TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE,

1871.

VOL. IV.

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

BY

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

ISSUED MAY, 1872.

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PREFACE.

In the present volume the arrangement of the *Proceedings* and *Transactions* which was adopted in the first two volumes has been again reverted to, as the separate publication of the former in anticipation of the whole work was not found to be so satisfactory and convenient to members as was anticipated.

The Board of Governors having decided that in publication preference should be given to those papers which add to the knowledge of observed facts relative to New Zealand, several papers of a general character have been held back, or are only given in an abridged form.

The editor has to acknowledge the assistance which he received from Mr. J. T. Thomson, F.R.G.S., in revising in the press the first proofs of his learned paper on the Whence of the Maori.

The facilities offered to the Board, through the courtesy of the Hon. the Colonial Secretary, for having the illustrations lithographed at the Government press, cannot pass unnoticed, while they have again to thank Mr. John Buchanan for the great care and skill which he has exercised as draughtsman. It will be observed that this year the illustrations have, in most cases, been drawn direct on the stone, which gives to them a more artistic effect.

The assistance received from Mr. R. B. Gore in preparing the Meteorological Report, which appears in the Appendix, must also be acknowledged.

In a volume consisting of articles of such varied characters mistakes will necessarily occur, and the chief of these are printed in an errata slip. It is, however, again necessary to call the attention of authors and the secretaries of societies to the desirability of forwarding papers and minutes of proceedings in such a shape that no re-copying may be required, nor questions arise as to the author's exact meaning.

It is satisfactory to note that the list of ordinary members of the Affiliated Societies is still maintained, and that the number of papers contributing original observations and researches shows a marked increase.

Wellington, 10th May, 1872.

ADDENDA ET ERRATA.

Page 15, line 12 from bottom, for "force" read "pace."
,, 33, ,, 10, for "Map, Appendix I.," read "The map in corner of Plate I."
,, 41, ,, 20–22. The colours are shown on the Plates by dotted lines.
,, 42, line 10, for "Map III." read "Plate I."
,, 75, on the Plate, for "V." read "III."
,, 96, ,, 2, for "tibia" read "tibiæ."
,, 104, on the Plate, for "VII." read "IV."
,, 114, ,, 13 from bottom, for "spine" read "specimen."
,, 115, ,, 4, for "guessed" read "grouped."
,, 181, ,, 1, omit "sp. nov."
,, 213, ,, 3 from bottom, for "brown" read "yellow."
,, 213, ,, 2 ,, for "1·5in." read "2·5in."
,, 233, ,, 14 ,, for "Phogiochila" read "Plagiochila."
,, 234, ,, 10 ,, for "Dumortiera" read "Dumortiera ?"
,, 234, ,, 9 ,, for "? hirsuta" read "hirsuta."
,, 245, ,, 22, for "Hooker's" read "Richard's."
,, 249, bottom line, for "*Alseuosmia macrophylla*" read "*Cyathea* sps."
,, 251, line 12 from bottom, for "?" read "!"
,, 253, ,, 13 ,, for "Spongeworts" read "Spurgeworts."
,, 255, ,, 21, for "pastoral" read "prostrate."
,, 257. ROSACEÆ. Insert next to "*Potentilla*" "*Geum urbanum*, L., var. *strictum*. Distribution — from Wairoa and Paparata (Auckland) southwards ; general. Differs from the typical form in the larger size of all its parts, and in the stout rigid habit. In Britain the typical form is abundant from Cornwall to Aberdeen."
,, 262. In the arrangement of species, insert below "5. *obcordatum*" the words "B. Flowers terminal."
,, 275, line 8, for "Corsysanthes" read "Corysanthes."
,, 280, ,, 14, for "xanthocarpa" read "ebenocarpa."
,, 282, ,, 17 from bottom, for "quercifolium, *Linn.*" read "quercifolium, *Ait.*"
,, 283, ,, 4, for "pessica" read "persica."
,, 283, ,, 20 from bottom, for "*Scholl*" read "*Schott.*"

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NEW ZEALAND INSTITUTE.

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

Board of Governors.

(EX OFFICIO.)

His Excellency the Governor. | The Hon. the Colonial Secretary.
His Honour the Superintendent of Wellington.

(NOMINATED.)

