were for delaying operations till the morning-star arose, others were for assaulting during the night. Then a war-party to the number, perhaps, of five hundred started off to scale the cliff. Just as the advance guard reached the edge of the plateau a woman who came out of one of the houses detected the presence of an enemy approaching because she could hear the rumbling of voices. It arose in this manner: The foot of one of the scaling-party loosened a stone, which rolled down the cliff, punishing the heads of those who were below. Some laughed, and others protested, for they were much disconcerted by this boulder rolling downwards, and breaking the heads of those it came across. The men who were being punished by the descending boulder called out in protest, and the woman heard them. She rushed back into the house and gave the alarm to the Ngatitoa. Instantly all the people were on the alert, buckling on their cartouche-boxes, and loading their guns. They poured out of their houses to find the war-party on the plateau, and the fight commenced at once. The bulk of the attacking force remained at the landing-place. The Ngatitoa were armed with guns and powder. Their assailants had none. In face of the guns, what could they do with their native weapons, for their only arms were *patiti*, and *meremere*, and *tewhatewha*, and *huata*, and *taiaha*? Of course they were utterly routed. The fugitives sprang over the cliff, and many perished. But now it was daylight, and the enemy could be seen. The whole force was now attacked by the Ngatitoa, and great was their defeat. They attempted to make their escape in the canoes, but they crowded into them in such haste and terror that many of them were capsized, and numbers of people were drowned. A remnant escaped, and reached the mainland in safety. So ended the fight on Kapiti.

"Subsequently to this Te Rauparaha thought he would come over to the mainland and explore the country; so he came over to Waikawa. When the Muaupoko, who had now concentrated themselves at Horowhenua and at Waiwiri, heard that he had come to Waikawa they began to lay plans for killing him. They sent an invitation to Te Rauparaha to come to Waiwiri, to this very place Papaitonga, to receive a present of food—that is to say, for a feast of eels—these lakes, Horowhenua and Waiwiri, being noted for eels. Te Rauparaha consented, and came with a party of about twenty. When he had arrived at Te Wi, near Ohau, the Muaupoko sent their messengers to inform the people at Horowhenua, also to the Rangitane, and to the Ngatiapa; and that very day, after nightfall, all the tribe assembled at Papaitonga. Te Rauparaha had slept two nights at Te Wi when the Muaupoko brought their present of eels from Waiwiri, saying that another present of a similar kind was on its way from Horowhenua. This was a mere subterfuge to keep Te Rauparaha at Te Wi till the arrival of the attacking force. That night they came on in their full strength from Papaitonga, and located themselves near Te Wi. You have seen that clump of pukatea-trees on the side of the road leading to the coast: that was where the Muaupoko collected. Te Wi, the place occupied by Te Rauparaha, was just beyond. Then disputes arose again among the chiefs: some were for attacking the party under cover of darkness; others advocated leaving it till daylight, so that none might escape. Ultimately it was agreed to make the attack at midnight. It was Ngarangi, a chief from Wanganui, who urged the night attack. So the attack was made; and when the people in the house heard the tramping of the feet of eight hundred men they rushed out in alarm. Some of the enemy had now come right up to the porch of the house. Then a voice was heard calling into the house, 'E Raha, e! ko te whakaariki, ka huaki' (O Raha, the war-party is upon you!); and there was a general commotion, the inmates of the house rushing out and taking part in the fray. Te Rauparaha's party had left their guns behind at Waikawa, and the attacking force had nothing but Maori weapons; so it was a hand-to-hand conflict. Then some would go back into the house, and others would come out to relieve them; and so the fighting went on in the dark. Just before the dawn one of the Muaupoko was killed, and they succeeded in wounding one of the attacked, named Te Poa, with a spear. When the great war-party saw how stubborn was the resistance of Te Rauparaha and his twenty followers they decided to set fire to the whare. A fire-stick was applied, and very soon the place was in flames, and the land covered with smoke. Then Te Rauparaha tore open a corner of the house, and rushed by himself, under cover of the smoke, into the Waikawa Stream. Here he found his brother-in-law, Te Rakaherea, concealing himself, with a spear stuck in his back. Te Rauparaha pulled out the spear, and before the morning broke they had made good their escape. But it was now getting light, and these were the only two who left the place alive and reached Waikawa. Among the killed were two of Te Rauparaha's own children—a daughter named Te Uira and a son named Poaka. Te Rauparaha was greatly incensed at this act of treachery towards him and his people, and very soon afterwards he sent an avenging war-party, who killed some Muaupoko stragglers on the beach at Waiwiri and at Horowhenua, and then returned to Kapiti. Then he sent messengers to the North, to Maungatautari, inviting the Ngatikauwhata, the Ngatiwehiwehi, and the Ngatihuia to come down in a body to seek revenge for the wrong that he had suffered. The Ngatikauwhata came from the North with the Ngatitama and Te Puohu, and on their way down they did some killing at Horowhenua; and, having carried all before them there, they came on and joined the Ngatitoa at Kapiti. After them came the Ngatihuia, who went right on to Otaki, where Te Rauparaha was now settled, because he knew that the tribes would rally round him. Then a war-party was formed, composed of Ngatihuia, Ngatitoa, and Ngatitama, and came on to Waiwiri. Do you see that bare promontory on the island yonder? At that time there was a large house standing on that point belonging to Takare. The chiefs of the pa were Takare, Paipai, and Te Kahuoterangi. There were other chiefs besides, such as Warakihi and others. On the arrival of the war-party it broke up into divisions, all this being carried through in the daylight. Forty men twice told stationed themselves at Te Ruapekapeka, on the very spot where your sons' house now stands, for at that time it was all dense bush; and in the spot which you have now named 'Maui's Garden' thirty men twice told were stationed; and in the place yonder—Otomuri—which is now all cleared, twenty warriors twice told. Forty twice told crossed over to the other side of the creek; and so on in parties the bush was occupied all along the edge of the lake, even as far as Marokura, that point of bush yonder in the direction of the sea. The reason for this disposition of the attacking force was the uncertainty as to whether the fugitives would make for the hills, or for Horowhenua, or in some other direction. On this account it was deemed best to surround the lake. At this point here, just down below us, known as Tumaiteuru, the landing-place for the canoes, ten men were stationed; but this was simply a piece of deceit, to put the people off their guard. My father's elder brother—Aperahama Te Ruru—was here, also Whakatupu—both chiefs of Ngatihuia—with Porokoru Kapeto, Te Riu, and others. It was arranged that in the early morning these men should call to the people on the island to bring them a canoe. In the morning accordingly Te Riu called to Kahurangi, 'E Kahu, e! Hoea mai te waka ki au Ko tou tangata tenei' (O Kahu, bring a canoe over for me I am your man). The people heard, but were in no hurry to come. Then he called again, 'Hoea mai te waka ki a maua ko to tangata. Ko Te Ruru tenei' (Send a canoe for me and your friend. Te Ruru is here). When Takare heard this he said, 'Hoea te waka. Hoe atu, me to titiro ano ki uta' (Paddle the canoe over; but as you paddle keep a sharp look-out on shore). Then two men got into the canoe—Te Kahuoterangi and Kokota. As they paddled off Takare ascended to the roof of his house and chanted a war-song, so as to apprise the men in the canoe that as soon as Te Ruru reached the place he would kill him. By this time Te Ruru and Whakatupu had taken off their clothes and were in the water, sitting concealed among the raupo flags. Whakatupu was armed with a tomahawk; the other man had an *onewa*, or stone club. The canoe came on towards the landing-place, and on nearing it they detected the heads of the two men among the bulrushes. The man in the stern of the canoe called out to the other to shove out again. But Whakatupu was too quick for them, and seizing the bows of the canoe, began to haul it in. The man at the bow standing up in the canoe dealt a blow at Whakatupu's head with his paddle. He parried the blow with his tomahawk, and then struck at his assailant in return, as it were flinging the tomahawk at him. It was not a very long-handled tomahawk, but a rather short one, reaching to about the waist. It cleaved the man's head open, and then fell into the water, the man also tumbling overboard quite dead. When the man at the stern saw this he jumped into the water and dived, coming up again out there in a line with the Maori hut standing yonder above the landing-place. Then the men on shore ran over to watch the landing-place, and they discovered the fugitive crouching low and making his way through the sedge and brushwood. Then Aperahama took the gun from Porokoru's hands, followed the man, and shot him; so there was an end of him also. As soon as the people in the pa heard the report of the gun they were on the alert; so also were the various sections of the war-party hiding in the bush. As soon as they heard it they were all astir. Te Tipi at once swam out from Paopaororo—that is the spot there opposite to us, where I made a clearing in 1883—I mean that point running out there in a line with the island. That spot was then, as now, covered with low bush, tawa, hinau, mapou, and other trees. Swimming out from that point, Te Tipi reached the island, and he kept firing his gun as he swam. This was one of the bravest warriors of the Ngatihuia and Ngatitoa. He had his cartouche-box around his neck; with his hands he kept reloading and firing his gun, whilst he used his legs for swimming. By the time Tipi reached the Papaitonga island the enemy had already fled, and were making for the shore in their canoes. However, he at once jumped into a canoe that had been left behind, and went in pursuit. When the canoes reached the shore the various sections of the war-party in the bush combined to attack them, and when they attempted to land at another point they were attacked again. Here and there a man who was swift of foot escaped, but the bulk were shot. All the chiefs were killed—Takare, Paipai, and all the other chiefs of the tribe. The dead numbered three hundred twice told, perhaps more, and included the women and children. As for the few who escaped, some took refuge at Horowhenua, and others fled to the mountains.

"After the fall of Papaitonga the war-party went on to Horowhenua, where there was more killing. Driven from there, the Muaupoko fugitives crossed over to Weraroa, and fled to the hills. Then the war-party returned to Papaitonga. What followed afterwards was according to Maori custom. Who would care to tell of it? When the bodies placed in the *hangis* were cooked they were calabashed, and formally handed over to the Ngatitoa as payment for the children of Te Rauparaha who had been treacherously killed by the Muaupoko. The uncooked meat was taken home and distributed as food for the tribe. But I have a horror of that part of the story. If you want to know about it ask the old men of the Ngatitoa—Ngahuka Tungia and the others. That is all."

[IN THE ORIGINAL.]

"Na, E hoa, e noho i konei, i runga i te hiwi nei, i te wahi marama, ka whakarongo ai ki taku korero.

"Ko Papaitonga tena e takoto mai na. Na o mua tangata na Muaupoko tena ingoa—ko Waiwiri te roto. He pa tera no Muaupoko. I reira ai kahore kau he ngaherehere o taua motu, ko nga karaka anake, he mea whakatupu i nga tahataha o te wai. Engari, i kapi katoa tena motu i te tangata, ara, i to ratou pa, e wha rau topu nga tangata i roto. Ko waho, ko nga wahi papaku o te roto, i poupoua iho ki te rakau, hei pataka iringa kai ma ratou.

"Ko tera motu i waho ra, ko te mea iti, ko Papawharangi te ingoa, he mea mahi tena na te tangata. He mea poupou a waho ki te rakau kia rite ano ki te wahi i kiia hei motu. Ka oti te poupou ka mauria mai nga pureirei i uta ka whakanoho ki roto ki te wai i te takiwa ano o aua pou, ka rupeke nga pureirei ka teitei ake, ka tahi ka kawea mai ko nga kowhatanga kakahi, ka rukea ki runga. Ka mutu tena, ko nga one-one ka mauria atu i runga i te waka ka ringiringi ki runga, ka hoatu ano he rarauhe maroke, he pureirei, he aha he aha, na kua tuawhenuatia taua wahi. I maranga ano nga whare noho ki reira; e wha nga whare i tu ki runga ki taua motu. Engari, kua pau haere i te wai tena motu. I mua ai i tae rawa ki te mutunga mai o nga raupo na. Otira, kei reira ano nga pou tawhito, kei te wai e mau ana, me nga wheua tangata, me nga angaanga hoki, kei reira kei te wai e takoto ana.

"Ko Papaitonga na, he whenua parekura, no mua noa atu, ara, no te parekura i a Hingakaha. I era whakatupuranga i pangia tena motu e te rewharewha, me nga iwi katoa hoki o tenei waitua—nui noa atu te tangata i rupeke ki te mate—e pukai mai na nga angaanga i runga i te whenua. Engari ka nohoia tonutia taua motu hei kainga mo ratou, taka noa mai ki te takiwa i haere mai ai a Te Rauparaha. I taua takiwa i tae ki te ono rau, ki te whitu rau ranei, nga tangata o taua motu, engari, e noho wehewehe ana, kei Porotawhao etahi, kei Horowhenua etahi, kei Waikawa etahi, kei te Waitaua etahi; engari ko nga mea e noho tuturu ana i Papaitonga e wha rau pea. Engari kia ata whakamaramatia e au ki a koe. Ko tenei iwi ko Muaupoko, i timata mai tona noho i Manawatu, i Karekare, neke mai Totara, neke mai Porotawhao, neke mai Horowhenua, Waiwiri, Ohau, Waikawa, Waitohu, Otaki, Katihiku, Waimea, tae noa ki Waikanae, puta noa ki Porirua—e noho wehewehe ana, i tena kainga i tena kainga. Te haerenga mai o Te Rauparaha ka tika mai ma Taranaki te heke—kahore i patua e Ngatiawa raua ko Ngatiruanui, i tukuna paitia kia haere mai a Te Rauparaha. Haeremai, ka tae mai ki Wanganui, ka tae mai ki a Turoa, ka hiahiatia e Turoa kia whawhaitia; na, kahore i kaha a Turoa, ko te take ko te tukunga paitanga mai e nga iwi nunui o Taranaki. Ka tahi ka tukuna kia haere mai i Wanganui. Haeremai, Horowhenua nei; ka noho, ka haere ano ki te whakataki haere i te whenua, a, tae rawa atu ki Waikanae. Haere tonu, Porirua ra ano, Poneke ra ano. Ka hoki mai i reira ka noho ki Kapiti. I haere nui mai ratou, e wha rau topu, ko etahi hoki o taua iwi i noho atu i raro (i Waikato). Te take i noho ai a Te Rauparaha ki Kapiti, hei kainga tuturu mo ratou ko tona iwi, he mohiotanga nana e kore nga iwi e tae atu ki reira ki te patu i a ratou, he takiwa moana hoki. Tetahi, he marama no taua wahi ki te titiro ki nga waka e hoe ana i te moana.

" Na, ka puta te whakaaro i a Turoa raua ko Paetahi, ka kakaitia ki nga rangatira o Muaupoko kia tikina atu kia patua a Te Rauparaha. Ka tahi ka haere nga tutu taua a Muaupoko ki Wairarapa—ki a Ngatikahungunu, ki a Ngatiapa, ki a Rangitane. Ka haere tahi mai hoki a Wanganui. Ka maranga te ope o aua iwi, kotahi mano topu, ka tahi ka eke ki runga ki nga waka ka hoe atu ki Kapiti. He ahiahi po tenei. Na, ka kite mai a Ngatitoa i Kapiti, ka mea ratou he rakau tere noa iho i te moana, kua pouri hoki. Ka u nga waka ki uta ki Kapiti, ka noho te ope na i te tahataha o te one, i runga hoki i nga waka etahi e noho ana, kia tae ano ki te weherua. Na ka tautohetohe nga rangatira, ko etahi o ratou e mea ana kia eke mai te whetu o te ata ka whakaekea ai, ko etahi e mea ana kia whakaekea hohorotia i te po. Ka tahi ka haere te taua ka piki i te pari, ka tae pea ki te rima rau tangata. Kua eke ki runga, ka tahi ka puta mai tetahi wahine i roto i te whare, ka puta ki waho. Na, kua rongo ia ki taua ope e haere puku mai ana, engari kua rongo taua wahine ki te umere o taua ope. Ko te take iana tenei. He kowhatu i taka i te waewae o te tangata i te pikitanga ake i te pari, ka taka iho ka pa ki nga upoko o nga mea e piki ake ana, ka kata ka umere etahi, ka raruraru hoki i taua kowhatu e taka hurihuri haere ana, e wawahi haere ana i nga upoko o nga tangata. Kua hamama te waha o nga mea e tu ana i taua kowhatu rere, a, kua rongo taua wahine. Ka tahi ka hoki atu ki roto ki te whare ka karanga ki a Ngatitoa, he taua tenei. Na, ka maranga katoa nga whare, ka whakamau i nga tatua, ka puru i nga pu, ka puta ki waho. Ka tahi ka haere atu, na, kua kite i te taua kua tae ki runga. Ko te nuinga o taua ope kei raro ano, ara te nuinga o taua kotahi mano topu. Ka tahi ka riri a Ngatitoa—ka haere te waha o te pu, i a ratou anake hoki te pu. Kahore tahi he pu he paura a taua ope i haere atu na ki te whakaeke i a ratou, he patiti, he meremere, he tewhatewha, he huata, he taiaha, nga rakau a taua iwi. Heoi, ka horo taua ope nei, ka rere i te pari, ka mate noa iho. Engari, kua awatea tenei, kua kitea noatia te tangata. Kino rawa te horonga o taua ope; ka uta hoki ki runga ki nga waka, ka tahurihuri i te tini o te tangata. He nui nga waka i tahuri ki te wai, a, mate ana taua ope. Ko nga morehu i ora i eke atu ano ki runga ki o ratou waka, i hoe atu ki uta. Ko te mutunga tenei o taua riri.

"No muri nei ka puta te whakaaro a Te Rauparaha kia haere mai ki uta ki te haereere i konei, ki te titiro haere. Na, ka tae mai ki Waikawa. Na, ka rongo a Muaupoko kua tae mai ki Waikawa. I tenei takiwa hoki kua huihui a Muaupoko ki Horowhenua, ki Waiwiri hoki. Ka tahi ka takoto te korero kohuru a Muaupoko; ka tahi ka kiia mai kia haere mai a Te Rauparaha ki Waiwiri, ara, ki Papaitonga nei, ki te tiki mai i te kai mana, i te hakari tuna; he wai tuna hoki a Horowhenua, a Waiwiri. Ka whakaae a Te Rauparaha kia haere mai, kia rua te kau pea o ratou. Te taenga mai ki konei ki Te Wi, i Ohau nei, ka tahi ka tukuna te karere o Muaupoko ki Horowhenua, ki Manawatu,—ki a Rangitane, ki a Ngatiapa,—ka haerea mai e taua iwi, i taua rangi ano i te po, ka tae mai ki Papaitonga. Ka rua nga po o Te Rauparaha e moe ana i Te Wi, ka whiua te tuna i tukuna mai i Waiwiri. Ka kiia e taua iwi kei te haere mai ano nga tuna o Horowhenua. Kahore, he whakawai noa iho kia noho tonu ai ki Te Wi, kia rokohanga mai ano e taua ope. I taua po ka tae mai te ope, ka haere nui atu nga tangata i Papaitonga, ka tae ki Te Wi. Ka tahi ka noho i te po ki reira. Kua kite na koe i te motu pukatea i te taha o te rori e ahu ana ki te tai—ko te wahi tena i noho ai taua ope; kei tua tata atu a Te Wi, te kainga i noho ai a Te Rauparaha ma. Na, ka tautohe nga rangatira, ko etahi e mea ana kia patua i taua po ano, ko etahi e mea ana, taihoa kia marama kia kitea te rerenga o nga toa. Kahore i whakaaetia ta teraka, engari i whakaekea tonutia i te weherua. Na Ngarangi tenei tohe kia whakaekea i te weherua—no Wanganui taua tangata. Ka tahi ka whakaekea, ka rangona e te whare te haruru o nga waewae o te waru rau tangata; ka tahi ka maranga ka rere ki waho; te putanga ki waho kua kite tonu i te taua, kua tata rawa mai ki te whatitoka o te whare; ka tahi ka karanga ki roto ki a Te Rauparaha—'E Raha, e! ko te whakaariki, ka huaki!' Heoi ano, kua oho katoa te whare ki runga, kua puta etahi ki waho, kua riri. Ka ngenge etahi ka hoki atu ki roto ki te whare, ka puta mai ano etahi ki waho ki te riri, kua mahue hoki nga pu i Waikawa. Me te ope whakaeke hoki kahore tahi he pu, he rakau Maori anake. Ka tata ki te awatea ka mate to Muaupoko i a ratou, ka tu hoki tetahi o ratou, a Te Poa, i te huata. Ka kite taua ope i te kaha o Te Rauparaha me ana hoa e rua te kau, ka mea kia tahuna te whare ki te ahi. Ka tahi ka whiua te ahi ki runga ki te whare, na, ka kainga te whare e te ahi, kua ngaro katoa te whenua i te paoa. Ka tahi ka wahia e Te Rauparaha te koko o te whare ka puta ia ki waho, ka rere ki roto ki te awa, tona kotahi. I reira hoki tona taokete a Te Rakaherea e noho ana, kua tu i te tokotoko. Ka unuhia e Te Rauparaha te tokotoko i runga i te tuara o taua tangata e mau ana—to raua oranga i ora ai raua i te po. Engari, kua tae tenei ki te ata, kua marama. Ko raua anake nga mea i ora, i tae atu hoki ki Waikawa. I roto i taua patunga i mate nga tamariki tokorua a Te Rauparaha. Ko te Uira te kotiro, ko Poaka te tane. Heoi, kua tau te pouri ki a Te Rauparaha mo tenei patu konihi i a ratou ko ona tangata. I muri iho ka haere mai te taua toto a Te Rauparaha, ka patua korahatia a Muaupoko i te one nei i Waiwiri, i Horowhenua hoki, na, ka hoki atu ano ki Kapiti. Ka tahi ka tukuna te tangata ki raro ki Maungatautari—ki a Ngatikauwhata, ki a Ngatiwehiwehi, ki a Ngatihuia, kia haere mai hei takitaki, hei ngaki, i tona mate. Ka haere mai a Ngatikauwhata i raro, me Ngatitama, me Te Puohu, ka tae mai, ka patu i Horowhenua. Na, ka mate a reira, ka haere tonu ka tae ki Kapiti, ki a Ngatitoa. I muri atu ko Ngatihuia, ka haere tonu ki Otaki, kua noho hoki a Te Rauparaha ki reira, kua mohio hoki ka rupeke nga iwi ki aia. Heoti, ka tahi ka haere mai te taua a Ngatihuia, me Ngatitoa hoki, me Ngatitama, ka tae mai ki Waiwiri. Ka kite na koe i te kurae marakerake i te motu na? I reira tetahi whare nui e tu ana, no Takare. Ko nga rangatira tera o roto o taua pa—ko Tekare, ko Paipai, ko Te Kahuoterangi. Tera atu etahi rangatira, ko Warakihi me etahi atu. Na, kua tae mai te taua ki konei ka tahi ka wehewehea—e wehewehe ana tenei i te awatea. E wha te kau topu i noho ki tena wahi ki Te Ruapekapeka, i te kainga o au tamariki, he ngaherehere katoa i taua takiwa. Na, i tera taha, i te wahi e kiia nei i naianei ko te 'Kaari-a-Maui,' e toru te kau topu; na, i tera wahi kua tuaina nei, i Otomuri, e rua te kau topu. Na, ka haere atu ano ki tera taha o te awa na e wha te kau topu, ka peratia haeretia te noho o nga tangata i te awatea—i te tahataha o te roto, i te ngaherehere e noho ana, taka noa ki tera taha o te roto, tae noa ki Marokura, ko te rae whakamutunga mai ra o te ngaherehere e anga ana ki te tai. Ko te take i peratia ai, he mohiotanga no te taua ka ahu ranei ki te maunga, ka ahu ranei ki Horowhenua, ka ahu ki hea ranei te whatinga. Koia i raunatia katoatia ai e te tangata. Ka noho i konei i te tauranga waka nei—ko Tumaiteuru te ingoa o tenei wahi—kotahi te kau nga tangata; engari he noho nukurau tenei, he whakakuare. Ko te tuakana o toku papa, ara, ko Aperahama Te Ruru i konei, me Whakatupu—no Ngatihuia aua rangatira—me a raua hoa, me Porokoru Kapeto, me Te Riu, me etahi atu. Na, kua oti te whakarite mo te ata ka karanga ai taua hunga nei i tetahi waka kia hoea mai ki a ratou. I te ata ka karangatia e Te Riu—ka karangatia ki a Te Kahurangi—'E Kahu, e! Hoea mai te waka ki au. Ko tou tangata tenei.' Ka rongo ano, engari kahore i hohoro te hoe mai. Na ka karangatia ano e taua tangata—'Hoea mai te waka ki a maua ko to tangata. Ko Te Ruru tenei.' Ka rongo a Takare. Ka karanga ki tona hoa, 'Hoea he waka. Hoe atu, me to titiro ano ki uta.' Ka eke mai ki runga ki te waka tokorua nga tangata, ko Te Kahuoterangi, ko Kokota. Ka tahi ka hoe mai, ka piki a Takare ki runga ki te whare, ka whakahua mai i te waiata, he waiata kohuru, kia mohio ai era i runga i te waha ka patua e ia a Te Ruru ana tae mai ki te kainga. Na, kua unuunu a Te Ruru raua ko Whakatupu i a raua kakahu, kei roto kei te wai e noho ana, kei roto i nga raupo, he kiri kau—he patiti te rakau o tetahi, o Whakatupu, he onewa, patu kowhatu nei, te rakau o tetahi. Ka tahi ka hoe mai, ka tata mai te waka ki uta, kua kite mai i nga mahunga o aua tokorua ra i roto i te wai; ka tahi ka karanga te mea i te kei kia whakahokia to raua waka, ka tahi ka reia atu e Whakatupu te ihu o te waka ka kumea mai. Kua tu taua tangata i te ihu ki runga me tona hoe. Ka tahi ka whiua ki te mahunga o Whakatupu, na, ka karohia ki te patiti, ka tahi ka whiua taua tangata e Whakatupu ki te patiti,—e hara i te kakauroa, engari he mea popoto nei, kei te umu o te tangata te roa,—ka motu rawa te upoko o taua tangata, ka taka atu ki te wai. Ka hinga hoki te tangata ki te wai, kua mate tono atu. Ka tahi ka rere te mea i te kei, ka rere ki roto ki te wai ka ruku, puea ake i waho ra, i te ritenga mai o te whare maori e tu na i runga ake o te tauranga waka. Ka tahi ka oma atu nga tangata ki te titiro i te unga ki uta, na, ka kitea e ngoi tapapa haere e kuhu ana i roto i nga kawakawa rakau, ka tahi ka tangohia e Aperahama te pu i te ringa o Porokoru, ka whaia ka puhia, heoi, ka mate taua tangata. Na, kua rongo nga tangata i roto i te pa ki te tangihanga o te pu, me te taua e kuhu nei i roto i te ngaherehere. Kua rongo, heoi, kua oho katoa ratou. Ka tahi ka kau mai a Te Tipi i Paopaororo—ko te wahi tena e takoto mai na i tawahi, i tuaina e au i te tau 1883—ara, ko te rae e takoto mai na i te ritenga atu o Papaitonga. He whenua tawa taua wahi, he hinau, he mapou, he aha he aha. Ka kau mai a Te Tipi i reira, ka u mai ki te pa, e pupuhi haere mai ana i roto i te wai. Ko tetahi tangata toa tena o Ngatihuia, o Ngatitoa. Ko tona hamanu kei tona kaki e iri ana, ko ana ringaringa kei te puru haere i tona pu kei te pupuhi hoki, ko ona waewae kei whakakau atu i aia. Tae rawa mai a Te Tipi ki uta ki Papaitonga, kua horo te hoariri, kua eke ki runga ki nga waka, hoe atu ai ki uta. Heoi, ka eke atu ia ki runga ki tetahi o nga waka i mahue, ka whai haere i muri. Te unga atu o nga waka ki uta kua huihuia mai nga wehewehenga o te taua e noho ana i roto i te ngaherehere, na, ka patua. Ka u atu nga waka ki tetahi wahi ka patua ano. E ora ana te tangata kotahi, ara, te mea e tere ana te haere, ko te nuinga ano i mate i te pu. Ka mate katoa nga rangatira, ka mate a Takare, a Paipai, me nga rangatira katoa o taua iwi. Ko nga mea i rupeke ki te mate e toru rau topu, nuku atu ranei—i mate hoki nga wahine me nga tamariki. Ko nga morehu i ora i tika atu etahi ki Horowhenua, i oma etahi ki te maunga.

"Ka hinga a Papaitonga, ka whai haere te taua nei ki Horowhenua, ka patu ano. Ka hinga a reira, ka whati haere a Muaupoko; ka whiti atu ki Weraroa. Ka oma ki te maunga. Na, ka hoki mai te taua ki Papaitonga. Heoi, ko a te Maori ritenga i reira. Ma wai hoki tena e korero? Ka maoa nga mea i whiua ki te hangi ka tahi ka tahuatia, ka tukuna ki a Ngatitoa, hei utu mo nga tamariki a Te Rauparaha i patua konihitia e Muaupoko. Ko nga mea mata i haria ki te kainga, i tuwhaina haeretia hei kai ma te iwi. Engari, e mataku ana au i tena korero. Uia e koe ki nga kaumatua o Ngatitoa—ki a Ngahuka Tungia ma. Ka mutu."

ART. LXX.—Te Kuri maori *(the Dog of New Zealand). A Reply to the Rev. W. Colenso.*

By TAYLOR WHITE.