Hon. W. B. D. Mantell, F.G.S. (retired 1868), Hon. Col. Haultain (retired 1869), Jas. Edward FitzGerald, C.M.G. (retired 1871), Sir David Monro, W. T. L. Travers, F.L.S., Alfred Ludlam, James Hector, M.D., F.R.S., Charles Knight, F.R.C.S.

(ELECTED.)

1871.—His Honour T. B. Gillies, His Honour W. Rolleston, B.A., His Honour Mr. Justice Chapman.

1872.—W. Rolleston, B.A., Mr. Justice Chapman, W. B. D. Mantell, F.G.S.

ABSTRACTS OF RULES AND STATUTES,

Gazetted in the "New Zealand Gazette," March 9, 1868.

Section 1.

Incorporation of Societies.

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

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

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation

or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

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

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

Regulations regarding Publications.

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

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

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

(*d*) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(*e*) Each Incorporated Society will be entitled to receive a proportional number of copies of the proceedings and transactions of the Institute to be, from time to time, fixed by the Board of Governors.

(*f*) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

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

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

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

Section II.

For the Management of the Property of the Institute.

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

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

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

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

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

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

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

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

Section III.

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

Section IV.

Of date 23rd September, 1870.

Honorary Members.

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

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

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

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

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society . . .	June 10th, 1868.
Auckland Institute	June 10th, 1868.
Philosophical Institute of Canterbury . .	October 22nd, 1868.
Otago Institute	October 18th, 1869.
Nelson Association for the Promotion of Science and Industry	September 23rd, 1870

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1871: *President*—W. T. L. Travers, F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., W. L. Buller, F.L.S., F.G.S.; *Council*—Robert Hart, James Hector, M.D., F.R.S., J. Kebbell, W. Lyon, F.G.S., W. Skey; *Honorary Treasurer*—F. M. Ollivier; *Honorary Secretary*—Captain F. W. Hutton, F.G.S.

Office-bearers for 1872: *President*—J. Hector, M.D., F.R.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., J. Kebbell; *Council*—Captain F. W. Hutton, F.G.S., C. Knight, F.R.C.S., W. T. L. Travers, F.L.S., H. F. Logan, John Buchanan; *Honorary Treasurer*—F. M. Ollivier; *Honorary Secretary*—R. B. Gore.

Extracts from the Laws 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 paid in advance, on or before the first day of January, in each year.

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

17. General Meetings for business of Members of the Society shall be held in the evening of one day or more in each quarter (the time and place of meeting to be fixed by the Council, and duly announced by the Secretary), to receive the Secretary's Report, and to carry out the general objects and business of the Society.

AUCKLAND INSTITUTE.

Office-bearers for 1871.—*President*—T. Heale, C.E.; *Council*—His Honour T. B. Gillies, Rev. J. Kinder, T. Kirk, F.L.S., H. H. Lusk, Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, Assoc. Inst. C.E., S. J. Stratford, M.R.C.S.E., T. F. S. Tinne; *Added 8th November*, 1871—T. Russell, J. L.

Campbell, M.D., J. M. Clark; *Auditor*— G. B. Owen; *Secretary and Treasurer*—T. Kirk, F.L.S.

Office-bearers for 1872: *President*—T. Heale, C.E.; *Council*—Hon. Colonel Haultain, T. Russell, J. M. Clark, Rev. A. G. Purchas, M.R.C.S.E, T. Kirk, F.L.S., T. F. S. Tinne, Rev. J. Kinder, J. Stewart, Assoc. Inst. C.E., His Honour T. B. Gillies, J. L. Campbell, M.D., H H Lusk; *Auditor*—C. Tothill; *Secretary and Treasurer*—T. Kirk, F.L.S.

Extracts from the Laws of the Auckland Institute.

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

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

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

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1871: *Patron*—His Honour the Superintendent; *President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—Hon. John Hall, Rev. C. Fraser, M.A., F.G.S.; *Council*—J. F. Armstrong, W. B. Bray, C.E., J. W. S. Coward, R. W. Fereday, W. Rolleston, B.A., J. S. Turnbull, M.D.; *Honorary Treasurer*—John Inglis; *Honorary Secretary*—Llewellyn Powell, M.D.