[*Read before the Hawke's Bay Philosophical Institute, 11th September, 1893.*]

IN Volume xxv. of "Transactions of the New Zealand Institute" I notice that Mr. Colenso, F.R.S., &c., has attacked me most bitterly because of my presumption in recording such information as I could collect from several correspondents, both in the North and South Islands of New Zealand, giving their experience and recollection of certain unusual canine forms which they had noticed in the earlier days of the colony, &c.

A good portion of Mr. Colenso's paper consists of quotations from the writings of Max Müller and others, which have no bearing on the subject-matter of the paper.

I will take the points in Mr. Colenso's paper, before referred to, in regular order, and will use the pruning-knife rather freely, not that I personally wish to differ therefrom, but where it seems that certain points will not stand criticism it is reasonable that they should be traversed, and, moreover, I have no wish to remain under a cloud longer than can be helped.

Previous to my writing my first paper on the New Zealand dog question* I had seen Mr. Colenso's paper on this subject in the Transactions,† and came to the conclusion that the subject was not "exhausted," but rather was dealt with in a one-sided manner. For instance, why should we be considered limited to one kind or one size in the Maori dog? We would seem to be able, by inference, to trace one breed of the dog to the islands of the Malay Archipelago, where there are many different species of large game to be hunted; and in such places it is reasonable to expect a dog capable of assisting his master in capturing this large game—forms of wild cattle, deer, pigs, and cassowary, &c.—because, if the Maori race is compounded of the junction of two pure races, the Moriori and the Negrito, would not these mixed peoples have the Papuan dog as well as that of the Moriori? And, supposing the Moriori people to be the original inhabitants of a great southern continent, now chiefly submerged, we may suppose the dog of pure Moriori

* Trans. N.Z. Inst., vol. xxii., p. 327.
† *L.c.*, vol. x., p. 135.

breed to have remained in New Zealand with such of the Moriori people who escaped to the high lands of New Zealand at the time of the aforesaid submergence.

The mixed race—the present Maori—may be the descendants of Morioris who, from expectation of returning to their former home, travelled onward until, coming in contact with a Negrito race, they acquired a taint of the blood of the latter people, but were ultimately compelled to retreat backward to islands which once formed the mountain-peaks of their original home. Hence the Samoans say that the distant land of the Maori, called Hawaiki, is not in this present world, but is *down below*.

Any way, we know that the Negrito race had, and still have, an able-bodied *hunting-dog*, however they came by it. We find the Australian blacks making use of the dingo, which they partially domesticate. Therefore, if the Maori are a crossed people, we get the Moriori dog, the dog of the Negrito, allied to the dingo, and such other varieties as may have resulted from the cross from the two pure forms.

Even supposing we only have in New Zealand a dog originally identical with that of Tahiti, this dog will have been resident in its new home some three hundred years under changed conditions. In its former home tropical fruits and fish were abundant; hence the dogs chiefly fed on the remains of their masters' feasts. But, on the other hand, these Polynesian or Negrito peoples had brought forward the pig from the Archipelago or from the mainland of Asia. In some of the Polynesian islands were found both the dog and pig; other islands were acquainted with the one or the other animal only; and in the Island of Niue was no animal of any kind, I believe, not even the rat. Here, then, in Tahiti we see the pig and dog kept by a Maori people. Yet Mr. Colenso supposes that the Maoris of New Zealand must have of necessity required the English dog, to match the pigs which Captain Cook brought to New Zealand from Tahiti or a contiguous island. Cook makes such entries in his writings as this: "Landed here some *pigs* and fowls, *which we brought from the islands*."

We know that animals of a white colour, not albinoes, but such having the eye of the normal colour, are almost invariably those which have been long domesticated by man. For instance, Professor Boyd Dawkins assumes that the white wild cattle of Chillingham Park and others are feral descendants of the domesticated *urus*. The fact of their being white precludes the possibility of their being an original form. Black is in nature the complementary colour to white, and therefore we expect to find these two colours (if I may so term it) running parallel in the same varieties of animals or domesticated species, as the Black Polled Angus and Highland ox, black and also white horses, sheep, goats, and pigs, not to mention rabbits, cats, rats, and mice, which mostly are deficient in colour in the eye, and so approximate to the albino. All these are altered from their pristine colour by the effect of domestication. So, when we read that the Maori of New Zealand were seen by the early navigators to be possessed of black dogs, white dogs, and spotted dogs, we may reasonably conclude that these dogs had been long under the influence of man.

It would be interesting to know what were the colours of the dogs first noticed among the other peoples of the Pacific. A. R. Wallace gives no description of dogs in the Archipelago. Were the original dogs of the Pacific islands white, black, and spotted, or is this seemingly long-domesticated form of dog the original dog of the Moriori people?

To return to my other argument, which I left uncompleted. If the *helpless* (?) dog of the islands came to New Zealand some three hundred years ago—before Cook's arrival at New Zealand—would not the changed conditions of its life in the new country, and the effect of "variation and domestication," alter its descendants so much that it would become useful to its masters in catching food, and also acquire the habit of providing its own aliment from the plentiful supply of ground-game, such as takahe, kiwi, weka, quail, and rats? The early navigators were only able to report on such doings of the Maori as concerned fishing and a life along the margin of the sea, for they were of necessity obliged to keep near their boats, and often to make a hasty retreat. Both parties were mutually suspicious and fearing treachery; therefore the Maori always saw the European armed and ready for the fray, and the European mostly saw the Maori, as it were, on the war-path. The European and Maori were not then accustomed to go a-hunting together; and whilst the Maori lived at his seaside villa the order of the day would be fishing and feeding on fish; so the dog is said to eat fish. But who was to say that the dogs did not go a-ratting on their own account when so inclined? A small English terrier is often trained to be very useful in catching pigs by the European, and supposing a party of Europeans were left for three hundred years on an island teeming with ground-game, and at the outset had only a few terriers to help them, would not the descendants of these small dogs have increased in size by the judicious selection of their owners during this long term of years? We may safely answer, Yes. What, then, would prevent the Maori selecting his most fitting and useful dogs and eating the puny sluggards? To my thinking, it is preposterous to limit the Maori to one particular shape or size of dog. Even the fact that each tribe of Maori were in dread of other tribes—this alone would cause a variation in the dogs of different tribes by preventing free intermixture. If we find no fossil remains of man or dog seemingly of any great age in New Zealand this will not go to prove the impossibility of a great southern continent inhabited by gigantic moas, the dog, and man. The great and extensive plains or low lands are now buried under the sea, together with all marks of their inhabitants, for the present islands of New Zealand would, under former conditions, be a very high range of mountains, covered in perpetual ice; and, supposing any living thing to die in these ice-covered regions, the dead carcase would be mingled with the ever-moving glacier, and carried onward to the lands which are now at the bottom of the sea. The disappearance of this continent may be coeval with that great convulsion of nature which occurred in the Northern Hemisphere, when the climate of Siberia was so suddenly altered that the living and gigantic mammoth was frozen in ice-blocks, which have remained as evidence to the present day. We have proof that man and the mammoth lived in the same country and at the same period of time in northern Europe, and where we find the evidence of man's existence there also is mostly found the remains of a canine form. The dog would seem to have always been the companion of man, or a feral animal utilised by man as a food-product.

I am sorry to say that I am denied the pleasure of again reading Mr. Colenso's paper on the native dog of New Zealand, Transactions, vol. x., and therefore must refer back to my remarks thereon, which were published in Transactions, vol. xxii.

"Mr. Colenso quotes from the writings of George Forster, 'A good many dogs were observed in their canoes, which they seem very fond of, and kept tied with a string round their middle. They were of a rough, long-haired sort, with pricked ears, and much resembled the *common shepherd's cur*. They are of different colours, some spotted, some quite black, others perfectly white.'"

Now, Mr. Colenso assumes that a *common shepherd's cur* must needs be a dog of small size, the result of cross-breeding between a sheep-dog and a small breed—presumably a terrier. Have we any evidence in English records that shepherds were accustomed to use mongrel dogs to work sheep in preference to using the pure-bred sheep-dog for the same purpose? I think the correct answer here is, Certainly no; such would be absurd. Therefore George Forster saw a similarity between those New Zealand dogs and the English sheep-dog.

"At Tolago Bay," Cook says, "the dogs were small and ugly." This I take to be a special remark, referring to a dog of a kind not previously seen among the Maoris, not that all other New Zealand dogs were alike—"small and ugly."

"Mr. Colenso quotes from Parkinson, 'In one canoe a handsome man, clad in many garments, upper garment made of black and white dogskin. . . . An old man sat in the stern of the canoe; had on a garment of some black skin, with long hair, dark-brown and white border.'" There would seem nothing here to sufficiently prove that all the dogs seen were small and ugly, and you will notice that we have no mention of any *dark-brown* dogs seen alive. "Dark-brown" might just as well refer to trimmings of moa-feathers, which are of a hair-like appearance.

Now to examine the fresh evidence which Mr. Colenso brings forward in his paper, Transactions, vol. xxv., as a rebutment of my own conclusions:—

"Crozet thus writes concerning their native dog: 'The only quadrupeds I saw in this country were dogs and *rats*. The dogs are a sort of domesticated fox, quite black or white, very low on the legs, straight ears, thick tail, long body, full jaws but more pointed than that of the fox, and uttering the same cry; they do not bark like our dogs. *These animals are only fed on fish*, and it *appears* that the savages only *raise them for food*. Some were taken on board our vessels, but it *was impossible to domesticate them* like our dogs—they were always treacherous, and bit us frequently. They would have been *dangerous to keep where poultry was raised* or had to be protected. They *would destroy* them just like *true foxes*. They have absolutely no other domestic animal than the dog.'"

Now, I would ask, why did not Mr. Colenso finish this quotation, which I here give from memory: "*The rats were similar to those of our woods and forests*"? Captain Crozet here gives a very clear description of the dogs which he saw; but it is to be noted no mention is made of spotted dogs, nor of brown-coloured dogs. You will observe that the feeding and habits of the dog are described in a contradictory manner. "These animals are only fed on fish." Of course, such would seem the case when the dog-owners were employed fishing on the coast. Again, "They would destroy poultry just like true foxes." This is right into my hand. If Crozet found these dogs snapping off the heads of his hens as often as they looked through the bars of their coops, it seems remarkable he should not have concluded that they were accustomed to hunt feathers. Therefore these dogs did hunt the ground-birds, to obtain food for themselves and their masters.

What we may infer from the remark on the Maori rat I am unable to say. Crozet does not say the rats of our towns or sewers, *but those of the forest;** but then we need not assume that Crozet had made a study of natural history. If he were country-bred he might naturally allude to the *Mus decumanus* in the home of his childhood; or it may have been the European black rat (*Mus rattus*), a form of which we have with us at the present day, as Mr. Colenso very correctly remarks.

Mr. Colenso quotes from Dr. Marshall, surgeon in H.M.S. "Alligator," who, after remarking on the rugged nature of the sea-shore and the prevalence of high winds, says, "rendering the supply of fresh fish very precarious, while the absence of native animals, and the paucity of those *imported*, such as *dogs* and pigs, occasion a dearth of *fresh meat*. . . . The dog, from the treble purpose served by it, of a *watch when living*, and *food* and *clothing* when dead, is highly valued by those he serves, and its *bones carefully preserved*. The skeleton of one, bleaching in the sun, was found on a high pole at the Namu, with the *tapu* or sacred thread wound round it, and a tuft of white feathers fastened to its skull." Mr. Colenso says, "Of course, Dr. Marshall received this information respecting their food, and much more, from Mrs. Guard, who, with her child, were residing as captives among those Maoris for five months."

Here, on the authority of Dr. Marshall, from information obtained through Mrs. Guard, we find that Mr. Colenso adopts the error in which these two had fallen by assuming that both the dog and pig were *imported* animals. Where, then, had the original native dog disappeared to so suddenly? But note how Mr. Colenso runs counter to the opinions expressed by Dr. Marshall:—

"Moreover, the *facts* stated by Dr. Marshall—(1) of the bones of those 'imported' dogs being 'carefully preserved'; and (2) the skeleton of another found 'set apart (*tapu* = sacred), bleaching in the sun, and ornamented with white feathers fastened to its skull'—are to me a convincing proof that such bones were *not obtained* from the common small New Zealand dog, whose *flesh had been used for food* (which *never could* become *tapu* with the Maori), but only from some peculiar and prized animal, such as an imported and high-priced and highly-valued one would be."

Yet Dr. Marshall distinctly says these dogs were highly valued "as a watch when living, and *food* and clothing when dead." Not a word about hunting or catching the wild pig. So far as my experience goes, the Maori kept the pig in a semi-domestic condition, and would round them up and catch those they wished without the help of dogs.

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* Perhaps meaning the black rat of Europe.

The respect shown to these remains of dogs described here corresponds to the surroundings of the skeleton of a dog wrapped in matting which was found by Captain Rowan, and referred to in Transactions, vol. ix., page 243, some years ago.

I maintain that we have no proof that the dogs seen by Dr. Marshall and Mrs. Guard were European or imported dogs, and that they were the *kuri*. No colour, form, or size is here given, but the matter of the *tapu* is of great interest.

Mr. Colenso entirely gives himself away when he says we have not proved beyond doubt that the original native rat (*kiore*) is living with us at the present day. Note the last paper on this subject (Transactions, vol. xxv.) by Sir W. Buller. Mrs. Guard was wrecked on the coast of New Zealand on the 29th April, 1834, at which time the dog, when living, acted as a watch, and was food and clothing when dead. (Note remarks further on in this present paper.) I am of opinion these were the *kuri*. Yet Mr. Colenso says Messrs. Marsden and Nicholas failed to see the native dog in 1814–15, but they saw *imported* dogs in great numbers, and also *running wild*. Where can I see an account of these dogs of 1815?

Mr. Colenso sums up the result of his observations or quotations thus: "It was really a domestic animal, small in size, with pointed nose, prick ears, and *very little eyes;* that it was dull, stupid, and ugly; of various colours—white, black, *brown*, and particoloured—with lank long hair, and a short bushy tail; that it was fed on fish and refuse offal, and that it was quiet, lazy, and sullen, had little or no scent, and had no proper bark." I fail to see where the authority for the brown colour is obtained; but that there were such I do not doubt.*

I have gleaned all the evidence on the native dog which is to be found in the account of Cook's "Voyages" round New Zealand, which appears to be given verbatim in Chapman's "Centenary Memorial of Captain Cook's Description of New Zealand," and will now place them before you.

When in Hawke's Bay, "A large canoe, with two-and-twenty armed men on board, came boldly up alongside the ship. We soon saw that this boat had nothing for traffic; yet we gave them two or three pieces of cloth, an article they seemed fond of. I observed that one man had a *black skin* thrown over him, somewhat resembling that of a bear, and, being desirous to know what animal was its first owner, I offered him for it a piece of red baize, and he seemed greatly pleased with the bargain, immediately pulling off the skin, and

* Mr. A. Hamilton says, in Trans., vol. xxv., p. 488, "In the mat under notice the upper and lower edges had a fringe of strips of dogskin, with black, reddish-brown, and white hairs twisted in."

holding it up in the boat. He would not, however, part with it till he had the cloth in his possession, and, as there could be no transfer of property if, with equal caution, I had insisted on the same condition, I ordered the cloth to be handed down to him, upon which, with amazing coolness, instead of sending up the skin, he began to pack up both that and the baize which he had received as the purchase of it in a basket, without paying the least regard to my demand or remonstrances, and soon after, with the fishing-boats, put off from the ship."

"Soon after this occurrence some natives in a canoe seized Tayeto, Tupia's boy, and tried to paddle the canoe quickly away. The marines fired at the canoe, and one man dropped; the boy, jumping into the sea, swam to the ship. This cape was therefore called 'The Kidnappers.'"

"This bay is called by the natives Tolaga. We saw no four-footed animals, nor the appearance of any, either tame or wild, except *dogs* and *rats*, and these were very scarce. The people eat the dogs, like our friends at Otaheite, and adorn their garments with the skins, as we do ours with fur and ermine."

"In one of the canoes that came about us as soon as we anchored we saw two men, who by their habits appeared to be chiefs; one of them was dressed in a jacket, which was ornamented, after their manner, with dogs' skin; the jacket of the other was covered with small tufts of red feathers. . . . In other seasons they have certainly plenty of excellent vegetables; but no tame animals were seen among them, except dogs, which were *very small* and *ugly*."

This definition of the dog I maintain to be only referring to the dogs of this particular district—of Tolaga Bay—and not applicable to all the dogs seen in New Zealand.

Page 28, "First Voyage," Queen Charlotte Sound: "The family, when we came on shore, was employed dressing some provisions; the body of a dog was at this time buried in their oven, and many provision-baskets stood near. Having cast our eyes carelessly into one of these as we passed it, we saw two bones pretty cleanly picked, which did not seem to be those of a dog, and which upon nearer examination we discovered to be those of a human body."

Page 133, "Second Voyage," Queen Charlotte Sound: "These new-comers took up their quarters in a cove near us, but very early next morning moved off with six of our small water-casks, and with them all the people we found here on our arrival. This precipitate retreat of these last we supposed was owing to the theft the others had committed. *They left behind them some of their dogs.*"

Here we have seemingly an instance of the owners leaving at a time when their dogs had gone on a hunting expedition on their own account. How easily would come about leaving, and subsequent wildness of dogs, when we remember the people of one tribe were always, or most frequently, on the alert to surprise and murder those of another tribe not in friendly alliance with them! Kill the owners of any dogs and it would be highly improbable that the dogs would chum in with the strangers; hence they would become feral, for they could easily support themselves, feeding on the flightless birds of the country.

"Further Notes on the Habits and Customs of the Maori," by Captain Cook: "But the great pride of their dress consists of the *fur* of *their dogs*, which they use with such economy that they cut it into *stripes* and sew them upon their cloth at a distance from each other—a strong proof that dogs are not plenty among them; these stripes are also of *different colours*, and disposed so as to produce a pleasing effect. We saw some dresses that were adorned with feathers *instead of fur;* but these were not common, and we saw one that was entirely covered with the red feathers of the parrot."

"Second Voyage," Massacre of boat's-crew from the "Adventure," Captain Furneaux, 17th December, 1774, at Ship Cove. Mr. Burney's report: "In a small beach adjoining Grass Cove we saw a very large double canoe, just hauled up, with two men *and a dog*. The men on seeing us ran into the woods. In this canoe we found things belonging to the lost crew—a great many baskets, some full of roasted flesh. On further search we found a hand belonging to Thomas Hill, it being tattooed 'T. H.' at Otaheite.

"The next bay, which was Grass Cove, we found no boat, but, instead of her, such a shocking scene of carnage and barbarity as can never be mentioned or thought of but with horror, for the heads, hearts, and lungs of several of our people were seen lying on the beach, and, at a little distance, *the dogs gnawing their entrails*."

A note appended to Chapman's "Centenary": "Earl (page 194) speaks of a rich feast, not of pork, nor fish, nor even the *kumara*, but of two old sturdy *large dogs*. There were only five persons allowed to partake of this delicious meal, which was, as well as the five partakers, strictly tapued for the whole of that day. A similar dish was offered to Cook at Otaheite."

Extract from introduction to Chapman's "Centenary": "The New-Zealanders assert that their ancestors *did not bring the dog* with them, but that it was introduced by a ship that visited the islands before the arrival of Cook. The obsolete name *pero* for that animal is identical with the Spanish name."

Referring to the above, I may state that New Zealand, or a part of the eastern coast, was shown on the Portuguese charts some fifty years before Cook's arrival at New Zealand.

"A strong proof of the visit of the Spaniards or Portuguese exists in the fact of Spanish names attaching in the old charts to capes on the eastern coast. The coast-line from Poverty Bay to Cabo Formosa, or East Cape, was laid down on the Portuguese charts, whilst Dusky Bay and portions of the south-west coast appear in the charts of the Spaniards previous to the voyage of Cook.

"Note: The Portuguese nomenclature appears to have been copied for some time at the Hydrographic Office. On the Admiralty charts of the Indian Ocean of 1827, against the draft of the group, appears this note: '*New Zealand, discovered and named by Tasman, 1642, but whose eastern coast was known to the Portuguese about 1550.*' And also, against Cook Strait, east side: '*Gulph of the Portuguese, 1550.*'

"The Spanish navigator, Juan Fernandez, in the year 1574, sailing from the coast of Chili . . . in a small ship, with some of his companions, reached in about a month a tierra firma, which was fertile and pleasant, and inhabited by a race of *white people*, well made, and dressed in a species of *woven cloth*, and who were of an amiable disposition. Several rivers fell into the sea, and altogether it appeared much better and richer than Peru."

Dr. Thompson estimates the distance between Peru and New Zealand as 7,000 miles.

The speaking of the natives as white may be in contrast to black of the Negro race.

From this view of the case we cannot deny the possibility —nay, even the probability—that a Spanish or Portuguese dog or dogs were left at New Zealand long before the time of Captain Cook, more especially when it seems certain that this word *pero* was only used by the Maoris of the extreme North. But that they also had the dog of Polynesia, or, at least, the recollection of its Polynesian name, there is ample proof, *kuri* and *kuli* being the name for dog all through Polynesia. I speak thus cautiously because, although the Maori had no pigs before they were brought to New Zealand by Cook, yet they had a knowledge of its Polynesian name, as Cook himself says.*

It seems that men of science in the Northern Hemisphere are, like ourselves, more or less ignorant as to what kind of animal the New Zealand dog really was. In the last volume of Transactions (xxv.) you will notice a translation from "The

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* A dog of the name of Pedro (Peter) might be left or stolen from a ship, and the Maoris would call it and its half-bred descendants *pero, pero*, in place of *moi, moi*.

Moas and Moa-hunters," by Monsieur A. de Quatrefages, in which occurs the following:—

"The Maori dog, which *came from* the Islands of Manaia, belonged to this Polynesian race, which *all travellers* describe as being vegetarian, and *must have retained* its natural habits in New Zealand. Besides, if the dogs had taken to *eating meat* their masters would have quickly discovered that this food affected in anything but an agreeable manner the flavour of their flesh, and they would not have failed to guard the observance of the habitual course. It is quite natural, therefore, that the Maori dogs did not behave like those which accompanied the old Danes of the *kjœkkenmœddings*, and that they did not leave, as these latter did, the trace of their teeth on the refuse bones around them."*

Note (86): "The dog was called *kuri* by the Maoris. This *local race* was small in size, of a *brown* or *yellowish colour, long ears*, and bushy tail. It is extinct now, and replaced by the European dog."

Note (87): "The flesh of our European dogs, who all more or less eat meat, has a particular flavour, reminding one of the odour of a badly-kept kennel, as was only too well known during the siege of Paris."

I may remark here that the Chinese are said to keep the dogs they eat in pens, as we do our pigs; but the Maori did not do so. We know that the dog is naturally a carnivorous animal and a general scavenger. For this latter purpose dogs are highly valued in eastern cities of Europe, as Constantinople, Cairo, &c. As for the Maori dog being a vegetable-feeder, the idea is absurd. Can we suppose that the Maori would toil at digging fern-root, cooking, and pounding it, and then giving it to his dog? Nor could he grow *kumaras* or other esculents in sufficient plenty to supply even his own requirements. Fish, flesh, and fowl were undoubtedly the main staple food of these people, more especially to those living in the frosty climate of the south. For flesh we may read dog and human flesh.

From fear of making this paper too lengthy I did not give the following entry of Captain Cook's, but possibly it may be of special interest: "During my last voyage, when we were continually making inquiries about the 'Adventure' after our separation, some of the natives informed us of a ship having been in a port on the coast off Teerawitte, but at that time we thought we must have misunderstood them. The arrival of this unknown ship has been marked by the Maori

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* I do not myself see how kitchen-middens could be formed where domestic dogs were present. Would they not carry the bones all about the place?

with more cause for remembrance than the unhappy one just mentioned. Taweiharooa told us their country was indebted to her people for the present of an animal which they left behind them. But as he had not himself seen it, no sort of judgment could be formed from his description of what kind it was."

This can hardly have been any kind of dog—though, perhaps, Cook might understand "large dog," or "something dog," to mean some sort of animal other than dog, for I am given to understand that when the Maoris first saw the horse they named it *kuri*, as other Polynesians who had no dogs, but possessed pigs, called the horse "the pig swift (running) on the land"—Tahitian, *puaa-horo-fenua;* and at another island they, on first seeing the dog, called them pigs (*broas*).* So we have proof of the difficulty of this investigation. *Te ra whiti* means a place in the direction of the sun's rising. Some suppose this ship to be that of the ill-fated Marion. (When Marion was murdered, Crozet took command of the vessel.) The headland in Cook Strait which Cook supposed to be then referred to was "known to the Maori as *To poroporo*," but possibly the natives really meant "at a distance eastward—far away."

In Dr. Von Jhering's paper "On the Ancient Relations between New Zealand and South America," Trans. N.Z. Inst., vol. xxiv., are the following remarks: "The fauna of East Polynesia has such a well-pronounced Mesozoic character that the supposition of a very old Pacific continent, breaking up in pieces more and more during the Mesozoic era, may give us a natural explanation. And the further we go westward the more frequently we meet with recent types—in New Guinea the genus *Sus* and *Muridæ;* in Australia, besides *Muridæ*, also *Canis*. The craving only to make of Australia a land completely without placental mammals accounts for *Canis dingo* being considered as a *race* of the *domestic dog*. This error has been settled definitely by Nehring.† *Canis* no doubt belongs to the oldest Carnivora. Species of *Canis* are found in India and Sumatra, and *C. dingo* is as well a domesticated sporting-dog as *Canis latrans* of the North American Indians,‡ or *C. ingæ* of the old Peruvians. . . . We shall have to give up the theory of the floating-trees with *Sus*, *Canis*, *Muridæ*, *Lacertidæ*, fresh-water Molluscs, &c., in their branches, as well as many other things of Wallace's hypothesis; and the botanists will not tarry to reduce the transports by currents and winds to a moderate measure."

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* Max Müller, "Science of Language."

† Nehring, Sitzungsber. d. Ges. naturf. Freunde: Berlin (1882), p. 67. Zoolog. Garten (1885), p. 164.

‡ The coyote (wolf).

The natives of the Polynesian Island Niue are of the *fair* Polynesian race, possibly without the admixture of Negrito blood, and akin to the Moriori of the Chathams. Their home is situated about two hundred miles to the east of Tonga, and nearly three hundred miles south of Samoa. It is about forty miles in circumference. These people had neither the dog nor the pig; whether without rats and lizards I cannot state. They would seem to have had no proper name for our term "*animal*," for in a translation of the Bible by the Rev. Frank Lawes the word "animal" is rendered "*four-boned bird.*" They, of course, speak a dialect of the Maori language: *E manu huifa*, "four-footed beast"; *e manu lele*, "a bird"—*i.e.*, a flying bird or animal. *Manu* I take to have been *bird* formerly,* but that after the introduction of animals to the island the addition of *lele*. "flying" = Maori, *rere*, "to fly or run," was used as a specific distinction. *Hui-fa*, literally "bone-four" (four-footed), which seemingly corresponds to Maori *uwha*, "the female" (of brutes only). Mr. Tregear, in his paper "Had the Polynesians a Knowledge of Cattle?"† treats the Maori *uwha* thus: "*U*, 'the female breast'; *wha*, 'four': Can this mean an animal having four teats, as the cow?" We seem to get the original form of Maori *u* in *uwha*, from Niue, *hui*, "a bone." Whether a good philologist could, by a study of the word *manu*, "a bird," prove that the old-time Polynesian lived in a land where no land-mammals existed I know not, but this would seem worth the looking-up. In Niue, *manu huifa he vao*, "beasts of the field"; *e tau manu huifa oti kua mea*, "all the four-footed beasts that are clean." The Maori *kuri* and *kararehe* are taken as equivalent to "beast"; yet these words, before the advent of Europeans, meant "dog." In Tahitian a goat is *puaa-niho*, literally "the pig with teeth" (on top of his head)—*i.e.*, the horned animal. This study, you see, would be very interesting if well followed up.

You will notice I have stated two issues—(1.) Had the Moriori, or first inhabitants of New Zealand, a dog (feral or domesticated) and the moa previous to the arrival of the Maori or mixed Polynesian and Melanesian race, bringing the *kuri* with them? (2.) Or were the original inhabitants of New Zealand (the backbone of a sunken continent) totally unacquainted with any land-animal other than varieties of the lizard, and birds? I will now give you part of a letter written by a gentleman whom I some time ago asked to procure me skulls of the Maori dog for examination, but whose name I at present withhold from publication: "While digging lately I

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* Maori, *manu*, a bird.

† Trans. N.Z. Inst., vol. xxi., p. 447.

found one (a dog-skull) under the sand, alongside a kowhai upright piece of wood, which had been the support, or one of the supports, of the roofing of an ancient Maori dwelling, which could only have been inhabited eighty or a hundred years ago, as no natives have been at the place for over that time. It is quite possible this dwelling may have been empty for two hundred years. I forward this head, and one found by my brother, and a lower jaw found by him at another old settlement. . . . Sometimes *very large* heads have been found, and at others *very small* ones. . . . If I had known some years ago I could have got you hundreds, but now they are getting scarce."