Office-bearers for 1872: *Patron*—His Honour the Superintendent; *President*—His Honour Mr. Justice Gresson; *Vice-Presidents*—W. B. Bray, C.E., R. W. Fereday; *Council*—J. F. Armstrong, J. W. S. Coward, J. S. Turnbull, M.D., Julius Haast, Ph.D., F.R.S., G. W. Hall, Ven. Archdeacon Wilson; *Honorary Treasurer*—J. Inglis; *Honorary Secretary*—Llewellyn Powell, M.D.

Extracts from the Laws of the Philosophical Institute of Canterbury.

VII. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

XXV. Members of the Institute shall pay two guineas for the first year of membership, and one guinea annually thereafter, as a subscription to the funds of the Institute.

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

OTAGO INSTITUTE.

Office-bearers for 1871 : *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—J. T. Thomson, F.R.G.S., J. S. Webb; *Council*—Daniel Brent, Robert Gillies, Stuart Hawthorne, M.A., John Hislop, Richard Oliver, James Smith, Rev. D. M. Stuart; *Honorary Treasurer*—W. D. Murison; *Honorary Secretary*—T. M. Hocken, M.R.C.S.E.

Office-bearers for 1872 : *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—Robert Gillies, T. M. Hocken, M.R.C.S.E.; *Council*—W. N. Blair, E. B. Cargill, S. Hawthorne, M.A., J. McKerrow, G. S. Sale, M.A., J. T. Thomson, F.R.G.S., P. Thomson; *Honorary Treasurer*—J. S. Webb; *Honorary Secretary*—D. Brent.

Extracts from the Laws of the Otago Institute.

3. From and after the 1st September, 1869, any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Society by two members, on payment of the annual subscription for the year then current.

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

9. An annual general meeting of the members of the Society held on the second Monday of July.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

Office-bearers for 1870–1 : *President*—Sir David Monro; *Vice-President*—The Right Rev. the Bishop of Nelson; *Council*—F. Huddleston, F. W. Irvine, M.D., Thomas Mackay, Alexander Sclanders, George Williams, M.D.; *Honorary Treasurer*—C. Hunter-Brown; *Curator and Secretary*—J. Smith.

Office-bearers for 1872 : *President*—Sir David Monro; *Vice-President*—The Right Rev. the Bishop of Nelson; *Council*—F. W. Irvine, M.D., Robert Lee, The Hon. T. Renwick, Joseph Shephard, George Williams, M.D.; *Honorary Treasurer*—J. Holloway; *Curator and Secretary*—Thomas Mackay.

Extracts from the Laws of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of members elected by ballot, who have been proposed at a monthly meeting of the Society, and elected at the ensuing meeting.

3. Each member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary meetings held on the first Wednesday in each month.

NEW ZEALAND INSTITUTE.

ANNIVERSARY ADDRESS

OF

THE PRESIDENT,

HIS EXCELLENCY SIR GEORGE F. BOWEN, G. C. M. G.

Delivered to the Members of the New Zealand Institute, at the Anniversary Meeting, held on the 23rd September, 1871.

Gentlemen,—

It is with great pleasure that I now proceed to open, with the usual anniversary address, the session for 1871 of the New Zealand Institute.

PROGRESS OF THE NEW ZEALAND INSTITUTE.

This is the fourth occasion on which we have assembled for the purpose of reviewing the progress achieved by literature and science in this country, and especially the efforts made by our own Association for their advancement. From the report recently laid before the Legislature, it will be seen that there is ample ground for congratulation in the continued success of the scheme under which we are organised. During the last twelve months our numbers have been increased by the accession of above two hundred new members; while the society recently formed at Nelson "for the promotion of science and industry" has been affiliated. The connection of all the chief provinces and cities of the Colony with this central body has thus been completed. Nor is it less gratifying to observe that our *Transactions* have been very favourably reviewed by many high authorities, both in England and on the continent of Europe; and that strong opinions have been expressed to the effect that a similar Institute for the systematic organisation of the various literary and scientific societies is urgently required in the mother country.

The progress and popularity of the New Zealand Institute may be regarded as a not unimportant evidence of the condition of intellectual studies and tastes in this community. And here I may be permitted to allude to what seems the prominent characteristic of public opinion at the present day; I mean the active interest that has been awakened in everything which tends to the diffusion of sound education, and to the better qualification of the youth of the Colony for fulfilling their duty and privilege of self-government. The measures adopted last year by the Parliament for the foundation of a Colonial University, and the actual establishment in the vigorous Province of Otago (in this as in other respects a true off-shoot of Scotland)* of a University which is already in operation, are striking proofs of the general desire for education of the highest class. At the same time the Bill introduced by the Government, and now under the earnest consideration of the Legislature, shows that primary and secondary education will also be zealously fostered by the State.

The recent arrival of several accomplished and learned Professors to occupy the chairs of the Otago University is an epoch in the history of New Zealand which may probably hereafter be more prominent in the annals of this country, and may exercise more enduring influence than many events to which greater present importance has been attached. The proposed system of Affiliated Colleges, on the basis of local examinations, is in accordance with the direction in which the English Universities are now tending. Like the constitution of our own Society, this appears to be the system best adapted to the geographical position of New Zealand; for, while it does not preclude the most successful College in whatsoever Province from proving and maintaining its pre-eminence, it encourages rather than limits that emulation by which alone a high state of efficiency in educational establishments can be secured.

NEW ZEALAND UNIVERSITY.

In connection with this subject, I wish to make one remark—of course, in my capacity, not of Governor of the Colony, but of President of the Institute. It is this:—In common with the joint committee of both Houses of the Legislature, and of most of those who have given full attention to the point, I think it very desirable that some well-considered and equitable arrangement should be made whereby the two existing University Councils may be amalgamated—by which our available resources may be economised, and there may be thus erected, on the foundations already so carefully laid, one great and truly national University of New Zealand.

TECHNICAL AND SCIENTIFIC EDUCATION.

Turning to the question of technical and scientific education, to which I drew attention in my address of last year, I have much pleasure in announcing that the scheme for establishing a course of practical instruction in connection

* "In almost all the periods of the history of Scotland, whatever documents deal with the social condition of the country reveal a machinery for education always abundant."—Burton's "History of Scotland," chap. 39.

with the Colonial Museum has been already so far carried into effect that the Laboratory has been adapted for the reception of a certain number of students.

NEW MUSEUM AT CHRISTCHURCH.

It would be improper, on this occasion, to omit mention of the Museum which has been opened during the past year at Christchurch. That institution is an eminent proof of the recognition which the claims of science receive in the Province of Canterbury, and of the admirable manner in which the liberal support granted by the Provincial Government has been applied.

REVIEW OF VOLUME III. OF THE "TRANSACTIONS" OF THE INSTITUTE.

I will now proceed to refer briefly to the annual volume in which the proceedings of the several Affiliated Societies are published. Our third volume, that for 1870, fully keeps up the character of its predecessors, and has been received with greater interest, from the fact that the large amount of carefully selected matter which it contains is more amply illustrated by drawings and figures than either of the volumes previously issued.

ZOOLOGY.

The name of Mr. Walter Buller, eminent among those of the contributors to the Zoology of New Zealand, appears at the head of several excellent papers —all interesting and valuable, as might be expected from so accomplished an observer in this branch of science, and especially in his own favourite department of ornithology. I would recommend particular attention to Mr. Buller's description of the *huia (heteralocha Gouldi)*, that rare and beautiful bird held sacred by the Maoris, which can be known in its native state to few colonists, but of which very perfect specimens are preserved in the Colonial Museum. Worthy also of especial notice and careful study is the conclusion of Mr. Potts' elaborate Essay on the Birds of New Zealand, the commencement of which appeared in the volume of our *Transactions* for 1869. There are other contributors to Zoology in the volume now before us, whose distinguished names would alone vouch for the value of their remarks. Foremost among these is the name of Dr. F. J. Knox, who remains devoted to the natural history of the Cetacea, and who has furnished some important papers on this and on other subjects. Moreover, it is gratifying to find among the contributors to this section of our *Transactions*, Dr. J. E. Gray, of the British Museum. This gentleman, so eminent in the scientific societies of Europe, has supplied a description of a new species of whale discovered in the seas around New Zealand. It may here be mentioned that during my visit in last February, in H.M.S. 'Clio,' to Milford Sound, I was myself so fortunate as to shoot three seals, which appear to belong to a species that has hitherto escaped accurate notice.

BOTANY.