These two skulls are surprisingly small. The two, and a piece of a substance like ruddle or red-ochre, were packed in a compass which might be supposed to contain one fair-sized skull. They must be very different from the one Mr. A. Hamilton found at Shag Point or River, and which he said was about the size of that of a collie-dog. Now, I would ask the question, Have we not here something worthy of note—a dog buried at the foot of a post—presumably "the chief corner-stone" of the building—for I suppose other parts of the skeleton were with the skull? Had the Maori a custom of making his new dwelling *tapu*, sacred to himself alone, or to be guarded by the spirit of the dog; or allied to the custom of *Rahui?* At one time in Europe it was customary to bury a slave, or some particular person, at the ceremony of laying the chief corner-stone, and perhaps we still have a survival of this idea when we in modern times place coins, newspapers, &c., under the foundation-stone. I would like the opinion of a good Maori scholar on this point. Of course, the old-time missionaries would set their faces against such customs as heathenish, and *would ignore them,* as in Europe idols and so-called sacred books of the old faith were destroyed or burnt.

In the Maori language are three words which mean both dog and quadruped—*kuri,* which is the most general term for dog; *kirehe* and *kararehe,* which seem allied to the verbs *karehe* and *rere,* "to run"; the latter also means "to fly" and "to flow," as water. The following quotation from Genesis, i., 24, will serve as a comparison with those given in the Niue tongue: *Te kararehe, me te mea ngokingoki, me te kirehe o te whenua.* In Rarotonga the pig, as the best-known quadruped, has acquired the meaning of animal or cattle, as *e pou oki ta kotou au* puaka *i te reira,* "and will also destroy your *cattle.*" At the present time to define a pig the Rarotongan will say *puaka maori*—*i.e.,* the indigenous animal. This gives us the meaning of our word *maori* as applied to the native race, meaning indigenous, common, or ordinary, and would seem to be short for *tangata maori,* "a man indigenous" (to the country). In

Tahitian the letter *k* of the Maori is lost, as *puaa*, "a pig"; but it is remarkable that the Maori *t* is changed to *k*, as *tangata* = *kanaka*, "a man." The *ng* of Maori = *n* of Tahitian.* In this language *puaa* also means cattle. So now I have called your attention to the remarkable fact that in various parts of Polynesia words originally meaning *dog*, *pig*, and *bird* are now, owing to the introduction of different kinds of animals by Europeans, come to mean *animal*, *beast*, and *cattle*. We may ask the question, Did these people, through their ancestors, at a former time know the numerous animals of the Continent of Asia, and, if so, how many generations intervened before these people, living on islands where such quadrupeds were not found, lost all tradition of and the names of once-known animals? And, again, if they never knew of the animals of the mainland, how do they come to possess the dog and pig? Have they met and mingled with a Negrito race in mid-oceanic islands, which latter race brought forward at different migrations at one time the dog and at another the pig? There is also the question of the domestic fowl, which, originally from India, might be carried forward by a Brahmin migration as far as Java. If so, possibly the dog and pig also came by way of India, and so by way of the Malay Archipelago onward to various islands of the Pacific and to far-away New Zealand. The pig and fowl came to New Zealand by the agency of Europeans. As Captain Cook says, "There we landed pigs and fowls which we brought from *the islands*"; and Maori tradition claims that they brought a dog, or the dog, in one of their canoes when they sailed from far-away Hawaiki.

Since Dr. Carroll has proved, by translating certain of the Easter Island inscriptions,† that they are of the same language as those found on the mainland of South America, in Peru, that formerly there was traffic between those two places; and, as we now find Easter Island inhabited by a Polynesian people, sufficient proof is obtained that man had successfully navigated the whole breadth of the Pacific between the Malay Archipelago and South America. Whether the Polynesians found any of the people who came from America still there when they took possession of Easter Island we have as yet no evidence; but it would be highly probable that a dog was brought from Peru and remained on Easter Island.

On the 21st June, 1764, the Honourable Commodore Byron left the Downs in Her Majesty's ship the "Dolphin," on a voyage of discovery round the world. At the Faukland, or Falkland Islands, when Byron's sailors went ashore, no inhabit-

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* The natives of the Sandwich Islands who join European ships as sailors are known as kanakas.

† "Polynesian Society," vol. i.

ants were found, but there were dogs, which had no fear of man—in fact, they seem, owing to curiosity alone, to have followed the sailors so closely that the latter, from fear, ran into the sea. How can we account for these dogs being there? and have any signs of previous inhabitants been found on the islands, such as stone implements, &c.? At a later period cattle had been left there, and had become feral. Darwin remarks on them in one of his works. The climate was said to be continually wet, and the land mostly peat-swamps. Now I notice that wool and frozen mutton is exported from this place to the European markets. Some may say, What has all this to do with the dog of Polynesia? To which I reply that a careful observer should, in doubtful cases, collect all information possible, which may, or may not, ultimately have a bearing on the case under consideration. The dog is one of the few landmarks which we may connect with Polynesian history, and, as such, should attract the attention of those who wish to study the whence of the Maori people.

A gentleman whom I quoted in my former paper under the *nom de plume* of J. B., owing to not receiving written permission to use his name previous to my sending in the paper, is Mr. James Bennett, of Lovell's Flat, Otago. Referring to remarks which were made on this former paper, I may say that it is not good policy to speak of our helpers as "second hand," or as "men of to-day." Every man, old or young, "gentle or simple," has a right to hold his own opinion on any given subject.

Art. LXXI.—*Spiders as Engineers.*

By Coleman Phillips.

[*Read before the Wellington Philosophical Society, 20th September, 1893.*]

On the 6th and 7th July of the present year there fell 4in. of rain, and we had a flood in the Wairarapa slightly higher than the flood on the 10th March last, when I believe the heaviest rainfall occurred that has been recorded for many years in New Zealand.

On the 8th July I rode round the run to see how the drains were acting. Most of the swamp-paddocks were under water, but the small drains on the higher ground in the bush were running swiftly. The sun had risen about half an hour, and the fog was lifting. I could not therefore help noticing the numerous geometric spiders' webs all around me, and the little bridges the animals had made across one of the drains, either the evening before or during early morning, each web being loaded with the fine particles of fog or dew. There had been very heavy rain on the 7th, so that the webs must have been spun out during the previous six or twelve hours from the time I noticed them—7.30 a.m. on the 8th. (It has never been properly explained by Darwin that by any process of reasoning a spider knew that it was safe to throw out its web, and that the day was going to be fine. I propose hereafter to read to members a paper bearing directly upon this subject, and being a continuation of the paper I had the honour of reading before members upon the Common Vital Force.)*

The first thing that really struck my eye was the heavy shore-stay construction of one of these bridges, and I got down to examine it. It was a typical suspension bridge, quite taut, but the shore-stays much more extensive, heavy, and intricate than our engineers usually make. It had two long down-stream steadying stays fastened to each bank; height above water, about 2ft. Drain itself, 4ft. to 5ft. wide, running through a fallen and burnt 5-chain track in the bush. The next bridge was a double bridge joined together by a centre span, but without so many shore-stays. The next one was also a double bridge, with strong upstream stays. The different parts of these double bridges appeared to support each other considerably.

The tautness of many of the bridges was peculiar, spiders' bridges being usually limber and free. Some of the double bridges were evidently accidental; but there could be no mistake in the tautening-up. No matter how the web crossed the stream, or crossed another web, the tautening-up when necessary put everything straight, and the structure itself in tension. The animal knew, I suppose, that in crossing water it would be necessary not to have too much play in the web, in order to avoid taking a plunge at times in the water itself, or the water rising to catch the slack.

No radiated-sail prey-web was hung upon any of these bridges. These were all suspended immediately on the side of the drain, or slightly overhanging the water, or upon the fallen burnt bush. There were vast numbers of these geometric webs, and very pretty they looked. I never remember seeing such a vast quantity, all of which must have been thrown out within the previous few hours. The animals perhaps were starving after a two to three days' rain. As the webs were spread out to the height of 8ft. from the ground upon any burnt limb, and as there were as many as ten or a dozen webs upon each limb, I thought at the time that it would be very difficult for any flying insect to escape being caught in one of

* See Trans. N.Z. Inst., vol. xix., pp. 592 and 593.

the webs. At the same time I could not help noticing that, numerous as the webs were, the little bush-birds flew in and out amongst them with unerring accuracy, never injuring one. The quickness and grace of the birds in avoiding the thousands of webs was most interesting to watch. I am particular in recording these circumstances and the exact date in order to allow future observers to watch the spiders work at this period of the year.

The downstream stays to the bridges (and nearly each bridge had two—one to each bank) were slack, and only served to steady the structures. The animals apparently threw these out as a matter of course, whether there was any wind or not. There was little or no wind that morning. We appear to dispense entirely with these shore-stays in our lofty flying bridges. But in the matter of the Victoria Bridge, lately washed away in the Brisbane floods, might not these shore-stays have been of great service? Of course, I do not for one moment wish to set my opinions against those of our great bridge engineers, seeing that I know very little of bridge-work; but I have always had great faith in nature's plan of construction. If we ever should use shore-stays like those to which I allude above, then I imagine such stays would have to be constantly inspected and renewed when worn at all. Two great cable-stays upstream might have saved the Victoria Bridge in Brisbane; but the engineer who constructed it can best say whether this was practicable or not. I only wish to point out that spiders apparently use such stays. The method of construction appeared to me to be as follows: The animal allowed so much web to float out of its spinnerets, and when it thought sufficient had gone to reach the opposite bank it tested the web, and if the web had caught on it took in the slack, and then attached the top-, bottom-, and side-stays, one by one, strengthening all and tautening all with cross-bars, the finished structure being an excellent suspension bridge. Most of the bridges were placed at an angle across the drain, showing how the web had floated out; but some were straight across.

The height of the shrubs forming the shore-pillars was about 1ft. to 18in. Along the edge of each side of the drain, and connecting pillar to pillar, were a multitude of side-webs (which I will call edge-webs), evidently for the purpose of further strengthening and tautening the bridges and pillars, and for quick locomotion. In its own mode of reasoning the little animal appeared to think that it *could* strengthen the shrub pillar by attaching shore-stays to its extreme tips, and side-stays also. I saw one bridge spring out from an edge-web, and then the edge-web strengthened and secured to the bank by a multitude of cross-bars. Amongst that myriad of webs I did not see a single spider, so I cannot tell to which order it belonged. I do not think it was *Argyroneta aquatica,* but rather an ordinary geometric spider. The bridge-structures and land-stays were evidently for the purpose of allowing the animal to pass quickly from side to side of the drain. With regard to the shore-stays beneath the roadway, I do not remember seeing such stays used in any of our suspension bridges. I suppose it is considered that they would only add weight to the structure. I fancy in this that strength is sometimes sacrified to lightness.

[NOTE.—Mr. T. W. Kirk has called my attention to the Hobson Street suspension bridge, Wellington, in which there are shore-stays beneath the roadway, and he informs me that they are not uncommon, only in low suspension bridges they form a danger in time of flood. Mr. H. B. Kirk, M.A., also informs me that across the Kaihu River, at Opanaki, Dargaville, there is a small bridge with both upstream and downstream stays.]

Immediately on the land-side of each bridge a geometric prey-net was always suspended, which makes me think that the bridge and the two land-webs belonged to the one spider. There was no reason, of course, why one spider should not have hung eight or ten prey-nets, and constructed two or three bridges. My sole reason for writing this paper is to call attention to the fact that we should stay our high bridges more than we do, and as far out as we possibly can, by pillars lessening in height, if necessary, to each shore. It may have been that if the Tay Bridge had been properly stayed, as these animals stay their structures, especially in the direction of the greatest wind-force, the late fatal collapse and loss of life there would not have happened. Of that I feel convinced. The enormous stays of spiders' webs must strike any person. Would it not, therefore, be a safe plan for our engineers to construct intermediate side-pillars up and down stream if necessary, according to the direction of the greatest wind-force; stay these pillars from the shore, and the bridge from the pillars? Might this principle not be applied even now to the great cantilever bridge over the Forth, or to Brooklyn Suspension Bridge in New York, or to Clifton Suspension Bridge? A couple of stays would greatly strengthen any bridge. Of what use would our tall ship-masts be without their side-stays? The two constructions are not analogous, I know, but the principle is almost the same. The vibration of the Brooklyn Suspension Bridge is so great that the trains are always drawn over it by ropes; it is not safe to allow the engines to drag them. The use of stays might reduce this vibration.

Art. LXXII.—*On a Common Vital Force.*

By Coleman Phillips.

[*Read before the Wellington Philosophical Society, 20th September and 1st November, 1893.*]

Section I.—Similarity of Construction.

I should like to refer to some of the facts I have been collecting for years past to illustrate the perfect equality of construction amongst all living things in the common vital force, and I would ask members to treat this section as following my last paper upon "Spiders as Engineers."

The first idea of a suspension bridge was suggested, I believe, by the creepers in the tropical Mexican forests, not from spiders' bridges. Brunel designed his famous boring-shield, with which the Thames Tunnel was excavated, solely by watching through a microscope the movements of the *Teredo navalis* (ship-worm), which used to be so destructive to our ships. The Eddystone Lighthouse is built on the plan of a tree-trunk, and is fastened to the rock in a manner similar to the way a tree clings to the soil. Our chief harbour engineers, supplied with the force of a hundred thousand men, cannot surpass the labour of the coral polypi in great protectective works.* The spiral stairways of some of our highest towers do not surpass in strength and design the whorls of the little sea-shell *Turritella*. What works have we to exceed in strength and lightness, combined with storage-capacity, the cells of the common honeycomb? How many things are there which we construct more accurate in measurement than the web of any ordinary geometric spider? Very few: the graded circle for an equatorial telescope perhaps is equal to the web in accuracy. Sir Joseph Paxton designed the Crystal Palace from the floral structure of the gigantic leaves of a water-lily (*Victoria regia*): thus, by solely patterning after nature, an obscure gardener became a great architect. Do any of our aërial machines compare for one moment with the mode in which nature carries, say, a thistle-seed fifty or one hundred miles through the air, although I must say that aëronauts try to copy the structure and movements of birds? But there are many inanimate microscopic things always floating in the atmosphere the form of which they had far better study. (The word "inanimate" may be wrong, as anything

* In Napier, Hawke's Bay, a breakwater is being constructed at a cost of £500,000. I do not think it possible to construct a harbour of any great utility there under a cost of £5,000,000.

that moves may be said to have life.) In laying its eggs on the water the gnat fastens them into the shape of a lifeboat, which it is impossible to sink without tearing it to pieces. The cocoanut in its husk is an admirable life-buoy, prepared to float for months from island to island; and similarly with other hard seeds I have met with in the Pacific. Salt water is usually death to the vitality of most land-seeds, but here we find seeds of trees and plants protected by their hard cases from any such harm. The strength of arch-construction in nut-fruits generally is wonderful, but the triangle of the Brazil nut, with its inner strengthening-braces, is not yet quite understood. Each of the teeth of the two little ovipositor saws of the saw-fly (*Tenthredo*) is furnished with smaller notches, so that the teeth are again toothed. None of the carpenters' saws that I know of go so far as this. The burhstones of mills are much like our molar teeth, which grind and grind away. The hoofs of horses are made of parallel plates like carriage-springs, or, rather, *vice versâ*, carriage-springs blindly follow nature's pattern. The finest file of human manufacture is a rough affair compared with the Dutch rush, used by cabinetmakers (horsetail = *Equisetum*). Our carpenters' plane is found in the mouth of the bee. The woodpecker is furnished with a powerful little trip-hammer. The squirrel carries chisels in its mouth, the hippopotamus adzes, and the jaws of the turtle and tortoise are natural scissors.

The diving-bell, after all, only imitates *Argyroneta aquatica*, a water-spider which carries globules of air down to its cell below the water-line, until it has there an excellent and secure air-chamber. I am indeed told of a spider which almost spins an actual diving-bell, and takes the air down in it. The iron mast of a modern ship is strengthened by deep ribs running along its interior. A porcupine's quill is strengthened by similar ribs. I do not say that the designers of the mast copied directly from the quill — they only blindly followed the principle, the similarity in construction being all through nature, and forming part of the common vital force, as I tried to point out in the paper upon that subject I had the honour of reading before this Institute in 1886.* All I am trying to show in the present paper is that discoverers in future, where they can, had better study carefully the simple designs and constructions in the natural world, such as the spiders' bridges I refer to, these being the best exemplifications of construction in vital force we possess — a construction, too, common to all living things. I do not say, however, that man cannot himself discover (he *does* discover, but he does not invent). The word "*inventor*" in

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* See vol. xix., pp. 592, 593.

its ordinary accepted meaning is really a misnomer, as man invents nothing. He only discovers the telescope, microscope, telephone, railroad, steamship, or electric marvels; he does not invent them, because they are in the magic womb of nature all the time; and scores of other marvels too, about which he at present knows nothing. A friend of mine holds that man invents when he adapts certain simple natural laws in a peculiar way, such as the compound microscope. I fancy the adaptation is in nature all the time, and man only discovers it. In my opinion, man only taps the box, and the marvels appear. The true rendering of the word, however, is correct, seeing that it is derived from *invenire*, "to come upon," and the peculiarity is that the marvels only come upon us as they are required for our benefit. Thus the man who discovered the steam-engine is said to be one Solomon Caus, of Normandy, in 1576. He was promptly put in a mad-house (*Bicêtre*), was there seen by the Marquis of Worcester, who revealed the matter to the public, and was considered to be as mad as Caus. The world was not exactly ready then, I suppose, for the discovery. Neither did electric communication "come in" until it was apparently necessary for European man to communicate quickly with the newly-discovered Continents of America and Australia. The same with the steamship. Before the time of Columbus the steamship would not have been of much service. Sailors hugged the land, and knew scarcely anything of the mariner's compass. Before the discovery of the compass and the revelations of Bruno, Galileo, Copernicus, and Newton, of what use would steamships have been? Man had no guide to cross the ocean save the stars. True, the compass was discovered by the Chinese three thousand six hundred years ago. But I do not wish it to be understood that the compass was absolutely necessary to navigation, as we managed without it by hugging the shore; but for much ocean traffic the compass and the other revelations, I hold, were absolutely necessary. (It is pleasant to find that astronomical discoveries are always named as such, and not by the word "inventions.") The electric light would not be of much service to the pigmies of Central Africa.

But let me proceed with the other examples I have been collecting. A fish constructs and weaves its nest much like a bird. Maoris and Fijians weave reeds most beautifully in their houses. Weaving was, and is still, a most useful art among savages, birds, fishes, &c. The shadow-bird of South Africa builds its nest with about a cart-load of sticks, in three compartments, divided by partitions—the outer one a guard-room for the male bird, the centre one a nursery for the young, and the inner one a living-room for the female. Like us, too, this bird is fond of decorating the walls of its living-rooms with any brightly-painted or shining thing. It will weave in a piece of sardine-tin, or a metal fork, or any bright thing for a picture. If the Dutch farmers miss anything of value, and there are shadow-birds' nests near, they always search the nests for the lost articles. A Kaffir's hut is much like that of an enlarged shadow-bird's dwelling, save that it has only one compartment, not three. From the round dome the improvement has gone on to the hip-roof, and from the hip-roof house right through the gamut of construction to the marvellous Taj Mahal. There is, however, little or no evolution in this, as beauty of design in construction or sculpture is all the time in the womb of nature, so that an African pigmy queen, once entering upon the gamut, might run through the scale to the Taj Mahal. We can see that in the wondrous beauty of form in flowers and plants, the construction of which should guide us in many of our buildings. No sculpture of the present day can equal the work, say, of Phidias, the Greek. By the principle of evolution we ought to be better now than Phidias.

In dam-building we do not much excel the beaver. The great dam-builders of India and Ceylon knew little or nothing, I should suppose, of the beaver's plans, but, as there was only one way in nature of doing the work, both the beaver and man simply followed the natural law, which clearly is a rule quite apart from natural selection. (I shall show later on, in subsequent sections of this paper, wherein I think Darwin's great theory of natural selection fails. In accounting for this law of similarity of construction it also totally fails.) I think the beavers' dams, however, are stronger than man's (in proportion, of course, to size), seeing that the beaver makes his a living dam, whilst ours is usually a dead structure. I think, too, the beaver makes his dam slightly convex, so that the down-pressure of the water always consolidates his structure. We build our dams straight across, the consequence being that they often belly out and carry away. Most of the great dams in Ceylon, and, in fact, nearly all our dams, are liable to be cut through by the wearing-action of flood-water. I have noticed that water falls over the peat of a New Zealand swamp, and does not wear that away. Living peat, I suppose, is equal in its way to a living dam constructed by beavers. I should recommend the trial of covering a great earth-dam with peat, and keeping it wet on the lower side of the dam by little trickling streams all along the face.

When our engineers found that hollow beams or shafts were as strong as, if not stronger than, solid ones they only discovered a principle very commonly seen in nature. A wheat-straw, if solid, could not support its head of grain. The bones of the higher animals are porous; and those of birds, where lightness and strength are most beautifully combined, are hollow. The framework of a ship resembles the bones of a herring. The tools in our engineers' shops follow nature's designs closely, especially in the adaptation of mouth, jaws, and teeth. Designers of such tools might study more carefully than they do the wonderful strength exhibited, say, by the jaws of a greyhound, or a crab, or by the beaks of many birds. As to the marvels of the microscopic world, I hardly dare in this short paper touch upon them. The whole subject forms a chapter of the paper I am preparing, which I trust soon to be able to submit to the consideration of members. I shall be glad to receive from members any further similarities in natural construction which have struck them, or which they have met with in the course of their reading.

[NOTE.—Mr. H. B. Kirk has kindly supplied me with some of the similarities I ask for—one, that of the pedicillaria of the large blue star-fish (undescribed, he believes), which he found in Lyall's Bay, in June, 1889. In this it will be seen that the shears are crossed at the base, so that tension on the base insures closing of the blades, as in scissors or pincers. The grippers with which great blocks of stone are raised are very often on this plan, and so are the grippers used in dredging. The twisted muscles are interesting, seeing that a turn on the untwisted part at the base would tighten or loosen the plait, and so close or unclose the pincers. The total length, including muscular band, is probably a little less than 1mm. He also sends me a sketch of a piece of apparatus very like sheep-shears, belonging to the same star-fish. Also a sketch of the three-bladed pedicillarium of the common sea-urchin. We appear to find little or no use for any three-bladed instrument acting upon a common centre. The same remark applies to the fine teeth of the sea-urchin, meeting at a common centre instead of along a line. Mr. Kirk also directs my attention to the fact that the photographic camera follows the same plan as the eye; that a telephone ear- and mouth-piece is that of the ear (here even the auditory nerve is functionally reproduced). The radula of Molluscs is on the same plan as the compound chain- or band-saw. The suckers of a cuttle-fish and a fly's foot are the same. Spiral springs are found in the spermatophore of cuttle-fish.* The spiral elaters, or spore-dispersers, of some Cryptogams are on a similar plan. The valves of the heart and the blood-vessels correspond in function with the valves of a force-pump, hydraulic ram, &c. Our flexible gas-tubing

* See Pl. vi., Trans. N.Z. Inst., 1883: Anatomy of *Sepioteuthis bilineata*.

strengthened by spiral wire follows the same plan as the spiral vessels of plants. I must thank Mr. H. B. Kirk for these additions to my list of analogies.]

SECTION II.—DISCOVERY *v.* INVENTION.

At the last meeting of the Society one of the members considered that I was not justified in saying the telescope was a discovery. He considered it an invention. I wish now to give instances of accidental discovery. I have been collecting for some years to prove that the common vital force directly guides man by constantly imparting to him, as if accidentally, secrets of great utility for his welfare; that these secrets are constantly being imparted, but fall upon barren ground if man is not ready to receive them. They occupy, as it were, a similar position to those microscopic germs of plants or insects, suitable to particular climates and conditions of life, constantly floating through space, and ready to blossom or spring into actual visible life and existence directly they find a suitable habitat upon any planet. So that when man's mental condition and surrounding acquirements are ready to receive any secret the secret comes out, and its beauty is at once admitted. I would ask pardon for thus boldly stating the thoughts of many years, as I am not a scientific man in the true sense of the word, but only an observer of natural phenomena. Now as to these accidental discoveries of great importance.

Edison, experimenting upon the telephone, to his complete surprise and amazement accidentally discovered the phonograph. Electrical discoveries are always named as such, and not by the word "inventions." We invent, perhaps, the apparatus for taking advantage of the discoveries.

Mrs. Nasmyth suggested to her husband one night in bed to place a wooden shoe, like the one she wore in wet weather, between the iron head and the piston-rod of his new hammer. Thus was the steam-hammer perfected. Before that accidental suggestion Nasmyth could not get his hammer to stand the shock of impact.

A little boy, wishing to play, attached a piece of string to the shaft of one of our first steam-engines, at the pit's mouth, so as to save himself the trouble of opening and closing the steam-valve. This was our first eccentric rod.

One of our first steam-engineers, desirous of preventing the escape of steam from frightening horses along the roads, turned the escape up the chimney, thus accidentally producing draught, and so giving us high speed.

It is said that the art of printing took its origin from some rude impressions taken for the amusement of children from letters carved on the bark of a tree.

Gunpowder was discovered from the falling of a spark on some materials mixed in a mortar.

Electricity was discovered by a person observing that a piece of rubbed glass attracted small bits of paper. Thales, of Miletus (600 B.C.), noted this with amber.

Musical notation was discovered by an Egyptian observer noticing the different ring of blacksmiths' hammers.

The beautiful capitol of a Corinthian column was discovered by an Athenian in his garden noticing a slab of stone placed accidentally upon a basket.

I think we owe the telescope to the children of a spectacle-maker in Germany, who, for amusement, looked through two or more pairs of spectacles to the distant sky. The microscope was naturally the reverse of the telescope, and followed down step by step to its present state of improvement;—for when man once perceives any secret in nature he is endowed with the power, for his own good, of following it out to the uttermost. Nothing is therefore too little for man's attention. A 6,000-ton steamer, or a great war-ship, are instances of man practically applying his discoveries. Would it not be absurd to say that man invented a great steamship, with all its steam and electric marvels? I should say that a steamship, or a railroad, or the electric telegraph, or telephone are fully as much guided by great natural laws as the formation of the hexagon cells of the honeycomb. I shall show later on how ridiculous and absurd Darwin's account of this cell-formation by natural selection really is.

Vaccination for smallpox was discovered by one of our medical men observing that milkmaids in the country districts were free from the disease.

A few drops of aquafortis fell accidentally on the spectacles of a Nuremberg cutler, and the process of etching upon glass was revealed.

The dew one night rusted the gun-barrrel of a sentry, and since then mezzotints have delighted the eyes of men.

The process of lithographing was perfected by purely accidental circumstances. A poor musician was anxious to know whether music could not be etched upon stone as well as upon copper. He had just prepared a slab when his mother, who evidently did not profit by his art, asked him to make a memorandum of some clothes to be washed. Neither pen nor paper being at hand, he wrote the list on the stone with an etching preparation, intending to make a copy at a more convenient time. When about to clean off the stone he wondered what effect aquafortis would have upon it. The application of the acid made the writing stand out in relief. He found he could make a perfect impression by inking the stone.

The perfecting of the Argand lamp was another discovery. Argand was once busy in his work-room before the burning lamp, whilst his little brother was amusing himself by placing a bottomless oil-flask over different articles. In his play he placed the flask over the flame of the lamp, and the flame suddenly shot up the long circular neck of the flask with great brilliancy. The hint was not lost, and the modern lamp-chimney was the result.

A hen one day walked through a clay-puddle, and immediately afterwards left her tracks on a pile of sugar lying near by. At each of her footprints the sugar had whitened. From this circumstance wet clay came to be used in refining sugar.

Many wonderful discoveries in chemistry have been the results of pure chance; and experiments have often revealed quite unexpected effects.

In medicine the discoveries are numerous and constant, and they are always named as such, and never by the word "invention." Thus Dr. Koch's discovery of the bacillus of tuberculosis. The bacilli of many diseases are found now to be destroyed neither by ice nor by sea-water.

It is said that Pythagoras discovered the 47th problem of Euclid. But this partakes rather of an abstract mathematical proposition. We know very little of these propositions, or the power of numerals. It cannot be said we invented these things. They were revealed to us like many other discoveries, and are no doubt fundamental principles of land-survey and astronomy in every planet.

I only give these few instances out of many discoveries in order to prove the direct action of what I consider to be the common vital force, and I shall be glad to hear or receive from members further accidental discoveries they know of as opposed to inventions. My wish, of course, is to prove that natural selection, or the doctrine of evolution, does not account for these remarkable phenomena.

SECTION III.—POTENTIALITY OF DIVERGENCE.

Whilst very many persons accept Darwin's theory of selection (natural or artificial) as the cause of the difference in species, many others disagree with it. Mr. Mivart holds, and others with him, that species change through an internal force or tendency. Darwin takes exceeding trouble to answer Mivart. I shall collect the objections to Darwin's theory later on. When first preparing this paper, many years ago, I knew nothing of Darwin's arguments, or even of Mr. Mivart's name. I have all along tried to think out my own theory for myself, and, so far, have not met with much encouragement from those to whom I have spoken about it. My arguments, however, will doubtless be weighed upon their merits.

I have not yet finished reading Darwin's "Origin of Species" (October, 1893); but what I have read has filled me with pain that so able a writer should have allowed himself to be so led astray. The apologies Darwin constantly makes for the inapplicability of his own arguments are very painful reading. Truth is always simple. Almost on every third page of his work Darwin admits that his theory fails. I grant that there is a certain amount of truth and reason in the theory, but it is mere side-play when we have to consider the real cause of the origin and divergence of species. Darwin's theory, to my mind, is like comparing the light of a candle with the sun. He only shows the procedure from cause to effect, his theory of natural selection not being the origin of species at all, but the play of progressive adaptation in the original plan.

I will instance, as well as I am able, the cases of divergence in fowls, sheep, cattle, horses, and plants, asking to be excused for many shortcomings. The first fowl we know of is the jungle-fowl of India and Sumatra, with the hackle feathers of the neck terminating in scales, partly showing its fish ancestry. From this fowl come the Malay, the Brahmapootra, the Chinese, the Leghorn (as Europe came to be more fully acquainted with Asia), the Spanish, then the French, and then the English breeds, all springing from and diverging from the one original stock, and all surging westward as civilisation advanced. Then, as America was opened up and settled, we got the Plymouth Rock and other North American varieties; and I suppose by-and-by we shall have South American and Australian varieties.

How comes it that we have the power to produce these varieties, either by selection or breeding? For it is quite possible to take a pair of fowls of two distinct and pure breeds, and produce a third variety, which can very quickly be made pure also.

In explaining this I shall explain the rule of law underlying the great principle of natural selection—viz., this power of divergence. The following appears to me to be the law: That no two things are exactly alike in nature — no two animals, birds, fishes, plants, blades of grass, flies, insects, bacilli. Each and all follow the types of their species; but no two are exactly alike in their construction—let us say, cellular or nervous construction. For if they were, then the danger would be that like would produce like, and some one disease specially severe upon that particular construction would sweep the whole order away. Thus if it were possible for two of the Chinese race to be exactly alike, and these two by their physique superior to the rest of the nation, and more suitable to the terrestrial conditions of things in China, then' their progeny would increase and multiply until the whole nation might become like them, when suddenly a disease specially fatal to that one organization would appear and extirpate it completely. But, as the rule of the vital force is that no two things can be alike, it is at once seen that no destruction of any one species can take place by any one disease or ailment.

This being granted, it follows that the power of divergence of all living things is without limit. In China, with 400,000,000 of inhabitants, we have consequently the power to diverge or naturally select 400,000,000 times. Similarly, in fowls, we have as yet but entered upon their variations. There may be, and doubtless are, thousands of other varieties yet to be selected, which can each be made pure. And these varieties fit themselves to climatic conditions as the conditions arise. We have seen fowls upon this planet produced step by step, variety after variety. But, nevertheless, no one can say that there may not be a thousand varieties yet to be produced by careful and judicious breeding or selection, suitable to a much larger planet and somewhat different climatic conditions. For the differences in fauna upon this planet, even during geological records, have been very remarkable. The vast difference between the moa and our domestic fowl opens up so wide a field of divergence that the mind is lost in conjecturing what the varieties may be of this one species alone of living things. There may, indeed, be millions of types of fowls to fill the gap between the moa and our common domestic hen.

In sheep the power of divergence is very remarkable also. A fellow-settler and I have been breeding Romney Marsh sheep for many years past. We both started with a certain strain of blood which we called the "Colonel" blood, from the name of the particular sheep imported. Our ewes also came from the late Mr. Ludlam's breeding, of the Hutt. Our residences are only thirty miles apart; but in fifteen years our sheep are totally different in type. Now, what had we done? We had each followed out in our mind's-eye, and kept to besides, the one particular variety or style of animal. The same with the differences in black-faced sheep, which no doubt came from the original black sheep. The same with the Lincolns, or Leicesters, or any of the English breeds. So limitless is the power of divergence that not only may each county in England have its particular breed of sheep, but each parish, each farm—that is, of course, so long as each variety can be kept apart from the other, and distinct. Fix upon the type of sheep you want, then breed in and select, is the plan. Yet, with this vast field of difference before us, Darwin tries to show that Mivart is wrong when he says that species change through an internal force or tendency. The term "progressive adaptation" appears to me to describe the process of development better than Mivart's terms, but that need not be discussed now. In cattle the same reasoning applies. We all know the differences between the Shorthorns, Ayrshire, Devon, Black Angus, Dutch, Guernsey, Alderney, &c.; but who can say how many other varieties exist in any one of these breeds, which, by careful breeding and selection, can be produced? To my mind, the varieties are limitless, owing to the law that no two things in nature are exactly alike. Moreover, the differences in varieties of cattle often depend upon differences in food-supply. Thus Black Angus is better suited than other breeds for poor pasture and bleak rough hills. In men the same reasoning applies. We have the Malay, the Negro, the Caucasian, the Chinese, the Australian, each with their well-known and distinct varieties. And these varieties (fixed and distinct ages before this planet was born) occupy climates suitable to them, or adapt themselves readily to any fairly habitable climate. But the power of divergence in each variety is so remarkable that we quite wonder when we say that any two English persons out of thirty-five millions are alike. Therefore it is quite possible to produce thirty-five million different and distinct types of English men and women, which reasoning applies to all the other races of men, even to the Negro. We can therefore see how admirably fitted humanity is to adapt itself by change to the requirements and conditions of a million planets. I think I am entitled to consider that there are other planets exactly the same as this earth, not only from astronomical research (the continents and seas of Mars, *ex. gra.*) and spectrum analysis, but also from meteoric iron being found exactly similar to native iron in Greenland and North America. As many millions of meteorites doubtless fall within this earth's atmosphere every week, if not every day, from the size of a grain of sand upwards, and as they contain nickel, phosphides, and other silicates exactly like we have here, I think it is beyond an assumption for me to say that there are other planets existing under exactly similar conditions to this earth. But, in order to arrive at truth, and to explain my theory, I ask to be allowed to assume that there are other habitable planets, so that from this wider field of analogy we may gain an insight into the true origin of and reason for the different species we have here. In a late lecture, Sir Robert Ball, F.R.S., stated that "he was of the firm belief that life existed upon the planet Mars because of the fact that under almost any conditions of existence on this earth—in the burning deserts, amidst the polar ice, deep down in the sunless depths of the ocean—life was found accommodated to what surrounded it." In saying this Sir R. Ball only exemplifies what I mean by the doctrine of progressive adaptation. For twenty years past my friends have been bored, perhaps, by my insistence upon this doctrine, as opposed to Darwin's theory. But, once admit the possibility of the existence of life upon any of the planets attending the millions of star-suns we see around us, then Herbert Spencer's theory of the survival of the fittest and Darwin's theory of natural selection fall to the ground as the primal causes of the origin of species. The doctrine of progressive adaptation, founded upon a vital force common to all the planets, is the only simple and reasonable one we have to fall back upon.

In horses the power of divergence is just as remarkable when we think of the Arab, English roadster, carriage-horse, racer, Clydesdale, Suffolk Punch, Shetland or Timor pony, mustang, piebalds, creams, &c. Herein we might go on *ad infinitum*, save that we confine ourselves as much as possible to the one variety which gives us speed as racers.

In dogs the play of divergence appears also to be limitless. What possible agreement is there between a toy-terrier and a giant St. Bernard? And yet the two belong to the one species. We have between these extremes all the different varieties in terriers, collies, poodles, harriers, foxhounds, greyhounds, dachshunds, spaniels, bulldogs, mastiffs, and all the genus mongrel. No order in nature proves the truth of this rule of the common vital force better than the divergence in dogs. We see before us almost thousands of varieties, from which we can take any one and produce others. I do not say that all these different varieties of dogs are not evolved or selected from the one original type. I further do not say that this original type may not have been the wolf. I will also admit, for the sake of argument, that the wolf may have been, and still is, but a variety of the first original wild animal which came, let us say, from the fish, which was produced from protoplasm, which came from microscopic bacteria in our atmosphere, or from space. But what I wish to prove is that through the whole gamut the power of divergence was laid strictly down in accordance with rigid lines of progressive adaptation, and, whilst we are given the power to select different varieties, the varieties themselves are fixed and certain. They cannot depart one iota from the lines laid down for them millions of ages since, and in millions of other places. We can see that in fowls, in dogs, in sheep, even in men. The wonder to me is that the varieties are so numerous that, as I have before said, we think it strange when two Englishmen are said to be "like each other." But the wonder is fully accounted for when we also see that the rule of the vital force appears to be that no two things are exactly alike in nature.

In plants the varieties and mutations are marvellous. Who can limit the changes of form and colour in, say, roses, chrysanthemums, ixias, sparaxias, eucalypti, or any order we care to comment upon? A short time since the chrysanthemum was only a button in size in our gardens. Now it is cultivated into huge blooms of all manner of shape and colour—incurved, outcurved, deep-red, golden, &c. We make shows now of the variation of this one flower. Lately, too, we are producing green and black roses. Will any person venture to say that these variations are not laid down upon strictly rigid lines of outcome—that it is, in fact, possible for us here to create one single variation by the most careful selection *new to the universe*—that we can, in fact, produce any one new variety? I scarcely think so. I feel convinced that the lines of development have long since been settled, and man but opens the lid of the magic box which contains them. By selection he produces flower-models new to him, perhaps, but so old that the age of this very earth is but a moment in the time of their life.

I wish to point out now that there appears to me to be a certain order in this power of divergence. Thus in each species there are subtypes of a fixed type. For example, let any person take a thousand photographs of English faces. He will find to his surprise that it is quite easy to arrange these pictures according to their subtypes; but, nevertheless, no two are *exactly* alike. The same with sheep, dogs, horses, chrysanthemums. A beautiful pair of well-matched carriage-horses is another instance. We admire them very much, and say they are well matched; but the driver or groom knows what a vast difference there is between the two animals when he attends to them in their stable. As to a perfectly-matched four-in-hand team, we scarcely ever expect to see that, even out of the millions of horses there are in Europe. But, still, horses follow their subtypes sufficiently for us to say they are fairly matched.

For brevity's sake, I need not follow the rule of this law into the insect world. The microscope will no doubt reveal its ruling there just as fully as our eyes tell us it rules in the species and orders I have already named. I might refer in this section to the fact that I have made a small collection of different forms of coral from the South Sea coral-reefs (Pacific Ocean), and the variation of form in this collection is very surprising. Nearly all the forms follow the mode of structure of plants. But why plant-life should thus be copied by the coral polypi beneath the sea is strange. Doubtless the branching method of growth is the best and only form of rapid building-up. But nothing shows to my mind the wonderful guiding-power of the force I speak of more than the coral polyp building out its branches beneath the sea—branches similar to the cellular construction in trees, lime branches following designs of which the polyp itself is supremely ignorant. It is the same with the frost upon our window-panes, which is often fern-leaved in shape, so that it appears as if the vital force itself is bound to follow certain fixed lines of construction, no matter what the subsequent variations or divergences may be. This implies that the force itself is subject to a higher law still. With that implication I fully agree, for in many things, especially in construction, the force appears to act blindly. But all I am at present called upon to do is to show the exemplifications of the force in different living things. I might perhaps be allowed here to refer to the varieties of pigeons, if only to show the maze Darwin found himself in when considering their wonderful divergences. The rule of the law I am now pointing out I think explains many of that great thinker's doubts and hesitations.* By admitting that no two things in nature are exactly alike the potentiality of divergence is practically limitless. The peculiarity with pigeons, however, is the wonderful and remarkable manner in which they differ and diverge from the parent stock: as if in sport or play, nature produces the carrier, the tumbler, the fantail, the pouter, the Jacobin, &c., all from the rock-pigeon—a lavish wealth of wondrous change giving us in this one species a perfect mine of observation and experiment. Who can define the limit of these divergences, or even their uses? For of what use is it to us here that some types of the tumbler-pigeon cannot fly a yard without tumbling head over heels? Therefore it follows that the theory of natural selection, failing in explaining these pigeon divergences we already see, cannot account for the potentiality of divergence yet to take place. In the few years we have been experimenting we have surely not exhausted all the mutations of pigeon form of life. It is therefore our duty to search for the rule of life which governs future changes. Darwin certainly lamentably failed to explain what he saw in pigeon variation.

The reason, I suppose, for these various divergences is, of course, to enable species, order, or genera to adapt themselves to the changing conditions of climate and surroundings in the different planets, geology showing us in this planet that many varieties of one species are born, live for a time, and die out, the species itself still going on, and existing in a slightly different form. And this divergence is not only necessary on account of the birth, growth, and death of the planet itself, during which the various climatic changes occur, but also on account of the alteration in other orders of living things upon which the particular species depends. But this

* See "Origin of Species," cap. ii.

subject of dependence of one species or order upon another will be treated in a separate section later on. All I am showing in this section is the potentiality of divergence and the reason of the law. For the more one studies the vagaries of animal life the more one is convinced that it is necessary to look quite apart from this earth to understand nature's designs; and until we do this—until we thoroughly grasp the immense field of divergence—a field that means all the millions of stars we see, their different wants, and the application of nature's law of divergence to those wants—we shall never understand why matters have been so mixed that deer weep, hyenas laugh, or elephants have the sagacity of men. These things, however, again go to prove the common nature of the vital force. I may perhaps be allowed here to give a few other instances of divergence to illustrate my meaning.

There are many varieties of antelope—some forty to fifty—and many of the rhinoceros. In South Africa there are four distinct species of rhinoceros; in North Africa, one, differing from all these; whilst the large Indian rhinoceros bears but slight resemblance to any of the former. A distinct species from any is the rhinoceros of Sumatra, and another is the Java rhinoceros. So we have eight kinds, all specifically differing from one another.

Now, what use have we upon this small planet for the different varieties of this particular animal? Scarcely any. Nor do I believe they have ever been of much use in nature's workings here. But in larger planets these different varieties may be of immense service, being partly amphibious. Only, as all creatures are bound to diverge, each particular animal having in itself the power of change and adaptability to circumstances, upon the slightest change of circumstances the animal adapts itself to its new environment. This law of divergence and progressive adaptation is like the most delicately-set hair-spring, ready to expand upon the slightest change of condition; in fact, it cannot help changing. It acts upon this small planet the same as it acts upon a much larger planet. So that no type can possibly be constant for ever. It must change directly the climatic condition of the particular zone alters, or any species happens to be transplanted to a different zone. Darwin mistook the exemplification of this law as to origin of species by natural selection. The same reasoning applies to the elephant. There is the Asiatic elephant and the Indian elephant. Great differences exist between the two species. And of the Asiatic elephant there are many varieties, some with tusks pointing downwards, some curving upwards, some with short legs and large trunks, others with small trunks and long legs, for swiftness. Then there is the white elephant, but he is an albino.

Albinoes, however, show up in every class of human being, birds, and animals, and, no doubt, insects, proving another unity of birth and the common nature of the vital force.) There is little or no use here for these different varieties of elephant, as one type would have been sufficient for us.

Then, there is the hyena, which laughs like a demented human being, with powerful neck and jaws for bone-crushing, and no back or hindquarters to speak of. This animal is sent by nature, apparently, to crunch up the huge bones of larger animals, for it usually resides in big-game countries, and shows that nature never even wastes bone-marrow. The hyena bristles its back hair when excited, just like a dog. Dogs, wolves, and hyenas have many points of resemblance, proving the minor doctrine of evolution, a doctrine I readily admit, seeing that it is by this path progressive adaptation plays its part in the production of new species—that is, new only to us, but actually far older than our hills. There are many varieties of hyena—the striped hyena, or *Hyæna vulgaris;* the Abyssinian hyena, the spotted hyena (*H. crocuta*), the brown or hairy hyena (*H. villosa*). These animals burrow just like dogs, having burrowing-claws for the purpose. (The power to burrow is possessed by many orders of living things, and shows another unity of design, deserving explanation in a separate section of this paper.)

ART. LXXIII.—*Public Ferneries: A Suggestion.*

By the Rev. PHILIP WALSH.

[*Read before the Auckland Institute, 19th October, 1893.*]

THE work of beautifying our towns should be of interest to every true citizen, and especially to the members of a body like the Auckland Institute, which may be said to be a kind of *ex officio* guardian of the arts and sciences, and the natural leader in all matters of culture and taste. I need therefore make no apology for introducing to your notice a point in connection with it which seems hitherto to have been overlooked, and one by which, at a comparatively slight expenditure of money and trouble, a great and permanent advantage might be secured.

In advocating the establishment of public ferneries in our principal centres of population—which is the object of the present paper—I may be excused if I enlarge somewhat upon a subject which, though familiar enough to older colonists, hardly comes within the observation of later arrivals and of the younger generation of our town populations—namely, the deplorable destruction of almost all forms of indigenous vegetation which is taking place throughout the country.

Few, of our townspeople at least, are at all aware of the great and increasing extent of this destruction, which is seen not only in the shrinkage from various causes of the area of standing bush, but in the thoughtless and wanton demolition of "specimen" plants that have survived the general wreck, and would, if permitted to remain, contribute largely to the interest and beauty of the landscape. A group of graceful fern-trees, growing in some damp and sheltered corner, have, perhaps, just managed to escape the devastating fire of the clearing; but, to save the trouble of splitting a few slabs, they are cut down to patch a fence or to build an outhouse. A lovely nikau palm has focussed the beauty of some little green clump that stands like an oasis amid the desert of charred stumps and bleaching skeletons; but, with the stately koraus growing beside it, it is slaughtered to furnish cheap decoration for a country ball-room. A rugged old puriri, scorched and torn, is slowly renewing its youth with a vitality rare amongst New Zealand trees. It has been contemptuously allowed to stand because its gnarled trunk will not yield a length of posts, or because it was too hard to chop up for firewood. One would fain hope that it was safe; but, alas! its buttressed roots offer a too-convenient place for the road-contractor to "sling his billy," and it is slowly roasted to death, while the road-contractor and his gang smoke their after-dinner pipes beneath its shade.

Now, the saddest part of it is that this loss is quite irretrievable. A nikau or a fern-tree, or, indeed, with few exceptions, any native tree or shrub, once destroyed, is, under ordinary conditions, never replaced. The seedlings, as they appear above ground, are at once browsed off by cattle or sheep; while, as to the wealth of ferns, which in the bush in its natural state occupy every available inch of space, they are in settled districts soon trodden down or consumed: in fact, for the greater part of our town populations they are practically non-existent; they have vanished with the bell-bird and the tui, and must now be sought amongst the far-off mountain-ranges whose steep crests and gullies are as yet comparatively untrodden by the ever-encroaching cattle of the settler.

The necessity of making some stand against this lamentable destruction has been recognised by the people of New Zealand in the setting-apart of blocks of land throughout the colony as State forest-reserves, not the least valuable of which is that of the Little Barrier Island, a place eminently suitable, both from its climatic and topographical conditions, as a conservatory for indigenous plant and animal life. Still, even though more adequate conservation of these reserves were made than is at present attempted, their advantages are not directly available to the bulk of our town populations. We want something nearer at hand, something that we can see and enjoy as a portion of our daily life. We are familiar with the blue-gum and the *Pinus insignis*, with the Norfolk pine and *macrocarpa;* the oak and the elm and the poplar are conspicuous in our streets and suburban allotments. But of the indigenous vegetation most of us know very little indeed. In fact, there are many native-born New-Zealanders who could not distinguish between a rimu and a kauri, and who are obliged to form their idea of the most beautiful forest in the world from the mutilated specimens of the pohutukawa which can hardly be said to adorn the coast-line of our harbour, or from the scrubby survivals in the Domain that are being rapidly exterminated by the more vigorous growth of the imported article.

Now, it seems to me that what is wanted in view of this state of things is a public fernery, as part of the recreational outfit—if I may use the term—of every important colonial town. I hope the time is not far distant when, as in the sister colonies, public opinion will sanction the expenditure of a sufficient sum to form and maintain a botanical garden in each of our chief centres of population, in which specimens of every native plant will find a home; but for the present it is perhaps best to be satisfied with a venture on a more modest scale. We have public parks, public libraries, public art galleries and museums; why not public ferneries? The cost would be proportionately trifling, while the advantages are so self-evident that it is almost unnecessary to enumerate them. Every visitor to the late Dunedin Exhibition must recollect that the fernery, though a mere temporary affair, on a comparatively insignificant scale, was one of the most popular of the sights in connection with the undertaking. Day after day, and all day long, the globe-trotter and the lately-arrived settler might be seen comparing the almost tropical luxuriance with the more scanty products of less favoured climes, while even to the native-born New-Zealander the wealth of assembled beauty was a revelation as grateful as it was unexpected. What this ephemeral "side-show" was to the visitors to the Dunedin Exhibition a public fernery would be to our settled population, only on a much more perfect and extended scale. To the inhabitants of the city it would supply a permanent and unfailing source of wholesome enjoyment at once elevating and refining. It would educate the taste of the country settler, and help to arouse his interest in the protection of that which he usually deems so worthless because it is so common. And to the traveller from abroad, seeking respite from the turmoil and glare of the busy thoroughfare, it would come as a glimpse of fairy loveliness, suggestive of Alpine heights and sylvan solitudes—of sound and lake and waterfall, inviting him to pause on his journey and join the ever-increasing band of explorers who annually find their way to our shores.

The City of Auckland possesses exceptional advantages for an undertaking of the kind suggested. Not only is the mild and equable climate of the province peculiarly suitable for the growth of every description of fern, whether native or exotic, but its varied topographical conditions help to make it the home of a very large number of species. Nor would the work of collection involve any great labour or expense. The remotest corners of our gulfs and islands—the favoured haunts of the most beautiful and rarest sorts—are now within easy access by means of coasting steamers, and there are not wanting throughout the country districts persons of taste and culture who would be only too glad to collect and forward such specimens as might be required.

To Auckland, then, should naturally fall the honour of leading off in an enterprise which would soon be taken up in every city in the colony. The question of cost would of course have to be faced; but the sum required, as already stated, would not be a very formidable one; whilst, as a matter of fact, the necessary funds are not usually wanting once the desirability of a public undertaking is admitted. The General Government might very fairly be asked to make an annual grant in support of an object of such wide-spread importance, to be supplemented by the city authorities, who would properly act as guardians and trustees; and it is also possible, and, indeed, quite probable, that in this, as in the case of other of our municipal institutions, some public-spirited person would come forward with substantial support.

Before dismissing the subject it may be as well to say a word as to site and structure, though of course these would be influenced by the conditions of individual localities. Speaking generally, a public fernery should consist of two departments, one in the open air in some sheltered position where a good water-supply is available, and the other under glass, or glass and trellis combined. It would, of course, be well if the two could be placed together, so as to form part of a single plan, and for the sake of economy of maintenance; but this is not of vital importance, so long as both are conveniently accessible. In the case of Auckland, the Domain gully and the Albert Park would respectively offer every advantage. As regards the plan of the building for the covered department, the cruciform shape, surmounted by a dome at the intersection of the arms, which is usually adopted for large conservatories, would probably be found most convenient and at the same time most externally imposing, especially if an aisle or lean-to were carried along the principal sides. By this arrangement the different sizes of the plants would be accommodated by the varying height of the roof, while from every part of the building the eye would be naturally led up to the central group. The larger plants should be placed in the ground, and a system of finely-perforated water-pipes carried overhead, so that a shower of rain could be turned on when required.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

Twenty-fifth Annual Report, with a Memorandum thereto.

Meetings of the Board were held during the past year on the following dates: 30th August, 1892; 11th January, 13th February, and 19th May, 1893.

The following members were elected by the incorporated societies as Governors of the Institute, in conformity with the Act: Mr. J. McKerrow, Mr. S. Percy Smith, and Sir Walter Buller.

The nominated members who retired from the Board in conformity with clause 6 of the Act are the Hon. Mr. Robert Pharazyn, the Hon. Mr. Mantell, and Mr. W. T. L. Travers. His Excellency had reappointed the Hon. Mr. Mantell and Mr. W. T. L. Travers, and appointed Mr. E. Tregear in the place of the Hon. Mr. Pharazyn.

Since the publication of last report the Institute has lost one of its distinguished honorary members by the death of Sir Richard Owen, K.C.B., D.C.L., F.R.S.

The members now on the roll of the Institute are: Honorary members, 29; ordinary members—Auckland Institute, 187; Wellington Philosophical Society, 147; Philosophical Institute of Canterbury, 75; Otago Institute, 106; Westland Institute, 70; Hawke's Bay Philosophical Society, 116; and Nelson Philosophical Society, 35: making a total of 765.

The volumes of the Transactions now in stock are: Vol. I. (second edition), 255; Vol. V., 22; Vol. VI., 23; Vol. VII., 112; Vol. IX., 114; Vol. X., 144; Vol. XI., 35; Vol. XII., 40; Vol. XIII., 40; Vol. XIV., 63; Vol. XV., 177; Vol. XVI., 175; Vol. XVII., 178; Vol. XVIII., 154; Vol. XIX., 166; Vol. XX., 168; Vol. XXI., 98; Vol. XXII., 98; Vol. XXIII., 178; Vol. XXIV., 180; Vol. XXV., not fully distributed.

The volume (XXV.) just published was issued in June, and contains seventy-six articles, together with addresses and abstracts of papers which appear in the Proceedings. The volume contains 612 pages of letter-press and 55 plates. The following is a comparison of the contents of the present with those of last year's volume:—

	1893. Pages.	1892. Pages.
Miscellaneous	134	246
Zoology	260	358
Botany...	82	44
Geology	36	28
Chemistry	6	...
Proceedings	50	48
Appendix	44	45
	612	769

The cost of printing Vol. XXIV. was £385 13s. 9d. for 769 pages, and that for Vol. XXV. £388 9s. for 612 pages, but this latter includes the sum of £33 18s. 9d. for a portion of the lithographic work which should have been charged to Vol. XXIV.

During the year the Board have published, at a cost of £179 16s. 8d., Parts V., VI., and VII. of the "Manual of the New Zealand Coleoptera," by Captain Thomas Broun, in continuation of the former parts which were published by Government. This work now comprises 1,504 pages, and describes 2,592 species of Coleoptera.

The Honorary Treasurer's statement of accounts shows a balance in hand in current account of £61 16s.

The amount devoted to the printing of memoirs and postponed papers (in accordance with resolution of May, 1885) is now £700.

Approved by Board.

Thomas Mason,
Chairman.

James Hector,
Manager.

11th July, 1893.

New Zealand Institute Accounts for 1892–93.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand, 29th August, 1892 ..	86	10	1	Printing Vol. XXV. ..	388	9	0
Parliamentary grant for 1892–93	500	0	0	Printing Parts V., VI., and VII. of "New Zealand Coleoptera" ..	179	16	8
Sale of volumes to non-members	59	4	0	Expenses of library, and miscellaneous ..	38	2	3
Contribution from Wellington Philosophical Society	22	9	10	Balance in hand ..	61	16	0
	£668	3	11		£668	3	11

Wm. Thos. Locke Travers,
Honorary Treasurer.

11th July, 1893.

MEMORANDUM REGARDING THE NEW ZEALAND INSTITUTE, BEING AN ADDITION TO THE ANNUAL REPORT PRESENTED 19TH JULY, 1893.

THE first scientific society in New Zealand was founded in 1851, the first President being Sir George Grey, K.C.B., D.C.L. It was named "the New Zealand Society," and was located in Wellington.

In 1862 a second society was established in Christchurch, as the Philosophical Institute of Canterbury, the first President being Mr. Julius Haast (since Sir Julius von Haast, K.C.M.G., Ph.D.).

Much useful work was done by these societies, but they met at very irregular intervals, and the funds collected were inadequate for the proper publication of the papers that were communicated by the members. They therefore languished owing to their being merely local societies, not having the sympathy of the colony.

The Exhibition held in Dunedin in 1865 brought prominently before the public the advantage of a more general organization for the development of the resources of the colony, and, soon after the establishment of a scientific department by the General Government, the New Zealand Institute Act was passed in 1867, and its administration was placed under the Director of the Geological and Natural-History Survey.

The New Zealand Institute has now been in operation for twenty-five years, which is a sufficient period in the history of a new country to indicate how far the practical results obtained by the working of one of its institutions have fulfilled the anticipations of its original promoters. The object sought was to foster public interest in the collection and discussion of original observations respecting the resources and natural history of this country. This is done to the best effect by the organization of a scientific society; but it was obvious that the geographical circumstances of the colony precluded the formation of any strong central society, capable of stimulating and directing such investigations by frequent meetings of its members, as can be done in other colonies possessing a chief centre of population, where all social institutions become naturally concentrated. The constitution of the New Zealand Institute was therefore intended to provide for the combination of local efforts in this direction by enabling the joint publication of papers read and discussed before local societies.

Experience has shown that in old countries the subscribed funds are generally insufficient for the proper publication of the transactions of small societies, and this drawback is still more felt in the countries where the number of members is small, while the field for original research is large; so that in a few years such societies languish after accumulating much information in manuscript that, if published, would be of great assistance in advancing the interests of the community.

Each member of the scientific societies affiliated to the New Zealand Institute receives a share of the parliamentary grant in the form of an annual volume of the transactions for the year of all the various societies. The presentation of this volume is regarded as a substantial equivalent for the subscriptions, and the fund which is created by local subscriptions is applied locally towards the maintenance of public museums in the different centres of population.

The educational effect of this organization can hardly be overestimated as a means of cultivating a love of knowledge, and disseminating information. To the influence of the Institute must in some degree be attributed the demand which is now expressed throughout the colony for elementary instruction in science, and the general recognition in New Zealand on the part of the public that it is necessary to obtain, as a branch of elementary education, the qualifications required for the comprehension and the utilisation of the scientific literature that is so characteristic a feature of the present age.

The Institute commenced with four branch societies in 1869, and only 258 members, but there are now eight societies affiliated, and the number of members increased to 1,327 in 1881, but has since fallen off to about 950, each of whom pays one guinea a year, which may be considered as a voluntary tax for an educational purpose.

There have now been 1,765 original communications, published in twenty-five volumes of the Transactions of the Institute, nearly all of which relate directly to the colony, and place on record matters of fact and observation that otherwise might not have been published. Of these papers, 412 are on miscellaneous subjects chiefly relating to the ethnology of the aboriginal races, or connected with the industrial resources of the colony; 671 are descriptive of the zoology of New Zealand; 229 refer to its botany; 117 are on metallurgy and chemistry in its relation to the colony; and 229 are on its geology and physical geography. In addition to these papers, which are published at length, abstracts of about 1,076 different communications are given in the Proceedings of the societies. The total number of communications to the Institute has thus been 2,841. Besides which a number of popular lectures are given each year under the auspices of the various societies, of which no record is kept.

The average size of the annual volume of Transactions and Proceedings is 640 pages and about 40 plates.

The funds at the disposal of the Board of Governors of the Institute have consisted only of the annual grant by Parliament of £500, an annual contribution from the Wellington Philosophical Society as an equivalent for rent of the library-room and the use of the lecture-hall, and a small sum arising from the sale of volumes. Nearly the whole of the funds are spent in the printing of the volume of "Transactions," only a very small amount being devoted to the maintenance of the library in the way of binding books. Nor is the information contained in these volumes confined to the colony, as they are widely distributed to the chief libraries in all parts of the world.

Forty-seven of the most distinguished men in science and literature, who have rendered special service to New Zealand, have been elected honorary members, while there are seventy-five corresponding societies and institutions that exchange their publications with the Institute. About 300 volumes per annum are acquired in this manner, a great number of which are placed in the General Assembly library.

The Board, having in view the publication of certain important memoirs relative to the natural history of New Zealand, the production of which will require a larger expenditure for proper illustrations than can be fairly charged to the annual income, have succeeded in saving up a small sum every year for the purpose of meeting this charge without interfering with the publication of the current work.

If the vote of Parliament is reduced to an amount that will not cover such current expense, the Board will find it necessary either to reduce the size of the volume by rejecting papers, or to make a call on the societies, which will give great dissatisfaction, as it will draw on funds that are at present locally applied in a most useful manner.

Considering the success of the Institute, and the great influence it has exercised in giving New Zealand a prominent name among scientific workers in all parts of the world, it might be injurious to the colony if the work of the Institute were seriously crippled.

Under these circumstances, the Board earnestly trust that the full amount of £500 will be voted as hitherto.

James Hector,
Manager.

Wellington, 24th July, 1893.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *14th June, 1893.*

Major-General Schaw, C.B., R.E., President, in the Chair.

New Members.—R. L. Mestayer, C.E., Rev. W. Rowse, T. Stoddart Lambert.

Address by the President.

As your Council has conferred upon me the great honour of nominating me as your President for the current year, the duty devolves upon me of opening our session by an inaugural address. I could wish that the honour and the duty had fallen to the lot of some one more worthy both by long service in our Society and by thorough acquaintance with some one, at least, of the many subjects which come within our province; but, as it has been your pleasure to confer upon me this temporary patent of nobility, *noblesse oblige*, and I can but fulfil its accompanying duties to the best of my ability, in the hope that the same kind partiality which has selected me will also excuse the defects of my address.

On looking over the Transactions of the New Zealand Institute for 1892, I observe that, of the seventy-six articles composing the volume, no less than twenty-two were contributed by members of the Wellington Philosophical Society; the remaining fifty-four by the societies of Auckland, Hawke's Bay, Canterbury, and Otago. Wellington has therefore well done its duty towards philosophy during the past year. I hope that the present year may not show much falling-off, notwithstanding the very serious loss we sustain by the absence of Sir Walter Buller, who, although he was unable to complete his intended address, contributed, nevertheless, five valuable papers last year.

The outlook for the present session is at this moment not quite so satisfactory as one could wish, but few papers having been promised as yet. I understand, however, from our honoured Secretary that in his long experience he has rarely known it otherwise, yet that as the session went on members rose to the occasion, and papers were prepared and read as the opportunity arose. Individually I should be glad to see a wider interest taken in this Society, and a correspondingly-increased number of members. The title "Philosophical Society" is so very comprehensive that no kind of wisdom is excluded. Any expert, for instance, who could give true information on such subjects as the following—and I am convinced there are many such in the District of Wellington—would be doing patriotic service by joining the Society and contributing a paper: Wool, and woollen manufacture; freezing-machinery, frozen meat, and heat-insulation; timber and forestry; grass seeds suited to different soils and situations; vine-culture, and wine- and raisin-making; apple orchards, apple-preserving, and cider-making; butter and cheese; fowls and eggs; fish-drying and -preserving, and oyster-culture; paints and pigments; horticulture; boat- and ship-building; architecture with reference to earthquakes and fires. These are subjects which are of interest to the community generally, and good papers on which would be very valuable. The list is very far from being exhaustive, and there are very many other subjects of a somewhat similar character which might be treated on with great advantage. What I wish to emphasize is that this Society does not restrict itself to natural philosophy, to birds and insects and earthquakes and rainbows, and kindred subjects, but would embrace also the works of man.

To attempt a critical summary of a series of papers embracing such a vast variety of subjects as were dealt with last year, would evidently be out of the question; but, probably, the subject of the widest general interest which, in a number of different papers and discussions, has been brought before us during the past year is that of the moa. Mr. Tregear, in his very valuable paper, has discussed the historical question from a new point of view, that of comparative philology, and I suppose there is no living man more pre-eminently qualified than he is for the task. I would also draw attention to those most comprehensive and suggestive remarks on the subject which were given by Sir James Hector in Otago, and which will be found recorded in the Transactions of the New Zealand Institute for 1892, pp. 555 *et seq*. I would express the hope that further explorations, on the lines he has suggested, may not only set at rest the historical question as regards Maori and moa, but may also give us much light on the evolution of varieties or species in prehuman times.

When the Australasian Association for the Advancement of Science met at Christchurch in January, 1891, the President, Sir James Hector, referred, amongst other defects in our scientific and practical knowledge, to the very unsatisfactory condition of our information on the subjects of magnetic variations and our ocean tides and currents. I fear that, since that date, nothing has been done to remove this lamentable state of ignorance, which really is equally discreditable and dangerous to a colony like this, having such very large shipping interests.

I sincerely hope that the Government, with their fine surplus of revenue, will now take action in these important directions, and also in that of completing our apparatus for the observation and record of earthquakes.

Earthquakes.

The question has been asked, Are there any peculiar meteorological conditions of the atmosphere which are connected with earthquakes? And lately the subject was discussed here with reference to wind. It did not appear that wind and earthquakes were directly connected, although it has been observed on several occasions in New Zealand that, when it has been blowing hard at the time of an earthquake, the wind ceased during the short period occupied by the shock or shocks, and then burst forth again. Possibly this effect may have been due to the rapidly-moving earth-waves having retarded, for a time, the motion of the air in contact with the surface of the earth, the directions of motion having happened to be opposite; and the subject is worthy of further investigation. But in some parts of the world it has been noticed that previous to an earthquake there has been a peculiar condition of the atmosphere, similar to that preceding a thunderstorm, causing disquietude to animals and giving warning to men, and that this condition of the atmosphere has disappeared immediately after the earthquake. I have not been able to trace any record of such a condition of the atmosphere having been noticed in connection with earthquakes in New Zealand, but in California it is a well-recognised phenomenon, and I believed it has been observed in other countries. It has occurred to me that the explanation may be found in the geological conformation of the country where this phenomenon has been observed, together with the facts that are known concerning thermo-electric batteries and electrical induction. If the geological structure of the ground underlying great plains be horizontal strata of varying materials, and in which either the lower strata are more heated than the upper strata, according to the known laws of increase of temperature with increased depth below the earth's surface,—or in which the upper surface is excessively heated by the sun,—then we may have the conditions required for the production of great electrical tension between the upper and lower strata, if some of the intermediate strata have become so dry as to cease to be conductors, and so are unable to relieve this tension quietly and gradually. This state of electric tension at the earth's surface would, by induction, cause a contrary electric condition in the lower strata of the atmosphere, and the peculiar meteorological effects referred to would be experienced. When the electric tension between the upper and inferior strata became so great that a subterranean electric discharge took place between them, equilibrium would be restored and the atmospheric disturbance due to induction would cease. The subterranean electric discharge would cause so great a shock as to produce the effects of the earthquake, probably by setting in action the potential energy stored up by the gradual cooling of the earth, and tending to produce shrinkage, crushing, and crumpling, and so unequal stress. Owing to the great contortions to which the strata have been subjected in the greater part of New Zealand, the conditions are perhaps not to be found here which would give rise to the phenomenon of such a subterraneous electric disturbance as above suggested; but in the great wheat-growing plains of California, where the premonitory atmospheric warning of an impending earthquake has been noticed, they probably do exist. It is possible that they may also exist in the great Canterbury plains, and it would be of interest to note whether any such premonitory symptoms are ever observed there previous to earthquake shocks.

Ornithology.

I would remark, with reference to ornithology, that in the early spring of three successive years—1888–89–90—Limestone Island, in Whangarei Harbour, was visited by a pair of small birds which I think I have identified as *Ptilotis chrysops*, or the yellow-faced honey-eater, described in Gould's "Birds of Australia," vol. i., pp. 521, 522. The birds sang very sweetly for a week or two each year in a large willow-tree close to the house in which I was living, and seemed to have the intention of building there; but I fancy they were deterred from doing so by the disturbance caused by a swing which hung from a limb of the tree. The shaking of the tree caused by the swing, and the laughter and merriment of the swinging children, probably scared them away. My ornithological instincts were not acute enough to harden my heart and induce me either to taboo the swing or to shoot the birds, so that I cannot be perfectly certain as to the identification; but, as I observed these birds carefully with binoculars, I have little doubt that they were a pair of this rather common honey-eater of New South Wales, which for some reason migrated to New Zealand to nest, and may therefore be classed with the cuckoos and other migratory birds which visit our shores. The song is so sweet and soft that it is utterly unlike that of any of the native New Zealand birds; it resembles that of the garden warbler of England, which I used to hear in Surrey and Hampshire every spring.

Ptilotis chrysops, Yellow-faced Honey-eater. ("The Birds of Australia," Gould, vol. i., pp. 521, 522.)

Crown of the head, back of the neck, all the upper surface, wings, and tail, dark-brown with a slight tinge of olive; throat and undersurface dark greyish-brown, the latter colour predominating on the chest; a fine line of black runs from the nostrils through the eye; this black line is bounded below by a stripe of yellow, which runs under the eye and over the ear-covert, and below this runs another parallel line of black, which commences at the base of the lower mandibles and extends beyond the line of the ear-coverts; immediately above the eye behind is a small spot of yellow, and behind the ear-coverts a like spot of white; bill blackish-brown; irides and eyelash dark-brown; legs leaden-brown.

Female like male, except that it is smaller.

Very common in New South Wales. Sprightly in habit, and sings sweetly.

Entomology.

With reference to entomology, a circumstance which may be of some interest to entomologists was observed by me in November, 1889, when I was at Limestone Island, in Whangarei Harbour. We had just made a large shallow tank of concrete on the beach above high-water mark to hold condenser-pipes for the steam-engine which worked a lime- and cement-mill. The tank was to be filled with sea-water, but the pump and pipes had not yet been fitted. Heavy rain occurred in the night, and, when I went to look at the tank in the morning, I found it nearly full of rain-water, partly from direct rainfall, partly from the drip from an adjoining roof of the works; but what surprised me was to observe a large number of swimming-beetles in the water. Whether these beetles were *Colymbetes rufimanus* or *Corixa zealandica* I am unable to say; but I think they must have been the former from their size and colour, and because they seemed identical with the swimming-beetles which were familiar to me from my early recollections of these insects in the Old Country. How they could have got into the tank was a mystery to me; and I supposed they must have been caught up by a whirlwind or waterspout and carried from the mainland and dropped into the tank. I had read of fish having been thus transported on some occasions. Lately I have had the opportunity of learning, from Mr. Hudson's excellent "Manual of New Zealand Entomology," that these beetles have wings, by means of which they are known to migrate from one piece of water to another. This fact—then unknown to me—explains the occurrence to some extent, although it still is very wonderful that the beetles should have migrated from the mainland to this little tank, for there are no pools or streams on the island. How did they discover the existence of the tank? It was an unfortunate discovery for them, for they were soon boiled to death when the condenser began to be used.

Evolution.

In connection with these beetles I would refer to one passage in the Manual, and employ it as my text in what I wish to say on evolution, as it is in accordance with the theories of evolution which are now very generally accepted. The passage I refer to is at page 23, where this swimming-beetle is said to be "only what a ground-beetle might naturally become if forced to lead an aquatic existence." Now, my imperfect observation leads me to believe that any ground-beetle now forced to lead an aquatic existence—*i.e.*, being put into water—will not become a *swimming*-beetle, but, if it cannot get out, will inevitably become a *dead* beetle. This, however, is not in accordance with the ultra-evolutionist theories of the day, which assume, in the words of Mr. Romanes, that "hereditary characters admit of being slowly modified whenever their modification will render an organism better suited to a change in its conditions of life." I am not prepared to say, much less to prove, that this is not true, or, rather, that it may not have been true at earlier periods of the world's history; but I do affirm that this statement is an hypothesis which has not hitherto been confirmed by facts, and my position is that, as true scientists, we are bound to separate hypotheses which have not been confirmed by facts from those which have been so confirmed. When Mr. Romanes quietly asserts that whales and porpoises were originally "terrestrial quadrupeds of some kind, which gradually became more and more aquatic in their habits," and that the changes in their conditions of life affected first their skin, claws, and teeth, then their bones and muscles, and general form, my faith in this teaching is too weak, my imagination too sluggish, and my hold on the facts of nature too strong, to allow me to accept this statement without proof. Indeed, were I convinced of the fact that such changes do take place, or have taken place in the past, I should have expected that water-mammals would have changed into land-mammals rather than the reverse, as all palæontological evidence shows that the waters were peopled first, and afterwards the dry land; and this is the view held by some evolutionary biologists. But to believe in miracles unsupported by any evidence, and from these assumed and unauthenticated miracles to argue that others occur, is neither reasonable nor scientific. That evolution, in some sense of the word, is as true of the animate world as it is of the inanimate, I suppose we are now most of us persuaded. The well-attested observations and researches of modern scientists have taught us that our world has been slowly moulded into its present forms and conditions by the constant operation of forces with which we are in some degree familiar; and the laws governing these forces have now been fairly well ascertained as far as they refer to inorganic matter, though even here we are still, as regards details, in the regions of hypothesis, and geologists differ considerably in their views as to the ways in which our earth has been moulded into its present form. Some hold chiefly to denudation, some to glaciation, some to volcanic agency, some to crumpling and cracking by shrinkage in cooling, and each has facts to support his theories; but so have the others, and no doubt all these causes have been operative. But the statement made by Lyell, in his "Principles of Geology," "The forces now operating upon earth are the same *in kind and in degree* as those which, in the remotest times, produced geological changes," is no longer accepted as a truth. As Professor Tait* says, "We have also recently obtained positive assurance that our globe was in the remotest times so hot as to be at least plastic—a condition, fortunately, not now prevailing either in kind or in degree." And Professor Huxley† speaks of "a very remote period when the earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy." Nevertheless, the great principles of geology so ably enunciated by Lyell have been abundantly established: the forces by means of which the surface of our earth has been moulded are still in action, if in a more moderate way than at first, and we can reason upon the facts we observe with considerable certainty and approximate accuracy.

We are in a different position, however, in regard to organic matter. Life is a new force which at some early period of the world's history first appeared, and which ever since has been present on earth, manifesting itself in endless varieties of plant and animal life. The succession of these varied forms of life, recorded in the strata of the earth, shows a progress or evolution, the earlier forms being generally simple, the modern forms in many cases very highly differentiated. The hypo-

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* Tait's Lectures, p. 165.

† "Critiques and Addresses," p. 239.

thesis that there are some fixed laws of life which have governed this progression or evolution, is almost forced upon us by the analogies of the inorganic world. To discover these laws is a search worthy of the highest human intellects. Darwin, Wallace, Herbert Spencer, and others have applied themselves to the task, and have thrown some light upon it; yet their views diverge, and none of them have been confirmed by facts as regards their bolder generalisations. Apparently the science of biology is now in about the same position as that of astronomy was in the time of Copernicus, perhaps even less advanced, and, considering the very much greater difficulty of the subject, it may be a very long time before the combined efforts of the human minds that are striving to unravel its mysteries will have advanced our real knowledge of biology to a similar position to that in which astronomy now stands. But if we adhere to the sound methods of inductive philosophy, and accept no hypotheses as truths until they have been thoroughly established by facts, our progress, if slow, will be certain and sure. The gathering of facts is work in which all careful observers can co-operate: the correlating of the facts and divining their significance requires the genius which is given to few. It seems to me that palæontology is at this epoch perhaps the most deeply interesting field of study, as there only can we hope to find evidence of the true way in which new species have arisen. In the "Encyclopædia Britannica," ninth edition, under the heading "Biology," it is stated: "The only perfectly safe foundation for the doctrine of evolution lies in the historical, or, rather, archæological, evidence that particular organisms have arisen by the gradual modification of their predecessors, which is furnished by fossil remains. That evidence is daily increasing in amount and in weight, and it is to be hoped that the comparison of the actual pedigree of these organisms with the phenomena of their development may furnish some criterion by which the validity of phylogenetic conclusions, deduced from the facts of embryology alone, may be satifactorily tested." The special geological epochs which appear favourable to such discoveries are the Mesozoic or Secondary, in which the first traces of bird-life have been found, and also that great abundance of gigantic saurians which is so wonderful to us; and the Kainozoic, or Tertiary, and Recent strata, which in their lowest beds give evidence of a new order of life, the great placental mammals, and in the latest of which human remains are first found. Up to the present time all theories of the evolution of life on our globe are practically unsupported by palæontology; and, until something more convincing to ordinary minds than Huxley's "horse series" has been brought to light, cautious people like myself must be content to remain inquirers alike as to the facts of the evolution of life on this earth and also as to its modes.

The palæontological record is undoubtedly imperfect. Multitudes of living things of all kinds must have perished in past ages without leaving any discernible traces in the sedimentary deposits produced in seas, lakes, and rivers, or buried by volcanic eruptions or in caves; yet vast multitudes of remains have been so preserved, and every year new specimens are being added to our series. Mathematics assures us that if there have existed transitional forms of life, such as the theory of evolution supposes, it is not conceivable that a fair proportion of them should not be found; but they have not been found hitherto. On the contrary new forms of life appear first in their fullest development, and if such forms still exist they are generally smaller, and altogether inferior to the earlier individuals. One need only compare the remains of the gigantic ferns and mares'-tails of the Carboniferous strata with living specimens, or the immense saurians of the Secondary formations, or the mammals of the Tertiary, or the recently extinct moa of New Zealand, with modern types of similar forms of life, to be convinced of this truth: in such cases there is evidence of degradation or extinction, not of progression. Or, if we consider the fact that the earliest form of mollusc of which we have a record, the brachiopod Lingula, is still to be found in the coral islands of Melanesia, apparently identical with its earliest progenitors who lived thousands of thousands of years ago, we are bound to acknowledge that there is no absolute rule of progressive evolution. Yet that, upon the whole, there has been upward progress, is also abundantly evident. The world in which man has lived is a far more perfect world than it was in any of its earlier stages.

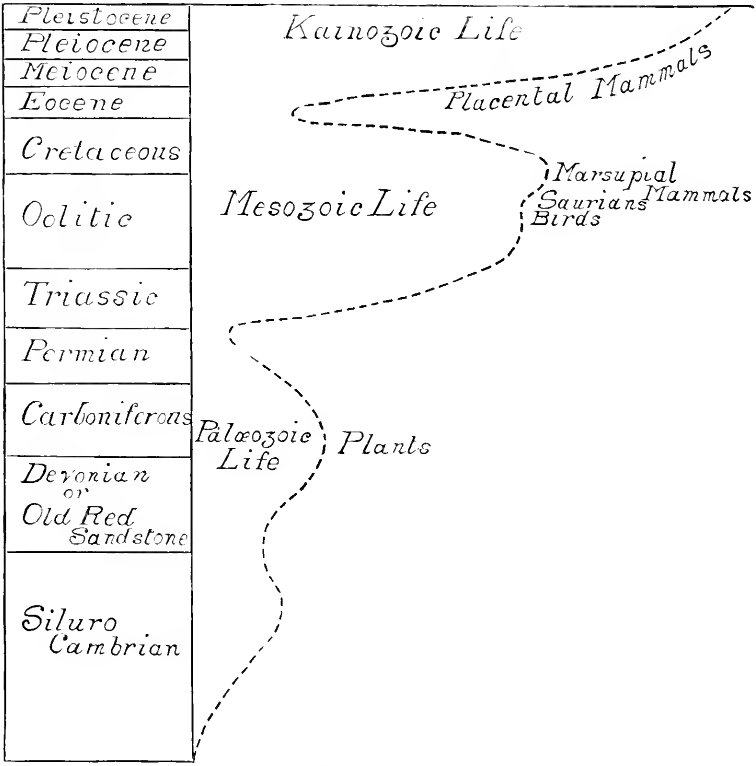
In tracing the history of the structure of the crust of our earth we often find that large formations which were deposited under the sea have been raised to form dry land, and in that condition have been subjected for long periods to denudation, have then again sunk below sea-level, and fresh sedimentary deposits have been laid down on top of the denuded surface; afterwards the whole has been raised again; and we find that the forms of life in the later strata are very different from those in the earlier strata. It is claimed that the evolutionary steps connecting the earlier and the later forms of life are unrepresented because they lived in a period not represented by these strata—the period when the lower strata were dry land—and so many pages of the record are missing, as it were. These pages exist somewhere, perhaps still at the bottom of the sea, and therefore inaccessible to us, but perhaps now forming dry land in some neighbouring territory whither the water life of the district which was raised migrated as their sea grew shallower and finally disappeared. In the latter case we may hope that the missing links, if there be any, may yet be found.

But it must be observed that such gaps are somewhat exceptional. We have series of strata of immense thickness which are evidently consecutive, and in them we find new forms arising without any apparent connection with what has gone before.

Some modern German scientists are of opinion that Darwinism will belong only to history after a few decennaries. Without going so far as this, it is yearly becoming more clear that heredity, natural selection, and migration will not account for a very large number of the facts of nature. In an interesting paper by Dr. Karl Müller, of Halle, which is printed in the "Transactions of the New Zealand Institute" for 1892, he shows that, apparently, the same conditions of habitat and climate are associated with the same types of life, irrespective of time and space; and, although it seems possible that in some cases his conclusions may not be justified, and that minute spores or life-germs have been carried in the air through vast distances until at length they have found a congenial home, yet it is becoming increasingly evident that the laws which, by their interworking, have produced all the endless varieties of life on our earth are very subtle and complicated, and that heredity and natural selection will by no means explain *all* the facts of nature, although they probably have been eminent amongst the many causes at work. As Professor Nicholson puts it in his "Manual of Palæontology," p. 53, "Certain classes of animals are always likely to flourish in places and times in which favourable conditions are present, wholly irrespective of any genetic connection between successive faunæ." And again at page 93, "Palæontology points in the main to the operation of some general law of evolution whereby the later forms of life have been derived from the older ones. That this law has acted along with, and has sometimes been counteracted by, some other and as yet obscure law regulating the appearance of new types, seems equally certain."

If with our present knowledge we were now to attempt to describe in a brief and general way the gradual development, or progress, or evolution of the world, the description would accord remarkably with that given in that grand series of pictures of typical periods in the world's history in the Book of Genesis.

Of the first and second days or periods we can of course have little or no trace now left on the face of the earth; yet astronomical science and geology combine their testimony in favour of the probable truth of the statements in Genesis,—assuming that the earth was at first intensely hot, and that it gradually cooled; then water condensed on its surface and settled in the hollows caused by contraction, and so began the great series of wearings-down by atmospheric agency, deposition of aqueous strata, upheavals, depressions, crumplings, and crushings which have moulded our earth through long ages into its present condition of mountains, hills, valleys, plains, seas, lakes, rivers. Then plant-life in water and on land first appears. Very dim are the records of plant-life in the earliest gneiss rocks of the Laurentian beds. They are in the form of graphite, in which only the faintest traces of organic structure have yet been discovered. But in the later "old red sandstone," and in the great "Carboniferous" strata, the evidences are clear and full of the growth of a comparatively low type of plants in most luxuriant abundance, and under conditions apparently of obscured skies and a steamy atmosphere. Some traces of low types of animal life in crustaceans, molluscs, and fish are also found in these strata; but the salient feature of this period is plant-life. I imagine that the description of the third day in Genesis refers to this period, which also covers the fourth day, during which the sky became less obscured by clouds, and the superabundant carbonic-acid gas was used up by plants, fitting the world for higher forms of life, and that, as plant-life was not to be referred to again in the notices of the subsequent days' work, the higher orders of plants which had not yet appeared, but which were to grow afterwards, were also mentioned at this time, as it were prophetically, or as being, according to evolutionary theory, potentially existing in the earlier forms. I do not think that this view can be considered as one which unduly strains the meaning of the original. It professes to be a Divine revelation, and, if it be in the form, as we suppose, of a series of visions, intended to explain in a general way how our earth and its inhabitants were brought into being, it seems probable that, as each successive advance in the scale of life was shown, its final as well as its earlier types would appear in the vision, and so each vision would be in some measure prophetic of what was to be afterwards. I have already avowed my conviction that in some sense there is a deep truth in the idea of evolution, and the view I have suggested as to the probable meaning of the enumeration of the higher as well as of the lower orders of plant-life in the creation of the third day is in accordance with the view of evolution which supposes that in certain life-germs there are potentialities of development in, it may be, a number of upward directions, which in course of time and in appropriate environments are accomplished; and so new varieties—it may be, new species and even genera—have been evolved. This period of intense activity of plant-life is followed by a pause or partial cessation of life-activity during the times when the Permian strata were being formed. I would observe, however, that this pause in the abundance of life, and the subsequent pause at the close of the Cretaceous period, were probably not so marked as would appear from Professor Phillips's diagram, which was prepared some thirty years ago in accordance with the facts then known. Since then extensive beds in North America have been discovered containing fossils which partially bridge the gap between the Cretaceous and Tertiary strata, and others in Bohemia which in some



degree perform a similar office in respect to the gap between the Permian and Triassic strata. Still, the general facts remain unaltered by these later discoveries. Then the strata of the Secondary or Mesozoic period were deposited, and they contain records of a time when the waters swarmed with varied life, and the air with winged inhabitants. The salient feature of this period is the appearance of the great saurians, and the teeming life in water and air. There is also an advance in plant-life suited to the clearer heavens, when sun, moon, and stars were now visible. This period would seem to correspond with the fifth day of creation, and to have its termination in that second pause, or great diminution of life, which seems to have occurred between the Secondary and Tertiary periods. With the commencement of the Tertiary period life-activity bursts forth again, and new forms appear—great terrestrial mammals, higher kinds of vegetation, flowers, fruits, and insects, and finally domestic animals and man.

The correspondence in all essential features between the Scriptural account and the facts of nature is complete. Science fills out the pictures with endless and wonderful details, and teaches us that the days of creation were not days of twenty-four hours, but of many thousands of years, and the use of the word in Scripture to denote long periods of time, in numerous places, removes all difficulty on that account. But science can only trace the facts in the order of their occurrence, and form conclusions more or less approximately true as to the duration of successive periods: it can give no account of the origin of the Cosmos. We can trace in many cases effects back to their immediate causes; but even then the interworking of the various forces is so complicated that we are often baffled in our search, and always we are foiled in our attempts by scientific methods to reach the origin of matter or of energy in their varied manifestations. Chemists tell us that their most powerful means of analysis have hitherto failed to reduce the number of simple substances, such as gold, silver, iron, carbon, oxygen, hydrogen, &c., below a certain number; but philosophers hold that eventually we shall discover a primitive atom, or molecule, from which all these substances have been built up. It may be so, but at present we know nothing of this primitive molecule, or of the mode in which these varied forms of matter have been produced. The case seems very similar with regard to plant and animal life. Naturalists inform us that there are so many kinds or species of life; each species reproduces itself, and so collectively lives on in its separate life: but hitherto the attempt to transmute one kind of life into another has been as futile as the attempt to transmute iron into gold. Philosophers hold that there was a primitive cell, or germ of life, from which all the varied kinds of life have been built up. It may be so; but at present we know nothing of this protean germ. I think that the suggestion I threw out with regard to the lower and higher kinds of plant-life—viz., that the earlier and simpler forms might have contained potentially the higher and later forms—has been definitely stated before by some writer on the subject, and it may be that such an evolutionary mode of creation was actually adopted in this and other similar cases—an evolution in each case up to a certain limit, which limit seems to have been finally reached when man appeared on the scene, for we have no evidence of any new species having appeared on earth since that time. Species have varied within their limits, but no new species has appeared. Artificial selection has not been able to produce a new species within the human era; still less has natural selection. Romanes has very fully stated all the different lines of evidence from morphology, embryology, geographical distribution, &c., which seem to support the general idea of some sort of evolution of life. But the theory that all the multitudinous forms of life which now exist, and which have existed, all perfectly fulfilling their parts in the great drama, should have been the result of forces acting according to fixed laws, and so interworking as to produce these results without design, but by so-called chance, seems to me mathematically impossible: the chances are millions to one against such results having occurred; the failures would immensely have exceeded the successes, and we have no evidence of any failures. Moreover, we must account for matter, forces, and the laws governing them. We are logically compelled to seek for a first cause.

And what is our ultimate experimental conception of force or energy? It is *will*. All the work of man on this earth is the direct result of his will-power guided by his intellect. If finite wills can produce such results, what limit can we assign to an infinite will guided by an infinite intellect?

I conceive of evolution as I do of education. By education all that is potentially within a human being may be brought out, but by no education is it possible to produce out of a dull boy a Shakespeare or a Newton. Up to his limits he can be educated, but not beyond them.

So, it seems to me, in the evolution of different kinds of life. The original germ contained certain potentialities, and up to those limits it was, by a suitable environment, evolved or unfolded, but never beyond them. The mystery of that germ remains as great as ever, and, however numerous the varieties, as yet we have no certain knowledge of a real transmutation of species, or of a gradual alteration of structure to suit an altered environment, such as is assumed as an axiom by Mr. Romanes. Until the theory has been proved to be a fact true science suspends its judgment and searches for the facts; although we may take the Darwinian theory of evolution, or some such theory, as a convenient working hypothesis for the present.

We may undoubtedly accept as a working hypothesis, which has very strong arguments in its favour, that the remarkable unity in structural design which we discern in the animate world has been brought about in some way through heredity, or natural descent, with variations. Such a working hypothesis has been found very helpful in classifying plants and animals, whether truly or not is still uncertain. Possibly in course of time the evidence may become so strong and consistent that we may be justified in looking on this hypothesis as a fact; we may even get so far as to learn under what conditions in the past the great variations in type forming new species and genera have occurred.

But what I wish to bring before this meeting is that at present we have no such certainties. We have only theories and probabilities in regard to evolution, and we are not justified in speaking of evolution, or modes of evolution, as if they were ascertained facts. Moreover, were the hypothesis of evolution established as a fact it would in no way alter or lessen the essential logical necessity for an efficient first cause and continuous energy.

May I be permitted, in conclusion, to express my regret that we English, whose language is now more widely used than any other in the world, should have chosen *not* to use it in our scientific nomenclature? The Germans have been more happy—they use their own language instead of a contorted Latin or Greek. For instance, in Insektenkunde, or insect-knowledge (entomology), Coleoptera are Deckflügler or Shield-wings; Hymenoptera, Hautflügler or Skinwings; Lepidoptera, Schuppenflügler or Scalewings; Neuroptera, Netzflügler or Lacewings; Orthoptera, Geradflügler or Straight-wings; Hemiptera, Halbflügler or Half-wings. I am afraid it is too late to attempt a change now, but if it could be done it would be a great blessing to the rising generation—almost as great a blessing as the adoption of a decimal system of weights, measures, and money, which we have hoped for so long, but which seems as far off as ever.

I am well aware that in alluding as I have done to the theory of evolution I have, as it were, thrown down the gauntlet and opened the door to criticism and discussion. Evolution at present may be said to be in the air, like Home Rule and the great Labour-and-capital question, and people hold very different views on such subjects. But discussion is always interesting, and very often the discussion which follows a paper is much more valuable than the paper which gave rise to the discussion, as the latter brings out many thoughts of many minds. I hope, therefore, that my address may prove fruitful in discussion, and in other papers.

Sir James Hector moved a vote of thanks to the President for his most interesting and suggestive address. It opened up a number of disputed questions which would cause a most interesting controversy, and would, he thought, be the means of bringing forward a number of interesting papers from some of the members during this session.

Mr. T. Kirk had great pleasure in seconding the vote of thanks. The address was most valuable on account of its suggestiveness. It would no doubt be taken up by members during the year. Some parts of the address would be considered unorthodox, but there was evidence that changes would take place in the evolution theory. The address touched on many questions of great use and interest.

Vote carried.

General Schaw returned thanks, and said he was quite prepared to have the address criticized, and he hoped it would be the means of our gaining additional knowledge on some important subjects.

Sir James Hector exhibited a snake found at the wharf here in some bananas from Fiji. There were only two kinds in that country, and both were harmless. It is exceptional to find venomous snakes in the Pacific Islands. He also exhibited a water snake found in the North of New Zealand. The introduction of snakes should be guarded against, as it would be awkward if they came from New Guinea or Queensland, where they are poisonous.

Mr. Kirk said that snakes no doubt did migrate to New Zealand, but they died out. They often reached even England in fruit. There is also a sea snake that visits us from Torres Straits.

General Schaw said it was interesting to know that snakes could make such long journeys through the sea.

Mr. C. Tanner would like to know if other dangerous visitors, such as centipedes, are likely to arrive in the same way.

Sir J. Hector explained that they could only come from Queensland or New Guinea, and he had not heard of any arriving. Live plants introduced here should be carefully searched for such things. In connection with this he might mention that a form of iris (*Homaria*) had been introduced to Victoria from the Islands that is very injurious to cattle and sheep.

Second Meeting: *28th June, 1893.*

General Schaw, President, in the Chair.

Paper.—"On the Disposal of Sewage by Application to the Soil (Sewage Farming)," by Dr. Chapple. (*Transactions*, p. 517.)

Sir James Hector said this was an opportune and valuable paper, but embraced so many subjects on which special expert knowledge was required that it was difficult on short notice to discuss it. For the success of a sewage farm it was generally admitted that a separate system, which prevents the admixture of storm-water with the sewage, was absolutely necessary, and he understood the city, in adopting the Shone system, was providing for this. The author had clearly explained the purifying agency of the oxidizing Bacteria. If these did not have full play, then this class of microscopic fungi, that throve in the absence of air, and to which group most germs of disease belong, would multiply; he instanced the case of Pasteur's sheep that died of anthrax, and, though buried 6ft. deep, yet spread the disease in the following year to a flock depasturing in the vicinity. Burying putrefactive matter in stiff clay soil was the very opposite of sewage-farming; but the latter must be well managed to be able to deal effectually not only with the ordinary healthy sewage of the city, but also with it under conditions of epidemic zymotic disease. In all arrangements the sewers and pipes must be easy of inspection for cleansing purposes. This, he understood, was one of the chief advantages of the Shone system.

Mr. Higginson stated that in his opinion Dr. Chapple deserved the thanks of the community for his excellent paper upon a subject of great importance to Wellington. The treatment of sewage by modern scientific methods was little understood by the general public. The inland English towns had been during recent years forced by Act of Parliament to adopt measures for the disposal of their sewage. Where a suitable area of land could be obtained irrigation was adopted in many cases, though the treatment by precipitation and the subsequent disposal of the sludge, either by manufacture into manure or destruction by cremation, was the general alternative. Sewage-irrigation farms had seldom yielded a profit owing to the enormously high prices paid for suitable areas, though with intelligent management they had generally cleared the working-expenses. Experience had amply proved that the operations of sewage-farming could be carried on without danger to health or annoyance to residents in the neighbourhood, provided the area was sufficiently large. The Berlin sewage farms alluded to by Dr. Chapple were about the largest and best managed in existence, and were pointed out as examples of what it is possible to do in the treatment of sewage successfully. In Wellington there was an ample area of the most suitable land for treating sewage by intermittent downward filtration, and which was so situated that there need be no fear of any annoyance to residents. Should it be decided to discharge the sewage into Cook Strait the anticipated possible damage to the telegraphic cable was, in his opinion, more imaginary than real. The point of discharge was at least three-quarters of a mile distant from the cable station, and at a tide-swept point. The volume of sewage, including the proportion of rainfall admitted, when the population had increased to 75,000, might be approximately represented by the quantity flowing at the rate of 180 lineal feet per minute through a pipe 36in. in diameter. Of this by far the largest proportion would consist of practically clean water, such as rain-water, bath waste, and flow from leaky taps; the sewage proper flowing from house sinks, closets, &c., not representing more than, say, one-eighth of the whole, while the solids would consist of a still smaller fraction of the latter. Under these circumstances he was of opinion that the probable amount of sewage deposit would be insufficient to damage the cable. With regard to the remarks made by Sir James Hector as to the effect of adopting the Shone system in Wellington, he explained that it was only upon the low-lying areas of the city, about one-third of the whole, that it was required, the remaining two-thirds being drained by ordinary gravitation.

Mr. Ferguson was glad that Dr. Chapple had brought this subject before the public of Wellington, and he hoped that the paper would be printed in the newspapers, so that the valuable information contained in it might become known to all. He did not agree with the author as to the limited quantity of land available for a sewage farm, nor that the site proposed was too exposed for growing crops. He considered the area of land was ample to provide for the whole of the sewage of Wellington, if properly managed. He did not think the amount of water to be disposed of was more than could be provided for. It was really a question of expense. He thought it was desirable to provide a separate system. He did not think the Bacteria referred to by Sir James Hector could occur if proper precautions were taken and sufficient land available. Dr. Chapple did not mention one objection generally made to the sewage farm—viz., to the infection of milk from cattle fed on the grass from the farm. But experience had shown that under proper supervision the milk would in no way be inferior to that from cows fed on other pasture. The sludge difficulty would be got over without precipitating the solids. On the sewage farm the whole of the solids would go on the ground, oxidize there, and become vegetable matter. Some straining would probably be required. The difficulty in other countries had been the want of sufficient land, but here we had everything favourable for a sewage farm. He was sorry that Mr. Mestayer was absent through illness. He himself was in favour of having a sewage farm, and he was pleased to be so ably supported by Dr. Chapple.

Mr. C. Tanner would like to know why there should be so great expenditure of money required in keeping up a sewage farm.

General Schaw complimented Dr. Chapple on his very lucid and interesting paper. The subject was perhaps unsavoury, but was of the very highest importance to the community. He drew attention to a subject that had not been alluded to in the paper—the semi-solid constituents of sewage, of which fatty matter from dish-water formed a large part. To deal with that was always a serious difficulty in sewage-farming. Precipitation in various ways had been resorted to. Electrical precipitation was apparently the best method, but then the solids had to be got rid of somehow. He was glad to hear that the question of solids had been fully considered, and that by distributing the sewage over a sufficient area of land the difficulties connected with it would be overcome. He thought it very important and satisfactory that this had been brought out in the discussion. The able and scientific men who were designing and carrying out the drainage system for Wellington might be thoroughly depended on to obtain unobjectionable results.

Dr. Chapple, in reply, said that, in reference to General Schaw's remarks concerning the disposal of the sludge, he would point out that the term "sludge" was usually confined to the abundant deposit after precipitation in the chemical processes, but that in broad irrigation only the larger solids were strained off, and the deposit, when tanks were used, was small in quantity, the whole of the solids suspended in the sewage being deposited over the land. Sir James Hector's example of anthrax springing from a buried sheep would be an example of bad management in a sewage farm, analogous to a decomposing deposit—a state of things never permitted on a well-managed farm. Pathogenic germs were destroyed by the Bacteria of the soil, and the absence of typhoid on the Berlin farms while an epidemic raged in the city was strong proof that the germs of disease were destroyed by the vegetative and bacterial processes. Sir James Hector's remarks about the absence of danger from deposit and tearing up in times of heavy rainfall, due to the separate system of sewage, had been referred to by Mr. Higginson. The system was only a "partially separate" one in the low-lying levels, but in the high levels (two-thirds of the town area) the rainwater would be admitted to the sewers, and the flow would in rainy weather be enormously increased. The danger of deposit and flood in times of heavy rain would thus have to be considered. In reply to Mr. Ferguson he admitted that one acre for every hundred of population might be a low estimate if the soil were porous, for some land took the sewage from up to five hundred persons for each acre. The bleakness of the situation might not be much objection, but the effect of southerly gales upon trees about the city, and the comparative absence of vegetation upon the sandhills, were unfavourable indications. He thought the popular prejudice against sewage-grown products would soon be overcome when people were educated to the fact that these were as pure and wholesome as those from any other farm. In conclusion he thanked those present for the kindly and appreciative way in which they had received his paper.

Mr. A. McKay exhibited a live kea or mountain-parrot (*Nestor notabilis*), which he had kept for about a year at his house, and which had become quite tame, and performed all kinds of antics, and in fact exhibited intelligence in a remarkable manner. He referred to a former paper that he had read before the Society on the same subject.

Mr. Travers quite bore out what Mr. McKay had said of the wonderful antics of these birds, and he related several remarkable instances of their intelligence. This specimen appeared larger than usual.

Sir James Hector said this was the bird that caused so much trouble with sheep. He first found them settled on the plant known as the "vegetable sheep," and this had no doubt led them to attack the sheep itself.

A collection of live specimens of *Peripatus novæ-zealandiæ*, collected by Mr. Stuart Duncan at Porirua, was exhibited by Sir James Hector, who pointed out that the great anatomical interest of this insect, which is probably the ancestral form of all insects and spiders, has of late further increased through the recent discovery by Professor Adam Sedgwick, of Cambridge University, of a minute structure of the cell-wall in certain tissues which throws light on the mechanism of the functions of reproduction.

Mr. Travers pointed out that he first found this insect in New Zealand, and gave specimens to Mr. Moseley, of H.M.S. "Challenger," who wrote a monograph on it, and it had since been dealt with by Professor Balfour. It is found in Chili, New Zealand, the Cape of Good Hope, and in the West Indies. This peculiar distribution goes to prove that there must have been a connection between these lands in former times.

Third Meeting: *26th July, 1893.*

Major-General Schaw, President, in the chair.

New Member.—Mr. George Allen.

Papers.—1. "Additional Notes on Rainbows," by T. B. Harding; communicated by R. C. Harding. (*Transactions*, p. 481.)

General Schaw said it was quite possible to have a bow formed by the reflected sun; he had explained this in his paper on Rainbows.

2. "On the Occurrence of *Xanthium strumarium*, Linn., in New Zealand," by T. W. Kirk, F.L.S. (*Transactions*, p. 310.)

Sir J. Hector said he had pointed out at a previous meeting the spread of a plant named *Homaria*, in Australia, and its injurious effect on cattle, producing symptoms that resembled those of anthrax. One species, with a handsome flower, was not uncommon in New Zealand gardens. He thought that not only ballast, but the soil in wardian cases, should be disinfected.

Mr. Travers said that he had often found quantities of insects and noxious plants in cases received from other countries. He had frequently urged the authorities to have such cases carefully examined, and the soil calcined, and all living things destroyed; but nothing had been done.

The remedy had been often pointed out by Mr. Maskell—namely, the establishment of a properly-equipped department to conserve such plants, &c., as were of benefit, and to destroy those that were injurious. The American Government set us a good example in this matter. The farmers of the country were the real producers, and they should be assisted.

Mr. Maskell was glad that Mr. Travers had touched on this important subject of the formation of such a department. He would again draw attention to the remarks he had made in his paper, printed in the last volume of the Transactions, on this subject. He hoped other members of the Society would take the same interest in the matter as Mr. Travers did.

Mr. T. Kirk gave a most interesting account of the noxious and other weeds introduced into New Zealand. Our climate was most suitable to such plants, and, unless checked, they would thrive. He mentioned that some of our New Zealand plants were changing the colour of their flowers to white, also the naturalised plants, probably owing to want of insects for fertilisation. Nearly all our mountain plants were pure white.

Mr. T. W. Kirk, in replying, said he had hoped that some remedy would have been suggested for preventing the spread of these weeds. He said that the matter was being taken up by Government.

3. "Ornithological Notes," by T. W. Kirk, F.L.S. (*Transactions*, p. 181.)

Sir James Hector said that had he known that Mr. Kirk intended reading a paper on this subject he would have been glad to place specimens in the Museum on the table. Several specimens of albinoes and variegated New Zealand birds were in the collection.

Mr. Hudson said that most albinoes had pink eyes. The white plumage might be a protection, especially in snow countries, and it was warmer.

Mr. Harding had seen a perfect albino in Napier which had been captured on the coast.

Mr. Hulke said that true albinoism was always accompanied with a change in the colour of the eye. He had heard of an albino Maori family.

Mr. Canavan said that on an island in Loch Ray the rooks and blackbirds were white, with red eyes.

General Schaw had seen a white blackbird in Ireland. He thought that there might possibly be something in this country against brilliant colouring, and that birds and flowers were affected by it. New Zealand seemed to favour sombre colouring in birds, insects, and flowers and foliage.

4. "Ossiferous Clay found at Queen Charlotte Sound." Mr. Tregear described the locality where the clay had been found. The bones were calcined, and seemed to be of several kinds. They might be the remains of whales.

Sir James Hector said that without further inquiry it was difficult to say how those heaps had been formed. Those near the beach certainly contained charred bones; but the last-found bone fragments, at a distance from the sea-shore, did not seem to have been burnt.

General Schaw exhibited some chips that showed imperfect spontaneous combustion, which could not be accounted for. The chips formed the nest of a laying hen.

Mr. Canavan exhibited the head and claw of a kiwi, of large size, belonging to a bird standing 3ft. 6in. high, and weighing 20lb. He described the habits of these birds, and said it was a pity that a few could not be caught and sent to Europe or elsewhere for exhibition. They were disappearing, and soon would be most difficult to obtain. Stoats and weasels were destroying all New Zealand ground-game.

Sir J. Hector said it was *Apteryx maxima*.

In answer to Mr. Maskell, Mr. Canavan stated that stoats and weasels were found in the bush, forty miles distant from where they were first turned out to destroy the rabbits.

Mr. Travers said they were doing good work in destroying rats, but when the rats were gone they would go for the lambs and fowls.

5. "Skeleton revealed by Dew," by General Schaw. (*Transactions*, p. 544.)

Mr. Hulke had seen the same phenomenon on wooden houses and iron roofs.

Mr. Harding had also observed it.

Mr. Hudson exhibited drawings of moths, &c., which he intended publishing with a new work he was at present engaged on.

A large grasshopper from Manawatu Gorge was exhibited by Mr. Werry.

A curious-shaped lemon, from Sydney, was exhibited by Mr. Cohen.

Fucoidal impressions from hydraulic limestone at Whangarei were exhibited by General Schaw.

Fourth Meeting: *9th August, 1893.*

Major-General Schaw, President, in the chair.

Papers.—1. "On the Importance of New Zealand Biological Collections," by G. V. Hudson, F.E.S. (*Transactions*, p. 199.)

Sir James Hector was surprised that Mr. Hudson, as shown by his paper, was so ignorant as to what had really been done by scientific workers in New Zealand. It was impossible for any museum to keep a staff of experts in all branches of science to provide collections in natural history such as Mr. Hudson required; but we had in the various museums sufficient material to assist collectors in most subjects. Of course, such collections as botanical and entomological it was impossible to keep up without great expenditure, and most of the best collections in those branches were in the hands of the collectors themselves, and would no doubt some day be handed over to our museums. Such collectors as Mr. Hudson himself, Mr. Maskell, Sir W. Buller, Mr. Colenso, Captain Broun, Mr. Fereday, and others had done much to assist workers in science in this country. As regarded minerals, shells, &c., there was no difficulty in identifying specimens from the type-collections in this and other museums. New Zealand was more advanced in local knowledge of geology, zoology, and botany than they were in England sixty years ago. Mr. Hudson was quite at fault in regard to his remarks about fossils. The geologist collected fossils for the identification of the structural formation of a country; he could not wait for their correct description by the palæontologist—this could only be done after years of labour. He did not think that the disparaging remarks of Mr. Hudson regarding the scientific work done in New Zealand should be passed over without contradiction.

Mr. Travers said that Mr. Hudson certainly undervalued the scientific work done in New Zealand. On the subject of botany alone he might instance the splendid work of Sir J. Hooker, Mr. Colenso, Mr. Buchanan, Mr. Cheeseman, and Mr. T. Kirk; and in other branches there was an equally good record. Notwithstanding the difficulty of travelling in this colony, and the great expense, no other country had done so much in the way of collecting. Mr. Hudson's paper might do some good, but he had failed to make himself acquainted with the true value of the scientific work done in this country, and he could not know what our museums actually contained.

Mr. Tregear regretted not seeing more young people taking interest in making collections, and getting ready to take the places of those present at the meeting. There were hundreds of graduates passing examinations in higher education, but few of them retained enough interest in their scientific studies to make them do practical work when the academic course was finished. Most of the work done for science in New Zealand had been unpaid work, and done for pure science' sake, not for its economic value. But the economic value had certainly been very great—far greater than many supposed. The economic value was not, however, the true goal for which scientists should work, though no one knew how, perhaps in a moment, great economic results might follow a discovery made by one seeking science only for its own sake. Mr. Tregear instanced the case of Professor Max Müller and his study of Sanscrit. The English Government in India was greatly troubled to know how to put down the custom of *sati*, or widow-burning, the English having promised not to interfere with the religious customs of the Hindustanis. The Professor pointed out to the Brahmin priests that the burning of widows was only inculcated in a corrupt text of the sacred books. The priests had to admit the truth which the Professor had pointed out, and since that time no women had been burnt on funeral piles in India. Thousands of lives were thus annually saved by this application of the learning of a true scientist.

Mr. Richardson said Mr. Hudson should remember that other collectors were quite as enthusiastic in their studies as he was in his particular branch. The collection of fossils was of the greatest importance.

Mr. T. W. Kirk thought that perhaps Mr. Hudson had been rather misunderstood. What he advocated was the appointment of a staff of cabinet collectors. For so young a country, we had, he thought, done well in science. He thought more should be done by the State.

Mr. Maskell agreed with some parts of the paper, and disagreed with other parts. There ought to be better collections of natural history than we had, but there were difficulties in the way. He did not agree with Mr. Travers and Mr. Hudson that collections made here should always be sent Home to England to be described. He thought that it would be better to do the describing here, and keep the collections in the colony. It was easy to obtain all books of reference out here, owing to the improved postal arrangements. He instanced a gentleman who had sent Home a valuable collection of fossil remains to be described instead of studying himself, and they had been lost on the voyage, off Cape Horn. If he had only kept them, or handed them over to some museum, they would have been safe. He would urge collectors to keep their collections here and describe them themselves, and they would have them for reference, and get the credit of working them out themselves.

General Schaw thought it was rather a disadvantage that there were so many museums scattered throughout the colony; it was a pity there was not one good central museum. He did not agree with Mr. Maskell about not sending Home specimens for description. If some of the objects mentioned by Mr. Travers had not been sent Home, we might not now know that such things existed here. He rather favoured the sending of them to England.

Mr. Hudson, in reply, thanked the members for the interest they had taken in his paper. In connection with Sir J. Hector's remarks, no one could appreciate the value of what had been done more than he did himself. At the same time, there remained an enormous amount of scientific work which required immediate attention, and the object of his paper was to bring some of this work under notice. Dr. Sharp stated as his opinion that in England, where the fauna had been worked at by hundreds of skilled collectors and observers, there was not yet a really good collection of British insects. Bearing this in mind, we could hardly claim to have anything at all approaching completeness in New Zealand. He considered Mr. Tregear's work especially valuable, as it was instrumental in preserving languages and traditions which would otherwise be completely lost. With regard to the fossils, he did not wish to undervalue their importance, but merely to point out that they could wait for a time, whilst the living organisms required immediate attention. As to Mr. Maskell's remarks with reference to the sending of insects to Europe, he would like to point out that Mr. Maskell knew so much about the *Coccidæ* that it was quite unnecessary for him to send specimens away. He (Mr. Maskell) could tell at once whether a scale-insect had or had not been already described. It was quite evident to any one who read the current entomological literature that Mr. Maskell was the world's authority on these insects. With other entomologists, whose studies embraced groups of far larger dimensions, it was absolutely necessary for accurate work that they should seek assistance from naturalists in Europe and elsewhere.

2. "On Old Maori Civilisation," by E. Tregear, F.R.G.S. (*Transactions*, p. 533.)

Mr. Harding said that Mr. Tregear's idea of the decadence of the Maori race from a higher state was a suggestive one. In his own paper, published in the last volume, he (Mr. Harding) had inferred something of the same kind from the high literary quality of their traditional lore.

Sir James Hector said that Mr. Tregear's paper was most interesting. He had himself always been of opinion that the Maoris of former days must have been acquainted with a written language, as otherwise their powerful development of the logical faculty would be incomprehensible.

Mr. Travers, as bearing on the subject of this paper, exhibited a portrait of the Maori chief Rangihaeata, painted by the late Major Von Tempsky. The natives recognised the portrait by the tattooing on the face.

General Schaw said that the subject was most interesting; it was not altogether remarkable that the Maoris possessed arts at one time which were now lost to them. The Cingalese had lost arts in the same way. We saw it in our own day: people who had civilisation, but who settled down in remote localities, became rough and uncivilised.

Mr. Tregear, in reply, said that he believed the tattoo-markings were used in the Treaty of Waitangi—the natives were identified by the tattoo-marks. It was not certain that the other islands knew about writing; they used a stamp—in fact, a sort of type.

Mr. F. Huddleston gave a description of some rock paintings found at Silver Stream and Albury, in the South, and he described the locality.

Sir James Hector said we were fortunate in getting these drawings from Mr. Huddleston. He exhibited similar markings on rocks, mentioned in one of the volumes of our Transactions. It was not quite clear yet how they had been done or who did them.

Mr. Maskell had seen and examined the Weka Pass drawings with a party of explorers. Some thought they were very old, others that they were done by natives of the present day, and others thought they were done by shearers who had taken shelter in the caves. Nothing yet was settled about their origin.

Fifth Meeting: *6th September, 1893.*

General Schaw, President, in the chair.

New Members.—Mr. J. Suckling-Baron, Mr. C. O'Hara Smith, Mr. Robert Tait, Mr. A. J. Litchfield, Mr. James Wallace, Mrs. R. G. Gibson.

Papers.—1. "On Mental Operations in Sleep," by R. C. Harding.

Mr. Tregear said that Mr. Harding had opened up a large number of debatable subjects in his paper. He could not agree with Mr. Harding's explanation of the causes of dreams.

Sir J. Hector said it was generally considered that the dreams of the healthy state were not different in kind from those arising from fever or any bodily or mental disorder. The most vivid dreams he had ever experienced were when suffering from starvation. The latent impressions in the mind of every one were so obscure and numerous as to provide ample suggestions without calling in the aid of external or occult influences, as suggested by the author. Dream-thought differed from waking-thought only by the non-exercise of the will and the absence of logical control.

Mr. Maskell was sorry Mr. Harding had not commenced his paper by explaining to us what sleep was, for until we knew this we could not tell what dreams were. He did not think that delirium in fever was the same as dreams.

Mr. E. Bell did not agree with the psychical-cause theory. He thought external causes did account for dreams. He gave instances of such dreams.

Mr. Tanner thought somnambulism and dreams were closely connected. There was no end to the question of dreams. Could we not dream when we are awake? He did not believe that dreams could be controlled by outside influence.

General Schaw said it was strange that after so many years we should know so little about dreams. Dreams were very sudden, and were often caused by a shock externally. One in a perfect sleep, he thought, did not dream.

Mr. Harding, in reply, said that those who had criticized his paper had not touched the main point at all—that of orderly mental operations in dreams. They had fixed upon him theories which he altogether repudiated. To suggest that commonly-accepted theories were insufficient was quite different from advancing theories of one's own. He had not hinted anything of a supernatural basis of dreams; all he had implied was that, as regarded two opposing camps of philosophers, he was not ranged with the materialistic party. As for the so-called "telepathy," he had only casually referred to the theory to remark that it was inadequate. That dreaming was an abnormal or unhealthy condition in itself he could not believe, though there were, of course, the special forms of dreams attending indigestion or fever. The nearest approach to dreamless sleep was that of utter exhaustion, and it was not a desirable condition. He did not think that the brain could be at absolute rest any more than the other great vital organs, and if it was in action there must be some kind of dream. Absolutely dreamless sleep must be much the same as death.

2. "On a New and Simple Method of projecting Occultations and Solar Eclipses," by T. B. Harding; communicated by R. C. Harding. (*Transactions*, p. 477.)

Sir James Hector gave some interesting information on the subject, which he illustrated on the blackboard. He also called attention to the occurrence on the 13th instant of an occultation of the planet Venus.

Sir James Hector exhibited some specimens he had recently collected at the Cheviot—viz., limestones of good quality, phosphatic nodules useful for manure, hæmatite-ore (64 per cent. of iron), and nickel found on the beach.

Sixth Meeting: *20th September, 1893.*

Major-General Schaw, President, in the chair.

New Members.—Miss Malcolm and Mr. Dawson.

Papers.—1. "On Spiders' Bridges, or Spiders as Engineers," by Coleman Phillips. (*Transactions*, p. 600.)

2. "On a Common Vital Force: Section I.—Similarity of Construction," by Coleman Phillips. (*Transactions*, p. 604.)

General Schaw said it was the universal practice to stay suspension-bridges now. The one over Niagara was an instance of this; it was stayed in every direction, especially downwards.

Mr. Hudson said it was not yet known how spiders threw and connected the web; the vision of the spider was supposed to be limited to an inch or so; butterflies saw a longer distance. He referred to the progressive development and improvement, and instanced the bee in connection with this.

Mr. Maskell did not think a spider could see to throw a web the distance mentioned, nor did he think they deliberately constructed these bridges. What did Mr. Phillips mean by "common vital force"? He could not agree with Mr. Phillips in thinking there was no difference between the instinct of an animal and the natural intelligence of man.

Mr. T. W. Kirk had seen such bridges as described by Mr. Phillips; the stays were sometimes 20ft.

Mr. Hulke mentioned that a Captain Brown was the first to build a suspension bridge, and took for his model a spider's bridge.

Mr. Harding could not see how "common vital force" had anything to do with the question. Man would no doubt follow the same course to do a thing that animals did, but the difference was that animals did not improve; the wonder would be if different ways were found to do these things.

Mr. H. B. Kirk said it was only when intelligent animals did such things that we could compare their work with that of man. Mr. Phillips had treated this subject in a new way, but there was really nothing new in it.

Mr. Phillips, in reply, said that the subject would be more fully treated in further papers he was now engaged on. He referred to his former paper on "Common Vital Force," which he said would answer some of the questions he was now asked to explain.

The Chairman hoped Mr. Phillips would continue his researches, and complete these interesting papers.

3. General Schaw gave an account of a remarkable phenomenon observed at Invercargill towards the end of last month (August), at 11 p.m., by Mr. Stock, son of the Ven. Archdeacon Stock. (*Transactions*, p. 545.)

Mr. Tanner said he had seen finer sights in the heavens in the neighbourhood of Invercargill than in any other part of New Zealand. He had once seen what appeared to be two suns on the horizon, and could not account for it.

Mr. Maskell had come suddenly into a warm region when travelling in Canterbury; probably this was caused by two bands of mist with a warm band between.

Mr. H. B. Kirk thought these warm patches were generally in sheltered places.

Mr. Phillips had seen bright lights at night in the Wairarapa district, and could not account for them.

4. Mr. G. V. Hudson exhibited five species of New Zealand *Neuroptera* (or lace-winged flies), and gave a short description of each. (*Transactions*, p. 105.)

Seventh Meeting: *11th October, 1893.*

Major-General Schaw, President, in the chair.

Before proceeding with the business of the meeting, the Chairman stated that he had received very full information from Mr. Stock regarding the phenomenon observed at Invercargill in August last, and referred to at last meeting. He considered Mr. Stock deserved the thanks of the Society for the trouble he had taken in the matter.

Papers.—1. "On Tuberculosis in Man and Animals: its Public Health Aspect," by Dr. Chapple. (*Transactions*, p. 526.)

Mr. Maskell agreed with the author that the State should protect the health of the people. How were the public to know when meat or milk was infected? Was there any simple test? Perhaps Dr. Chapple could inform the meeting.

Mr. Richardson thought the Government were doing something to protect the public; it would take time. Was lamb affected with lung-worm fit for consumption?

General Schaw pointed out that the Jews carefully inspected their meat before using it for food. They were a long-lived race.

Mr. T. W. Kirk asked if boiled milk was not more liable to infection than fresh.

Dr. Chapple, in reply, said that if milk was very bad it would decompose very rapidly, but it was difficult to discover whether it was diseased or not without a microscopic or analytic test. If it was bad, it would present a mottled appearance, and here and there the tissue would be soft; but it was hardly likely to be sent to a house in that state. Evidence of tuberculosis would most likely be found along the ribs in the shape of tubercles of the size of a pea or grape. Otherwise it could only be detected by proper examination by a veterinary surgeon. There might be sufficient in a joint to make it extremely dangerous, but which could not be detected by a casual examination. As to lung-worm, there was no possibility of it being communicated to mankind, and there would be no danger in eating lamb affected with it; it was an external animal. It had been positively demonstrated two or three months ago, by Dr. Syms Woodhead, that boiling milk removed its infectious power. Well cooking meat, even if affected, also minimised the danger of infection.

2. "Contribution to a Knowledge of New Zealand Sponges," by H. B. Kirk, M.A. (*Transactions*, p. 175.)

Mr. G. V. Hudson asked what were the Metazoa. Were they a group equivalent in value to the sub-kingdom Protozoa? He did not remember seeing the group mentioned in Nicholson's "Zoology."

Mr. Maskell said this was a valuable paper. He hoped Mr. Kirk would be able to continue such good work. The spicules referred to formed a large portion of the diatomaceous earth used in commerce, as found at Oamaru and other places in New Zealaud. The flagellated cells were, he presumed, the animals that built up the sponge. Did they become free, or remain in the sponge?

The Chairman asked if all these sponges mentioned by Mr. Kirk were now living.

Mr. Kirk replied that the sponges were placed among the Metazoa on account of their life-history; that a segmented ovum contained in a special cavity passed through the changes that characterized the Metazoa; that the complication in the canal system arising in development from the Ascon to the Sycon and Leucon types was clearly in the nature of advance and differentiation; that the flagellated cells, when freed from the sponge, could not use flagellum for locomotion, but depended on amœbid movements, being thus easily distinguished from free monads; and that all the main types of canal system were present in sponges now living. The specimens referred to in the paper could be obtained at Lyall Bay and on the coast at Napier.

3. "Notes on Spiders," by Major-General Schaw. (*Transactions*, p. 107.)

Eighth Meeting: *1st November, 1893.*

Major-General Schaw, President, in the chair.

Papers.—1. "Common Vital Force: Section II.—Discovery *v.* Invention," by Coleman Phillips. (*Transactions*, p. 609.)

Mr. C. Pharazyn said that this was too abstract a subject to discuss at short notice. Perhaps it would be better to defer discussion until the series of papers was completed. The greatest inventor only adapted, after all had been said.

Mr. Tanner did not think the author had enlightened us sufficiently on the difference between invention and discovery. He thought an invention might be a discovery, but a discovery could not be an invention, unless it was mechanically applied.

Mr. Tregear did not quite understand what the author meant by vital force. He got terribly mixed up in regard to this power. He could not agree with the author's views.

Mr. Lambert said, with regard to the force mentioned by Mr. Phillips, that under certain circumstances the intellect of a person became acute, and he used it. He mentioned an instance that occurred to himself, which was carried out successfully. It was an instrument he discovered that would be absolutely correct for perspective drawing.

Mr. Phillips replied briefly.

2. "Common Vital Force: Section III.—Potentiality of Divergence," by Coleman Phillips. (*Transactions*, p. 611.)

Mr. Tanner said there was a limit to the changes mentioned by the author. No mongrel could perpetuate itself. The tumbler pigeon could fly without tumbling. You could not change the species into a different order.

Mr. Hudson said that all the questions mentioned by Mr. Phillips were answered in Darwin's "Origin of Species." We did not gain much from these theories—facts were what we wanted. He explained what was meant by divergence of character according to Darwin.

Mr. Maskell did not admire Darwin—it was making ropes of sand, nothing tangible or solid on which to build theories; and so it was with Mr. Phillips's paper: there was nothing to go upon, and he had not defined what he meant by "common vital force." He did not say whether it was material life, intellect, or mental faculties. The question was, what is nature? It had never yet been defined. He agreed with Mr. Phillips that no two people were alike; but in microscopical life objects were absolutely alike—we came across absolute identity in individuals of the same species. That would do away with Mr. Phillips's theory.

Mr. Phillips, in his reply, said that Darwin was not a theorist; he carefully collected his facts, and then his theories came out. If Mr. Maskell was right in regard to the similarity of microscopical individuals it would be difficult to carry on the study of medical bacteria. Was the microscope of sufficient power to enable us to settle the question?

The Chairman said that such papers as that just read were useful. Darwin certainly brought forth facts, but he did not quite agree with the theories Darwin founded on those facts. Whether there was any limit to varieties was an open question.

3. "On the Date of the Extinction of the Moa," by H. C. Field; read by Mr. Tregear. (*Transactions*, p. 560.)

Mr. Tanner said the information given was nearly all hearsay, and not of much value. He thought there might be a difference in date of extinction in the North and South Islands. No great period could have elapsed since the moa was seen, as was proved by the finding of ring-bones of the neck, which were very tender and would not keep long.

Mr. Lambert had found bones in many localities, and had heard stories of parties seeing the moa at the present day, but the stories always turned out to be untrue.

Mr. Drew said he had found numbers of neck-bones and egg-shells of the moa in the drifting sand. The natives said they had seen and eaten the moa, but they were not to be relied on, nor, indeed, were the European stories to be believed. He thought the bones in the South seemed older than those in the North. There was really nothing new in Mr. Field's paper. He exhibited two pieces of carved bones found at the Wellington Heads, supposed to be human, but he thought them moa-bones.

Mr. Maskell exhibited a plant of *Cineraria*, the leaves of which were much damaged by a leaf-mining larva. He stated that the grub was just now very prevalent in Wellington, on many plants, probably chiefly on *Cineraria* and sow-thistle. It was evidently dipterous, and he had hatched out a large number of the full-grown flies. These appeared to belong to a dipterous group, the "Phytomyzidæ," and the insect was clearly allied to the fly which in England infests celery and turnips and peas. He was sending specimens Home to Mr. C. Whitehead, Adviser to the Department of Agriculture in England, to ascertain the true affinities. The pest, as far as he knew, had not been observed in New Zealand until 1892, and threatened to become rather troublesome; but at a future time he might give further information.

[While this volume is in the press (March, 1894) a letter has come from Mr. Whitehead, who identifies the insect as *Phytomyza affinis*, Fallen. He says, "This insect is very troublesome in England to many plants, mainly of the *Compositæ*. It is found in enormous quantities on chrysanthemums and on allied plants. I cannot find any note of the insect attacking turnips or other *Cruciferæ*. It would be very serious if it did; but I should be inclined to think it would not attack such coarse heavy leaves as those of turnips." In this colony the fly attacks, up to the present, *Cineraria*, sow-thistle, artichoke, chrysanthemum, groundsel, and a number of other plants. Mr. Whitehead goes on to say, "I do not think arsenical washes would be effectual in preventing egg-laying. Spraying with paraffin or carbolic acid would be far more likely to keep the fly from depositing eggs."]

Ninth Meeting: *13th December, 1893.*

Major-General Schaw, President, in the chair.

Papers.—1. "Further Notes on Coccidæ," by W. M. Maskell. (*Transactions*, p. 65.)

Sir James Hector said that he did not think it was necessary to invoke any mysterious or supernatural action to account for this curious form of gall. It was simply a morbid vegetable growth, whose plant-tissue took an abnormal form under continued irritation by the insect.

Mr. Harding did not think the author meant that there was anything supernatural in the work. He himself did not think these animals constructed these galls; they were a vegetable growth—a deviation of the plant-growth: the vital force of the plant did the work after the insect had perforated the twig.

Mr. Travers said that in *Knowledge* there was a most interesting paper on the construction of galls, by Mr. Butler. It treated of their formation from the earliest stages. He considered the galls changed with the life of the insect.

Mr. T. Kirk considered that it was fairly established that galls were the result of morbid vegetable growth, but how formed it was not clear. The dog-rose plant was a good instance, showing the earlier cellular structure, which became changed into a perfect cylinder; but why growth should be fostered in this manner could not be explained.

Mr. Poynton: May not the gall be a part of the animal, like the shell of a snail?

Mr. Maskell, in reply, said that he did not say anything about the supernatural, nor was there any need for it. The gall in question was partly vegetable and partly formed of animal secretion. What Mr. Kirk said was quite correct, and galls of quite different shape were frequently produced by insects seemingly almost identical. But the peculiar and puzzling point about this gall was the position of the insect, which was placed as far as it could possibly get from the food-plant.

2. "Notes and Observations on M. A. de Quatrefages' Paper on Moas and Moa-hunters," by W. Colenso. (*Transactions*, p. 498.)

Sir James Hector said that, with regard to the translation of his paper, Miss Buller was not aware at the time that it had previously been translated, and, moreover, it had been added to by Sir W. Buller, and the Board considered that it would be convenient to have the translation included in the Transactions. The fact that it had called forth such an able paper from Mr. Colenso was in itself a sufficient proof that it was wise to print it. The question as to whether the moa did exist was not the point, but rather, when was it known *first* to exist?

Mr. Tregear had supported the printing of the translation of Quatrefages' paper, although he did not agree with the writer. We could not at present settle the question of the age of the moa traditionally. He could not understand why there was no tradition on the subject. It would no doubt be found hereafter. There was really nothing new in Mr. Colenso's notes.

Mr. Tanner thought it a pity Mr. Colenso had been so personal in his notes on the subject. He had given no additional information.

Sir James Hector referred briefly to his recent trip to Australia, and exhibited a number of interesting specimens he had secured during his trip. Referring to Adelaide, he said he had inspected the sanitary arrangements of that city, and he believed it to be the best-drained town in the world, and he looked forward to the time when Wellington would be in a similar position, especially as we were fortunate enough to have the same engineer to carry out the works here as they had in Adelaide—namely, Mr. Mestayer.

The following is a list of the specimens shown: 1. The giant crab, from Tasmania. 2. Lobsters similar to English lobsters: these, Sir James said, should be introduced into New Zealand waters. 3. Siliceous sinter with gold, from Mount Morgan, similar to the New Zealand White Terrace deposit. 4. A new mineral, eastite. 5. Tasmanian oysters: these oysters are becoming extinct in Tasmania. 6. Skulls of tiger, kangaroo, and wombat.

Mr. Cohen exhibited a carpet-snake from Fiji.

Mr. Lambert exhibited a meteorite found in Kaiapoi sandhills.

3. "Notes on Birds observed on a Voyage to England, and on the Return Voyage," by Sir W. Buller. (*Transactions*, p. 182.)

4. "On a New Species of *Ophiuridæ*," by H. Farquhar. (*Transactions*, p. 109.)

Annual Meeting: *21st February, 1894.*

Sir James Hector in the chair.

New Members.—Mr. Hawthorn and Mr. Barnes.

Abstract of Annual Report.

Ten meetings were held, and forty-three papers were read. More interest had been taken in the proceedings, especially by ladies. Fourteen new members had joined.

The Society had nominated Major-General Schaw to represent them on the Board of Governors of the New Zealand Institute for the current year, and he had been duly elected.

The balance-sheet showed that the receipts for the year, including the balance brought forward, amounted to £169 15s. 6d., and the expenditure to £112 11s. 3d., leaving a balance in hand of £57 4s. 3d. There was also a sum of £23 0s. 10d. lodged in the bank at interest, which increase brought the credit balance to £80 5s. 1d. A sum of over £26 had been spent on literature; and the cost of insuring the library was £7 10s.

Election of Officers for 1894.—*President*—Major-General Schaw, C.B., R.E.; *Vice-presidents*—Mr. S. Percy Smith, F.R.G.S., and Mr. C. Hulke, F.L.S.; *Council*—Sir James Hector, K.C.M.G., M.D., F.R.S., &c., Mr. E. Tregear, F.R.G.S., Mr. G. Denton, Mr. R. C. Harding, Mr. W. T. L. Travers, F.L.S., Mr. W. M. Maskell, Mr. G. V. Hudson, F.E.S.; *Secretary and Treasurer*—Mr. R. B. Gore; *Auditor*—Mr. T. King.

In proposing the re-election of General Schaw as President, Sir James Hector referred to the valuable service that gentleman had rendered the Society during the past year. He was pleased to see that General Schaw's re-election as President was so warmly agreed to by those present.

The following papers were read:—

1. "On New Cyperaceous Plants, or Cutting-grasses," by T. Kirk, F.L.S. (*Transactions*, p. 260.)

2. "On New Zealand *Sonchus*, or Sow-thistle," by T. Kirk, F.L.S. (*Transactions*, p. 263.)

Mr. Tregear said this grass reminded him of the sacrificial knife used by certain natives. It might have been taken as a model by them. The sow-thistle, he remarked, was good for food.

Mr. Richardson considered that these plants were useful for fixing drifting sands.

Mr. Hulke thought these sow-thistles should be cultivated, as the root was valuable, and could be much increased in size.

Mr. Harding thought it more likely that sharks' teeth had suggested the cutting-knives referred to by Mr. Tregear.

Sir James Hector pointed out how the sow-thistle was being destroyed by the American blight; the harsh-leaf kind seemed to escape, it was the soft kind that was attacked, and the ground was taken up by a plant that was doing mischief.

Mr. T. W. Kirk said this insect (the black fly or leaf-mining insect) not only attacked the thistle, but also the *Cineraria*, as pointed out by Mr. Maskell at a previous meeting. He found arsenic spray a good thing for destroying this blight.

Mr. T. Kirk said that the aphis only attacked the sow-thistle described by him periodically.

3. "The Story of Papaitonga, or a Page of Maori History," by Sir W. Buller. (*Transactions*, p. 572.)

Mr. Tregear said there were many points of great interest in this paper, especially the building of the island on the lake; it reminded him of the lake dwellings.

4. "On a Remarkable Maori Implement in the Hunterian Museum at Glasgow," by Sir W. Buller. (*Transactions*, p. 570.)

5. "On a Curious Maori Flute in the Collection of the late Dr. Shortland," by Sir W. Buller. (*Transactions*, p. 568.)

AUCKLAND INSTITUTE.

First Meeting: *29th May, 1893.*

Professor C. A. M. Pond, President, in the chair.

New Member.—J. D. Harris.

The President delivered the anniversary address, the title of which was given as "Tennyson and Browning: A Retrospect of Victorian Poetry." (*Transactions*, p. 548.)

On the motion of Mr. Upton, seconded by Dr. Purchas, a vote of thanks was accorded to the President for his address.

Second Meeting: *19th June, 1893.*

Professor C. A. M. Pond, President, in the chair.

New Members.—Dr. Mackellar, G. W. S. Patterson.

Mr. Cheeseman exhibited, for Professor F. D. Brown, some branches from a puka-tree (*Meryta sinclairii*) growing in his garden, and which had been almost killed by rats gnawing away the bark. The branches exhibited had almost the whole of their bark removed by the attacks of the rats.

Mr. F. D. Fenton urged that the Institute should represent to the Government the desirability of making terms with Mr. Colenso for the completion and publication of his Maori dictionary. No living person was better acquainted with the Maori language than Mr. Colenso. It was known that for many years he had been collecting material for such a work; and, although a previous Ministry had decided to discontinue the small yearly expenditure required for its preparation, he was sure that all those acquainted with Mr. Colenso, and with the immense amount of time and labour given by him, would agree that such a course was unworthy of the colony. Mr. Fenton spoke at some length as to the necessity for the preparation of a really good and complete Maori lexicon, and the desirability that the work should be done by an accomplished Maori scholar like Mr. Colenso.

A long discussion ensued. It was at length resolved that

Sir G. Grey should be asked to represent to the Government the desirability of approaching Mr. Colenso for the purpose indicated by Mr. Fenton.

Paper.—"The Geology of the Kuaotunu Goldfield," by James Park, F.G.S. (*Transactions*, p. 360.)

Third Meeting : *3rd July, 1893.*

Professor C. A. M. Pond, President, in the chair.

Mr. T. H. Smith gave a lecture on Maori implements and weapons, illustrating his remarks by the exhibition of specimens selected from the Maori collection in the Museum. (*Transactions*, p. 423.)

Mr. F. D. Fenton spoke in commendation of the lecture, and, on his proposition, a vote of thanks was unanimously awarded to Mr. Smith.

Fourth Meeting : *7th August, 1893.*

Professor C. A. M. Pond, President, in the chair.

New Members.—E. Clifton, T. J. Steele.

Professor F. D. Brown gave a popular lecture on "The Liquefaction of Gases."

Fifth Meeting : *28th August, 1893.*

Mr. James Stewart, C.E., Vice-president, in the chair.

Papers.—1. "Notes on the Crater of White Island," by Captain Fairchild.

Abstract.

For very many years the crater of White Island was believed to be permanently filled with warm water, which sometimes became so hot as to reach a state of ebullition. Early in 1868 the island was visited by H.M.S. "Brisk," and a rough survey of the crater was made by Lieutenant Edwin, of that vessel. According to Captain Fairchild this survey is a correct representation of the state of the crater for many years previous to 1868 and up to 1879, during which period he frequently visited the island.

Some time during 1879 H.M.S. "Pearl" visited the island, and found the crater quite dry, this being the first time such a state of things had been noticed. The officers of the "Pearl" reported the matter at Wellington. It excited some interest, and the Government, through Mr. G. S. Cooper, telegraphed to Captain Fairchild, who happened to be at

Napier with the "Hinemoa," instructing him to proceed at once to the island, and report as to its condition. This he did, and found the lake perfectly dry. He was able to walk across the floor without the slightest difficulty. But within two months the lake filled again, and resumed its ordinary appearance and temperature.

During the following seven years, 1879–86, the island was regularly visited by Captain Fairchild, who always found the crater filled with water. On three occasions he crossed it in a dingy which was dragged to the lake from the landing-place by his sailors.

In June, 1886, a few days after the eruption of Tarawera, White Island became unusually active, and the crater again became dry. The steam-jets surrounding the crater were unusually active for many months after the eruption. About six months after the eruption, Captain Fairchild visited a large one situated at the head of the lake. He was accompanied by Mr. Lodder and others. The steam-vent was then emitting what appeared to be intensely bright-red flames, which rose to a height of at least 12ft. above the mouth of the vent. The party approached sufficiently near to throw stones down the vent.

From the time of the eruption of Tarawera until the middle of 1893 the lake remained perfectly dry. During this period it was visited every three months by Captain Fairchild, or whenever the "Hinemoa" passed the island in the performance of the regular lighthouse duties. On none of these visits did he find any signs of the crater having been filled with water. He was therefore much surprised on landing on the island a few weeks ago to find the lake again filled, and presenting an appearance exactly similar to what it did over twenty years ago.

There is very little thermal action going on at the present time. The water of the lake was boiling in one or two places, and some of the hot springs and steam-vents near the sides of the crater were feebly active. But, as a whole, the island was remarkably quiescent. Since the time of his previous visit huge landslips had taken place on the sides of the crater, many thousands of tons of material having been brought down; but otherwise there was little sign of any physical changes of importance.

2. "Notes on the New Zealand Bats," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 218.)

3. "Why should School-teaching provide only for the Counter or the Desk?" by James Adams, B.A. (*Transactions*, p. 452.)

Sixth Meeting: *11th September, 1893.*

Professor C. A. M. Pond, President, in the chair.

The Rev. J. Bates gave a popular lecture on "The Persistence of Savagery."

Seventh Meeting: *9th October, 1893.*

Mr. J. H. Upton in the chair.

The Right Rev. W. G. Cowie, D.D., gave a popular lecture on "The British Empire in India."

Eighth Meeting: *23rd October, 1893.*

Professor F. D. Brown, Vice-president, in the chair.

New Member.—T. B. Allen, B.Sc.

Papers.—1. "Note on the Nesting Habits of the Matuku, or Bittern," by P. E. Cheal:—

"I forward herewith four eggs of the matuku, or bittern, found in the swamp at Whakahara, Piako. As the nest is seldom seen, I send the following particulars of its discovery: On Wednesday, 30th August, when chaining along the boundary of the Takapau-Rerekau Block, and about one mile and a half west of the Waitoa River, and three miles east of the Piako River, my chainman's son walked a little distance from the party and stumbled over the nest, very nearly falling upon the bittern, which rose and flew away. On examining the nest I was pleased to find five eggs therein. The nest was quite exposed, being situated in a small toetoe tussock not 4in. above the level of the swamp-water. It was composed of a few layers of dry rushes, laid across one another, without any attempt at nest-making. Interspersed with the rushes was some fine down, but whether from the bittern or from some other bird I cannot say."

2. "Public Ferneries: a Suggestion," by the Rev. P. Walsh. (*Transactions*, p. 619.)

3. "On the Occurrence of some Rare Minerals in New Zealand," by James Park, F.G.S. (*Transactions*, p. 365.)

4. "New Species of *Araneæ*," by A. T. Urquhart. (*Transactions*, p. 204.)

5. "Notes on the Course of the Waikato River," by L. Cussen. (*Transactions*, p. 398.)

Annual General Meeting: *19th February, 1894.*

Mr. T. Peacock in the chair.

Abstract of Annual Report.

The number of members on the roll on the 1st February, 1894, was 177, of whom 13 are life members and 164 ordinary subscribers. The number of new members elected during the year has been unusually small, amounting to six only. Sixteen names have been withdrawn—four from death, five from resignation, and seven from non-payment of subscription for more than two consecutive years. As the number on the 1st February, 1893, was 187, there has been a net decrease of ten during the year. It is the melancholy duty of the Council to notice the decease of Professor C. A. M. Pond, who was elected President of the

Institute at the last annual meeting, and who died in October last, before completing his term of office. Professor Pond's connection with the Institute has been but short; but nevertheless his varied attainments and amiable personal qualities had secured the respect and esteem of the members generally. The Institute can ill afford to lose such an earnest and sincere worker, and the Council feel sure that his premature death will be deeply and widely regretted. Mention must also be made of the decease of Mr. G. B. Owen, who served on the Council in the early days of the society; and of Sir W. Fox, so well known from his intimate connection with those who laid the foundations of the colony, and from the important part which he has taken in its political history.

Full and detailed information respecting the financial position of the Institute will be found in the balance-sheets appended to the report, but some remarks of an explanatory nature will be useful here. The total income of the general account has been £944 5s. 6d. Last year the amount received was £805 13s. 9d., so that there has been an increase of £138 11s. 9d. during the year. The interest yielded by the invested funds of the Costley bequest has been £474 7s. 6d., while the Museum endowment has contributed in rents and interest on investments £314 5s. 8d. The members' subscriptions have amounted to £129 3s., a sum slightly below that received in 1892–93. The total expenditure has been £890 10s. 11d., leaving a credit balance of £53 14s. 7d. in the Bank of New Zealand. The invested funds of the Institute amount at the present time to £12,489 3s. 10d., showing an increase of £1,118 13s. during the twelve months. It has been found advisable to vary the mode of investment of a large portion of this amount, with the object of placing it in a position of unchallenged security, from which a moderate but reliable income could be obtained. This has not been done without much and anxious consideration on the part of the Council, and they are confident that the result is in every respect satisfactory.

The third and final payment of £1,000 on account of the Waikanae Block has been received and duly invested. Some small sales, chiefly of township allotments, have been made, realising in all £184 11s. 6d. In addition to this, a sum of about £150, derived from sales effected some time back, and which was erroneously paid into the Public Account, is still in the hands of the Government, but will doubtless be handed over before long. The Council have been in constant communication with the Crown Lands Board respecting the utilisation of the remainder of the endowment, but, as has been pointed out in previous reports, there is little demand for country lands except under perpetual lease, and under that system the rents are so small, and are paid with such irregularity, that the Council are unwilling to sanction its adoption as a mode of dealing with the endowment.

Eight meetings have been held during the year, at which sixteen papers were read and discussed.

The attendance of visitors to the Museum on Sundays has been 10,288, being an average of 197 for each Sunday; and 30,500 on week-days: a total of 40,788 for the year.

The total number of volumes in the library at the present time is 3,392. The collection of books and pamphlets relating to New Zealand, for a large portion of which the Institute is indebted to the liberality of the late Mr. J. T. Mackelvie, now contains 749 different works, and is probably the most complete public collection of the kind in the colony.

The Council have always taken a strong interest in the proposed acquirement by the Government of the Little Barrier Island, for the purpose of preserving thereon some of the rarer birds of New Zealand, which otherwise will probably soon become extinct. In fact, the suggestion to set aside the island for this purpose was first made by Mr. F. D. Fenton at a public meeting of the Institute held many years ago. At the same time the Council urged Sir R. Stout, then Premier of the colony, to purchase the island from the native owners without delay. Since then the Institute has brought the matter under the notice of successive Governments and before the Australasian Association. Public opinion has been expressed in favour of the proposal in an unmistakable manner, and of late years it has been warmly supported by Lord Onslow and Sir W. L. Buller. But the negotiations for the purchase of the island are still incomplete; and several of the native owners have yet to be dealt with. In the meantime several natives and Europeans are living on the island. Fires have been allowed to spread, and in the last week of January of this year a serious one was reported, which lasted at least a week. By degrees the island is being rendered less suitable for the purpose of a preserve. But in addition to this the island has been visited by collectors, and specimens of the very birds which it was hoped might survive have been shot and brought to Auckland. The Council much regret the continuance of this state of affairs. No time ought to be lost in completing the purchase; all residents should be removed, and the caretaker should be armed with full powers to prevent unauthorised persons from landing on the island.

Election of Officers for 1894.—*President*—J. H. Upton; *Vice-president*—Professor F. D. Brown; *Council*—Rev. J. Bates, W. Berry, C. Cooper, G. Mueller, E. A. Mackechnie, T. Peacock, Rev. A. G. Purchas, E. Roberton, M.D., T. H. Smith, J. Stewart, C.E., E. Withy; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S, F.Z.S.; *Auditor*—W. Gorrie.

On the motion of Bishop Cowie, it was unanimously resolved, "That this meeting views with regret the delay that has taken place in securing the Little Barrier Island for the purpose of preserving some of the rarer birds of New Zealand, and would respectfully urge upon the Government the desirability of bringing the purchase of the island to an early conclusion; and further requests the Council of the Institute to bring this resolution under the notice of the Government."

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *3rd May, 1893.*

Professor Bickerton in the chair.

Paper.—"Chlorine a Cure for Consumption," by Professor Bickerton.

Second Meeting: *7th June, 1893.*

Professor Bickerton in the chair.

New Member.—W. G. Pye, M.A.

Professor Bickerton gave a short address on "A Simple System of Graphic Formulæ as applied to Organic Chemistry."

Third Meeting: *5th July, 1893.*

R. M. Laing, M.A., B.Sc., in the chair.

New Member.—P. Marshall, M.A.

Paper.—"The Nelson Earthquake of 12th February, 1893," by G. Hogben, M.A. (*Transactions*, p. 347.)

Fourth Meeting: *2nd August, 1893.*

Professor Bickerton in the chair.

Papers.—1. "*Conchothyra parasitica*," by Captain F. W. Hutton, F.R.S. (*Transactions*, p. 358.)

2. "On a New Rail from the Auckland Islands," by the Hon. Walter Rothschild; communicated by Captain Hutton. (*Transactions*, p. 180.)

3. "On New Species of the New Zealand *Musci*," by R. Brown. (*Transactions*, p. 302.)

FIFTH MEETING: *6th September, 1893.*

Professor Bickerton in the chair.

Paper.—"On a Tridymite-Trachyte of Port Lyttelton," by P. Marshall, M.A. (*Transactions*, p. 368.)

SIXTH MEETING: *4th October, 1893.*

Professor Bickerton in the chair.

Papers.—1. "On Four New Species of New Zealand *Musci*," by T. W. Naylor Beckett, F.L.S. (*Transactions*, p. 274.)

2. "On some little-known New Zealand Mosses," by T. W. Naylor Beckett, F.L.S. (*Transactions*, p. 277.)

3. "On a supposed Fire-drill found in the Cave, Moa-bone Point, Sumner," by Captain F. W. Hutton, F.R.S. (*Transactions*, p. 516.)

4. "On a Doleritic Dyke at Dyer's Pass," by R. Speight, B.Sc. (*Transactions*, p. 408.)

Professor Bickerton gave a short address on Nova Auriga in connection with his theory of cosmic impact, showing how all the phenomena in the new star had been predicted by him as likely to happen if two bodies collided.

SEVENTH MEETING: *1st November, 1893.*

Professor Bickerton in the chair.

Papers.—1. "On *Lessonia variegata*," by R. M. Laing, M.A., B.Sc. (*Transactions*, p. 304.)

2. "On a New Plesiosaur from the Waipara River," by Captain F. W. Hutton, F.R.S. (*Transactions*, p. 354.)

3. "Further Contributions to the Knowledge of the Terrestrial and Fresh-water Fauna of New Zealand," by H. Suter, (*Transactions*, p. 121.)

4. "Check-list of the Terrestrial and Fresh-water Molluscan Fauna of New Zealand," by H. Suter; communicated by Captain Hutton. (*Transactions*, p. 139.)

5. "On an Improved Seismograph," By W. A. Carew. (*Transactions*, p. 461.)

6. "On the Genus *Pottia*," by R. Brown. (*Transactions*, p. 288.)

7. "On the Genus *Gymnostomum*," by R. Brown. (*Transactions*, p. 296.)

8. "Our Immortal Cosmos," by Professor Bickerton, F.C.S.

9. "Stability of Cosmic Spheres," by Professor Bickerton, F.C.S.

10. "Theory of Hail," by Professor Bickerton, F.C.S.

11. "Evidence of the Theory of Partial Impact supplied by Nova Auriga," by Professor Bickerton, F.C.S. (*Transactions*, p. 464.)

12. "Supplementary Note to Paper on Little-known New Zealand Mosses," by T. W. Naylor Beckett, F.L.S. (*Transactions*, p. 277.)

Abstract of Annual Report.

During the year seven meetings have been held, at which twenty-three papers were read, as follows: Zoology, 3; botany, 7; geology, 6; physical science, 1; chemistry, 2; astronomy, 3; miscellaneous, 1.

The number of members now on the roll is sixty-six, as against seventy-five of last year, but there have been added twenty-one associates, who by paying a smaller subscription are entitled to nearly all the privileges of members. These mostly belong to the photographic section, which has been doing good work, with Mr. S. Page as secretary. The library has been largely increased by the addition of new volumes, some of which are valuable works on early science in New Zealand.

The balance-sheet shows a total receipt of £47 8s., and a total expenditure of £90 4s. 2d., thus leaving a credit balance of £32 10s., including the amount of £75 6s. 2d. carried forward from last year.

Election of Officers for 1894.—*President*—R. M. Laing, M.A., B.Sc.; *Vice-presidents*—Professor Bickerton and Dr. W. Thomas; *Secretary*—R. Speight, B.Sc.; *Treasurer*, J. T. Meeson, B.A.; *Council*—T. W. Naylor Beckett, F.L.S., F. C. B. Bishop, S. Page, W. G. Pye, M.A., W. H. Symes, M.D., H. R. Webb, F.R.M.S.

OTAGO INSTITUTE.

First Meeting: *9th May, 1893.*

Dr. T. M. Hocken, President, in the chair.

After a few introductory remarks, Dr. Hocken was called away; and Mr. C. W. Adams, Vice-president, made a speech welcoming the members and their friends, and on behalf of the society offered a hearty welcome to Professor T. J. Parker on his return from a visit to England.

A number of interesting exhibits were displayed in the biological laboratory, notably a beautiful specimen of an albatros in the down, and some of the specimens acquired for the Museum in England by Dr. Parker. A special exhibit was a collection of bird-skins from the Chatham Islands, containing a pair of the extremely rare rail (*Cabalus*), and a number of scarce birds. With these was a collection of over a dozen well-finished stone axes and tools, with grinding-stones, found in one place at the Chatham Islands. As the Museum was unable to afford the money necessary for the purchase of these collections, a subscription list was started, and the Council of the Institute supplemented the amount collected by a grant, which enabled the Curator to secure the specimens for the Museum.

It was announced during the meeting that the Council had received a letter from Mr. G. M. Thomson, F.L.S., drawing attention to the inactivity of the Government in the matter of setting aside Resolution Island as a sanctuary for native birds, and that the Council had appointed a committee to confer with the Otago Acclimatisation Society as to the best mode of forwarding the matter.

The following gentlemen were elected members of the Institute: Thomas Mackenzie, Balclutha; Murray Aston, St. Leonards; W. Shacklock, Dunedin.

Second Meeting: *13th June, 1893.*

Dr. T. M. Hocken, President, in the chair.

Dr. J. H. Scott read a paper entitled "Contributions to the Osteology of the Maori and Moriori Races: Part I."

(*Transactions*, p. 1.) Diagrams and specimens illustrating the paper were exhibited.

Dr. T. J. Parker read a paper on the occurrence of a rare fish at St. Clair—*Lophotes cepedianus*—a genus and species new to New Zealand, this being the third known specimen, the other two having been recorded from the Mediterranean and the Sea of Japan. (*Transactions*, p. 223.)

Mr. Hamilton, the Honorary Secretary, exhibited some material, mainly broken tubes of scapulæ and fragments of barnacles, dredged by Captain Fairchild south of the Bounty Islands, in 110 fathoms. The shells contained were of about thirty species, all small, and mainly shallow-water forms.

The President announced that Mr. D. Petrie, F.L.S., had presented a copy of Dr. Berggren's work on "Azolla," in German and Swedish, to the library; that the Council had forwarded an order for books for the library to England, and had taken steps to complete the set of "'Challenger' Reports."

New Members.—T. N. Brown, Roslyn; Alexander Thomson, Dunedin.

Third Meeting: *11th July, 1893.*

Dr. T. M. Hocken, President, in the chair.

Mr. D. Petrie, F.L.S., presented a paper "On some Newly-discovered Native Plants." (*Transactions*, p. 266.)

Mr. Petrie gave a popular account of the species described in detail in the paper, together with observations on their habitats, &c. In the discussion which followed, the President took the opportunity of informing the members that the Council had resolved once again to approach the Government to induce them to print a new edition of "The Flora of New Zealand," and thus to render accessible to botanical students the descriptions of the large number of species discovered since the original edition was published.

Dr. Parker then exhibited some models of restorations of extinct animals recently added to the Museum collection.

Two species of fish received lately by the Museum from this neighbourhood were shown—*Congromuræna habentata* and *Brama raii.*

Mr. Hamilton read the first part of a paper on the modes of burial formerly observed among the inhabitants of New Zealand.

The President notified that Dr. Belcher would be unable to deliver his lecture on "Sophokles" at the next meeting, as previously announced.

New Members.—Dr. Gordon Macdonald, A. McNicol, J. E. Tennant, J. H. Hoskings.

FOURTH MEETING: *12th August, 1893.*

Dr. T. M. Hocken, President, in the chair.

Dr. Parker exhibited, and gave an interesting popular lecture on, a large number of natural-history specimens (preserved in spirit), and also models of botanical specimens (very greatly enlarged). A large number of members and their friends were present. The meeting-room, having recently been re-seated, was found much more convenient than on former occasions when a number have been present.

It was announced that the large and expensive work by Cooke on British fungi had been purchased for the library.

FIFTH MEETING: *19th September, 1893.*

Mr. C. W. Adams, Vice-president, in the chair.

Mr. A. Wilson, M.A., read an interesting account of his observations on the phases of bird-life observed by him in his garden and in his daily walks through the Town Belt. The birds mentioned were nearly all introduced birds.

Mr. Melland and Dr. Parker both spoke on the paper, and expressed the hope that other members of the society would follow Mr. Wilson's example and record their observations on the animals or plants under their daily observation.

Dr. Parker then showed some models recently obtained for the Museum, illustrating the development of the chicken, and gave a most interesting lecturette on the points illustrated by the preparation.

It was announced that a catalogue of the library was now printed in connection with the catalogue of the Otago University.

SIXTH MEETING: *10th October, 1893.*

Dr. Hocken, President, in the chair.

The President read the third part of his description of the foundation and settlement of Canterbury, being No. 15 of the series of lectures on the early history of New Zealand, delivered during past sessions to members of the Institute. Maps and early pictures of the district were shown.

SEVENTH MEETING: *14th November, 1893.*

Dr. T. M. Hocken, President, in the chair.

Dr. Scott presented the second part of his paper, "Contributions to the Osteology of the Maori and Moriori Races." (*Transactions*, p. 1.)

Dr. Parker read a paper "On some Moa-skulls recently discovered at Enfield." (*Transactions*, p. 223.)

The Honorary Secretary communicated a paper "On Earthworms," by W. W. Smith, of Ashburton. (*Transactions*, p. 155.)

Dr. Parker communicated a paper "On the Pig-fish," by A. Stenhouse, Dunedin. (*Transactions*, p. 111.)

Mr. Hamilton laid on the table a continuation of his paper in the Transactions of last year on the fissure at Castle Rock, and exhibited the series of bones of the male and female of *Harpagornis* lately recovered by him from the fissure. (*Transactions*, p. 226.)

Mr. Hamilton also laid on the table notes towards a bibliography of the moa. (*Transactions*, p. 229.)

Mr. Hamilton showed six kinds of living terrestrial orchids in flower found growing in the neighbourhood of Dunedin.

Mr. F. R. Chapman exhibited two spikes of *Antherium* from plants from the Auckland Islands, grown in his garden, and made a few remarks on the result of two years' cultivation of the plant in his garden.

New Member.—F. J. Heatly.

The annual general meeting was then held.

ABSTRACT OF ANNUAL REPORT.

After giving details of the proceedings of the past year; the report goes on to say: "Early in the session, the Council had the question brought before them of again urging on the Government the desirability of taking steps to proceed with the subject of the Resolution Island reserve for native birds. A deputation was appointed, which, together with some of the members of the Acclimatisation Society, interviewed the Hon. Mr. Ward, who undertook to keep the matter in view. The Council trust that the matter will shortly be placed on a more satisfactory footing and a caretaker appointed, as no time should be lost in the matter.

"The Council presented a petition to Parliament through Mr. James Allen, again urging on the Government the desirability of printing a new 'Flora of New Zealand.' Several of the other societies have also forwarded similar requests, and it is hoped that the repeated recommendations of this society and the other branches of the New Zealand Institute may have the desired effect.

"A resolution was passed at the July meeting, That, at the end of this year, a report of the Council shall be printed, together with the rules, and such other information concerning the publications, books, &c., available to members as shall be thought necessary."

The balance-sheet showed a total receipt for the year of £92 8s., which, with the balance brought forward of £98 4s. 2d., made a sum of £190 12s. 2d. The credit balance forward this year was £72 17s. 9d.

Election of Officers for 1894.—*President*—E. W. Melland; *Vice-presidents*—Dr. T. M. Hocken, C. W. Adams; *Treasurer*—Professor F. B. de M. Gibbons; *Secretary*—A. Hamilton; *Auditor*—D. Brent; *Council*—F. R. Chapman, Dr. T. J. Parker, Dr. Belcher, Dr. Scott, G. M. Thomson, Dr. William Brown, Dr. Chilton.

WESTLAND INSTITUTE.

ANNUAL MEETING: *19th December, 1893.*

ABSTRACT OF ANNUAL REPORT.

The report conveyed the thanks of the society for donations and papers received, and likewise to the Borough Council for their usual subsidy. It was also stated that the library would shortly have a welcome addition in a parcel of new books expected in the beginning of next month, and that several new papers have been added to the reading-room, with the prospect that more will be done in the ensuing year.

The balance-sheet closed the financial year with a credit balance of £9 14s. 11d., the revenue for the year being £119 15s. 4d., and the expenditure £110 0s. 5d.

ELECTION OF OFFICERS FOR 1894.—*President*—Mr. H. L. Michel; *Vice-president*—Mr. W. C. Fendall; *Honorary Treasurer*—Mr. A. H. King; *Trustees*—Messrs. Barron, Churches, Cresswell, Croft, Fowler, Gill, Macandrew, MacFarlane, Mahan, Morton, Ross, and Wade.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *8th May, 1893.*

Dr. Moore, President, in the chair.

Inaugural address, "The New Mesmerism," by the President.

Second Meeting: *12th June, 1893.*

Mr. T. Humphries, Vice-president, in the chair.

Papers.—1. "A Maori Pa at Lake Te Anau," by Taylor White. (*Transactions*, p. 513.)

2. "A Humble Precursor of Darwin — Rev. Ezekiel Blomfield," by W. Dinwiddie.

3. "The Volcanic Outburst at Te Mari, November, 1892," by H. Hill, B.A., F.G.S. (*Transactions*, p. 388.)

4. "The Geology of the Country between Dannevirke and the East Coast," by H. Hill, B.A., F.G.S. (*Transactions*, p. 392.)

Third Meeting: *10th July, 1893.*

T. Humphries, Vice-president, in the chair.

Papers.—1. "Notes on Two Peculiar Introduced and Naturalised South American Plants" (notes on the aloe, prickly pear, and hemlock-leaved heron's-bill), by Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 323.)

2. "More Last Words about Tongariro and its Neighbourhood," by Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 483.)

Fourth Meeting: *7th August, 1893.*

Dr. Moore, President, in the chair.

Paper.—"Forms of Burial: a Plea for Cremation," by Mr. P. S. McLean.

Fifth Meeting: *11th September, 1893.*

Dr. Moore, President, in the chair.

Papers.—"Mohammedanism and its Present Relations with Christianity," by the Bishop of Waiapu.

2. "Some Difficulties of a Self-taught Student of Chemistry," by C. J. Cooke.

3. "The Dog of New Zealand: a Reply to Mr. Colenso," by Taylor White. (*Transactions*, p. 585.)

4. "Pebbles and Drifting Sand," by E. W. Andrews. (*Transactions*, p. 397.)

Sixth Meeting: *9th October, 1893.*

Mr. J. W. Craig in the chair.

Papers.—1. "*Iulus fijiensis*," by Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 106.)

2. "List of Fungi recently collected in the Bush District," by Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 320.)

3. "On Four Notable Foreign Plants" (notes on the banana, vanilla, edelweiss, and rose of Jericho), by Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 333.)

4. The Effect of Electricity on Plant-growth," by H. N. McLeod. (*Transactions*, p. 463.)

5. "How Spiders walk on Water," by Taylor White.

Prior to the papers being read, Mr. Colenso made some remarks appropriate to the anniversary of Captain Cook's arrival in Hawke's Bay, and read extracts from a letter from Sir Joseph D. Hooker relating to the recent discovery of Sir J. Banks's manuscript narrative of the "First Voyage."

Abstract of Annual Report.

Your Council beg to report that six ordinary meetings were held during the session, and were well attended by members and their friends. The plan of providing tea and coffee, which was adopted for the first time this session, was found to have a beneficial effect on the attendance. The number of papers read before this branch was eighteen. About twenty new volumes were added to the library.

Your Council are glad to report that the financial position of the Institute is most satisfactory, the debit balance which has appeared in the statements of the last few years having been at length wiped out. The number on the roll is 100, but, as several of these have now resigned, it is desirable that an effort be made to increase the membership.

The Council are glad to report that a catalogue of the library has been prepared and printed, and may be obtained by members. The library has been thoroughly overhauled and rearranged, and is now in an exceedingly satisfactory condition.

The balance-sheet shows the total receipts for the year as £103 7s. 11d., and the expenditure £88 3s. 3d. The total assets of the Institute are valued at £781 4s. 8d.

Election of Officers for 1894.—*President*—T. Humphries; *Vice-president*—J. W. Carlile, M.A.; *Hon. Treasurer*—G. White; *Hon. Secretary*—W. Dinwiddie; *Auditor*—J. Crerar; *Council*—Miss Browning, J. H. Smith, J. W. Craig, H. Hill, B.A., F.G.S., H. H. Pinckney, B.A., J. Ringland.

NELSON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *12th June, 1893.*

The Bishop of Nelson, President, in the chair.

New Member.—Mr. Edward Lukins.

Paper.—"The Geology of Nelson." By W. F. Worley. (*Transactions*, p. 414.)

Presentations to the Society.—Specimen of a species of Ray, from Mr. Johnston; a carved model of native canoe, from Mrs. Duncan; a collection of geological specimens, from Miss Wells; specimens of vegetable caterpillars, from Mr. St. John.

Mr. Lukins exhibited interesting specimens of dredgings from off the Bounty Islands.

ANNUAL MEETING: *11th December, 1893.*

The Bishop of Nelson, President, in the chair.

The Hon. Secretary's report showed that only one meeting had been held since the last annual meeting.

The Hon. Curator's report stated the Museum to be in fairly good condition, and enumerated the presentations during the year.

The Hon. Treasurer's report showed a balance in hand of £17 3s.

ELECTION OF OFFICERS FOR 1894.—*President*—The Bishop of Nelson; *Vice-presidents*—Mr. A. S. Atkinson and Dr. Boor; *Hon. Secretary*—Mr. R. I. Kingsley; *Hon. Treasurer*—Dr. James Hudson; *Hon. Curator of the Museum*—Mr. R. I. Kingsley; *Council*—Dr. J. W. Mackie, Messrs. J. Holloway, J. W. Joynt, R. I. Kingsley, and F. Worley.

A resolution was passed that in future the meetings should be held monthly, on the second Monday.

Presentations to the Society.—Book of lithographs of ferns from Queensland, presented by Mr. A. W. Bain; piece of coral from Mauritius, presented by Mr. A. H. Patterson; skin of carpet-snake, and hornet, from New South Wales, by Mr. J. P. Miller; specimens of coprolites, &c., from Cambridgeshire, England, by the Curator; a facsimile of a rare historical tract in Italian and Latin, date 1572, by Mr. R. I. Kingsley.

Papers.—1. "Description of a New Species of *Pimelea*," by T. Kirk, F.L.S. (*Transactions*, p. 259.)

2. "The Massacre of St. Bartholomew," by R. I. Kingsley.

Addendum to Proceedings of Wellington Philosophical Society for 6th September, 1893.

THE following is an abstract of Mr. R. Coupland Harding's paper "On Mental Operations in Sleep" (see p. 658).

ABSTRACT.

The author said he did not intend to deal with the phenomena of dreams in general—a wide subject—but with those interesting and exceptional instances in which there was continuous rational effort, productive of a definite result, and in some cases, as those in which the dreamer imagines he reads from a book or engages in a discussion, when there was the appearance, at all events, of the operation of an independent intelligence. A theory very commonly accepted, that dreams were merely the imperfect reflection and confused repetition of thoughts that had occupied the mind during waking-hours, however it might apply in numerous cases, was entirely excluded in certain classes of phenomena which he had himself noted. He was inclined to disbelieve the common assertion that the action of the mind in sleep was inconceivably swift. The anecdotes in support of this view were, as a rule, ill authenticated, and, even if true, were exceptional. In natural and healthy repose all the vital operations were much slower than in waking-hours. The motion of the blood through the brain was slower and steadier, and the mental operations were correspondingly deliberate. Dreaming was a natural feature of healthy repose, and he doubted whether sleep was ever absolutely dreamless. Like any other natural function, it was perverted by disease; but it was only to the normal and healthy condition that his present remarks had reference. The difficulty of exactly recalling dream-impressions, however vivid at the time, was the cause of much embellishment, intentional and otherwise. At a former meeting an English scientific authority had been quoted as saying, "All dream images are vague and undefined." This assertion was too sweeping. The generalisations of our waking-moments might be as vague as any dream-image, as when Proctor vainly tried to analyse the mental idea conveyed by the words "passer-by," or "by-stander." His own dream-image of a ship, or of the skeleton of a beast, for example, would be necessarily a vague phantom,—as a memory sketch would be absurdly incorrect: but when he dreamed of a book the image was clear enough. It might be unlike any book he had ever seen; but it was always such as he could reproduce in every detail of form, size, style of type, and decoration. He would divide the more or less orderly mental operations of sleep into four classes, examples of all of which had come within his own experience: (1.) Active constructive work, such as the composition of essays, problems, verses, &c., bearing a general resemblance to ordinary work of the kind in waking-hours, though, as a rule, exceedingly poor in quality, showing that the critical faculty is in abeyance for the time being. (2.) The apparent passive reception of matter of the kind, as in the reading, or hearing read, narrative, essay, or verse. (3.) The debating or discussing such matters with a supposed second person. (4.) The working-out of a

concealed problem. Of these, the last two were the more complex, and in the fourth case the ordinary line of operation in waking-hours was entirely reversed. In the second class, the introduction of a second personality was so similar to the common illusions of sleep that classes 1 and 2 might fairly be taken as different forms of the same phenomenon. It was not so easy, however, to account for the illusion of debate, where the adversary often replies with a quite unexpected argument, which the sleeper finds it difficult to meet. As an example of the illusion of reading, he only lately imagined that he was reading a certain newspaper (of which, by the way, he had never seen but one copy). The dream paper corresponded perfectly with the real one; but contained two printers' errors so odd that he (as was his custom in such cases) made a note of them. He remembered both on waking. One was in an article on homœopathy, where the compositor, mistaking the word "dilution" for a collocation of numerals, had set it up "DI LV XIII." Such an error, though possible, was in the last degree improbable. The other he had forgotten. By what strange process were these blunders at once invented and presented to the dreamer with a full sense of their grotesque incongruity? As for the solving of problems, he had repeatedly had "nuts to crack" in sleep, had succeeded, and had felt real pleasure when the answer flashed upon him. Did he at the same time unconsciously construct the problem? The most sustained effort of the kind that he could remember was a double acrostic in verse which he imagined he was reading in a magazine. This he studied, word by word, until he succeeded in working out the whole. He was unable to recall all the details on waking, and problem and solution may have been alike defective. Not having noted it at the time, he could only now remember that one of the key-words was "Oriole"—exactly such a word as is chosen by the constructor of this kind of riddle. Had he set himself that puzzle? He was aware that much had been written upon the main question; and he had no theory to propound. What he maintained was that the phenomenon of dreaming did not stand by itself, and could not be accounted for in the easy off-hand way in which many writers on popular science dealt with it. An inquiry of this kind was not a mere matter of idle curiosity; for, as the mental machinery was for the time outside of voluntary control, the phenomena of dreams might enable some idea to be formed of the operations of the mind in certain forms of insanity, whether induced by ordinary disease or by specific nerve-poisons such as alcohol, cannabis, or morphia. The paper thus concluded: "Any theory of mental operations, conscious or unconscious, must be, to borrow a term from the botanist, either endogenous or exogenous. I incline to the latter. There are phenomena seemingly suggestive of a transference of thought or perception which may be illustrated by what is known as induction in telegraphy, when the current jumps from wire to wire, and the message is recorded by the wrong instrument. Such a suggestion fails to meet the cases I have indicated. It is, I think, the more reasonable view that our most original thoughts and inventions, sleeping or waking, orderly or otherwise, reach us from an exterior sphere. Where the soil has, by thought and training, been duly prepared, the living germs fall, and in due time bring forth their fruit, good, bad, or indifferent, each after its kind. Who has not felt a thought flash on him from without, impressing itself like a lightning photograph? Has not the *afflatus* of the poet always been recognised as an inspiration? And even the broken and imperfect phenomena of dreams may throw light on the obscurer operations of the human mind."

APPENDIX

METEOROLOGY.

Comparative Abstract for 1893 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean. Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation=100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
Auckland...	30·020	1·030	60·5	11·9	43·0	146·0	30·0	0·434	82	53·810	203	...	...	5·9
Previous 29 years ...	29·989	...	59·2	...	...	...	...	0·387	73	40·884	181	...	...	...
Wellington	29·963	1·421	56·7	11·7	48·0	150·0	24·0	0·343	74	53·034	186	215	690 on 17th Aug.	4·8
Previous 29 years ...	29·928	...	54·7	...	...	...	...	0·335	73	50·622	159	...		
Dunedin	29·868	1·266	50·9	13·7	58·0	144·0	26·0	0·280	75	54·495	184	151	510 on 22nd July	5·6
Previous 29 years ...	29·984	...	50 2	...	...	...	...	0·277	73	35·037	159	...		

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.	
	1892.	1893.	1892.	1893.	1892.	1893.	1892.	1893.
Auckland	59·2	60·4	65·5	66·2	62·5	61·3	53·6	54·2
Wellington	55·3	57·5	61·7	61·5	57·4	57·1	49·3	50·7
Dunedin	51·4	52·6	56·8	56·4	51·7	50·9	44·7	43·5

REMARKS ON THE WEATHER DURING 1893.

JANUARY.—Generally fine weather, with prevailing northerly winds. Very showery during latter part in South.

FEBRUARY.—On the whole a wet month in North and over centre, with strong N.E. and N.W. winds; in the South small rainfall, but changeable weather.

MARCH.—Fine weather in North; but heavy rain over centre; and fine with light showers in South. Moderate winds.

APRIL.—Fine in North and over centre; but showery and foggy in South.

MAY.—In North showery, with prevailing S.W. winds; over centre also generally wet weather from S.E. and N.W.; and in South showery, except fine during middle of month. Winds S.W., and foggy at times.

JUNE.—A wet and severe month, with prevailing southerly winds and frequent hail and snow, especially in South.

JULY.—Unpleasant wet weather generally, although mild for time of year.

AUGUST.—In North wet, with prevailing S.W. winds; over centre very heavy rains, especially in early part of month, from N.W.; in South showery, but small total rainfall, and moderate S.W. winds.

SEPTEMBER.—In North fine weather, with moderate variable winds; over centre still heavy rain from N.W. and S.E., but not cold; in the South also showery and unpleasant, with variable winds.

OCTOBER.—In North and over centre much finer weather, although strong N.W. winds over latter; in the South very showery, with prevailing N.E. winds.

NOVEMBER.—Heavy rainfall in North; generally fine over centre, with fresh N.W. winds; and very heavy total rainfall in South, with intervals of fine weather; winds N.E. and S.W.

DECEMBER.—Showery in early and latter part of month in North, with prevailing S.W. winds; over centre generally fine, winds S.E. and N.W. and moderate; in the South wet weather, with N.E. and S.W. winds.

EARTHQUAKES reported in NEW ZEALAND during 1893.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Auckland ..	12	..	..	..	..	..	..	..	..	..	..	..	1
Rotorua ..	..	..	17	..	..	..	..	..	..	..	..	..	1
Napier ..	..	..	..	21	..	..	14*	..	..	..	..	..	2
New Plymouth	..	12*	..	..	..	..	..	23*	..	..	..	..	2
Marton ..	..	..	..	..	..	..	..	..	..	24*	..	..	1
Feilding ..	..	..	..	..	18*	..	..	..	..	24*	..	..	2
Shannon ..	..	..	..	..	..	..	..	..	..	24*	..	..	1
Palmerston N.	29*	12*	..	..	..	..	..	..	..	..	..	..	2
Dannevirke ..	..	..	..	..	18*	..	..	..	..	..	..	..	1
Pahiatua ..	..	..	..	..	..	..	..	..	..	11* 24*	..	..	2
Woodville ..	..	..	..	21	..	..	..	..	..	24*	..	..	2
Masterton ..	..	..	..	..	..	..	..	..	..	24*	..	..	1
Wellington ..	13, 28	10,12*, 18	17	21	12,13*, 18, 27	15	..	4*, 23	..	11	..	9	16
Nelson ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Blenheim ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Christchurch ..	..	..	..	..	1	..	..	..	..	..	..	..	1
Lincoln ..	..	12*	..	..	1	..	..	..	..	..	..	..	2
Lyttelton ..	..	..	..	..	1*, 10, 18	..	..	..	..	..	..	..	3
Ashburton ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Westport ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Reefton ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Hokitika ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Greymouth ..	..	12*	..	..	..	..	..	..	..	..	..	..	1
Queenstown ..	..	..	..	..	20*	..	..	..	..	..	..	..	1
Dunedin ..	..	12	..	..	..	..	..	..	..	..	..	..	1

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. 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 as far as indicating the geographical distribution of the shocks.

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1873.

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1875.

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1877.

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1878.

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1883.

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1885.

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1890.

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F.

G.

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I.

K.

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M.

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26
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