Among those to whom this Colony is most indebted for fresh investigations of its Botany, Mr. Kirk occupies a high place as a writer on this engaging and practically useful branch of study. It will be seen that nearly all his papers are confined to the Province of Auckland; and it is to be regretted that we do not receive from other parts of the Colony more frequent communications on the same subject. Mr. Kirk's botanical researches have led him to the conclusion that while many native trees and plants are much more rare than formerly, and are confined to smaller areas, none have become extinct.

EXHIBITION OF THE NEW ZEALAND FLAX.

In connection with this portion of my address, I should draw attention to the exhibition now open in the Colonial Museum of numerous and well-arranged specimens of the New Zealand flax (*Phormium tenax*). As I have remarked in previous addresses, it cannot be too often repeated that the main object of Parliament in founding and endowing the Institute and Museum was to furnish practical assistance in the development and utilisation of the rich natural resources of these islands. Now, this flax exhibition is an excellent illustration of the value of the method of conveying instruction through the eye, by means of classified specimens; and this kind of education is one of our fundamental and necessary functions. The present collection will form a good basis for future reference; and it is to be hoped that it may prove the means of rendering permanent an industry, the importance of which to New Zealand can hardly be exaggerated, if only a satisfactory solution of the difficulties involved in the process of manufacture were discovered. The experience in this respect already acquired has been somewhat dearly purchased; but even a cursory inspection of the exhibition is sufficient to show that much progress has been made, and that a large amount of accurate information respecting this entire subject has been collected. All will admire the varied and beautiful specimens of the manner in which the Maoris have adapted this indigenous fibre to almost every purpose of domestic economy. Several of the articles of native manufacture show at once thought in contrivance, taste in design, and skill in execution.

BOTANIC GARDENS.

There is a very important and practical application of science, regarding which I must here say a few words. I refer to the formation of Botanic Gardens and Nurseries for the rearing of useful and ornamental trees and shrubs. Planting is now generally recognised as an essential step towards the future prosperity of every new country. The character of the climate, the comfort of life, and the beauty of the scenery, all depend, in no slight degree, on this work. Some progress has already been achieved in this respect throughout these islands. During the past year I have derived great satisfaction from witnessing the efforts made at all the principal centres of population. Each province has its own peculiar advantages; but on this occasion I wish to allude especially to that garden which forms an essential adjunct to our Institute. It is now a little more than a year since the Botanic Reserve was placed under the management of the Board of Governors, and there is good reason to be satisfied with the advance already secured. Not only has the luxury of a pleasant recreation ground been conferred on the inhabitants of Wellington, and on the numerous visitors who reside here during the sessions of the Colonial Parliament, but a field has also been provided for interesting experiments in practical botany. The preservation of the beautiful patches of native forest, which still survive in the ravines, and the affixing the names of the various trees and shrubs, have created, at a small expense, a Botanic Garden of the most useful kind. Visitors are thus enabled to render themselves familiar with the indigenous vegetation of this country, with its scientific classification, and with the beauty and value of the flora of this and of other lands.

CHEMISTRY.

In the department of Chemistry, nearly all the papers are by Mr. Skey, the Analyst to the Geological Survey of New Zealand; and the Institute is fortunate in possessing among its members a gentleman so well qualified to handle this branch of science.

GEOLOGY.

We must all deplore the loss by drowning, while in the zealous discharge of his duty, of another officer of the Government Survey—Mr. E. H. Davis—to whom our *Transactions* owe several instructive geological papers.

On the above, and on a variety of miscellaneous subjects, we have a number of interesting contributions by Dr. Hector, Dr. Haast, Mr. Travers, Captain Hutton, and others of our leading associates. The last, but by no means the least important paper in the third volume of our *Transactions* is the opportune lecture, by Mr. Justice Chapman, on the "Political Economy of Railways," which will excite the more interest from the fact that the Colony is now about to undertake extensive public works, such as those of which the learned Judge has so ably treated.

On the whole, it may be safely affirmed that the Institute has no reason to be dissatisfied with the amount of work which it has accomplished during the first three years of its existence; and if we look to the large accession to its numbers during the past year, and to the interest which its labours have excited, alike in this and in the neighbouring colonies and in the mother country, we may confidently regard the progress already made as only the germ and infant promise of a far greater development and success in the future.

OFFICIAL VISITS OF THE GOVERNOR.

After this brief and imperfect sketch of the recent *Transactions* and present position of the Institute, I will proceed—so far as time will allow, and in accordance with a request addressed to me—to give a short account of my official visits during the past year to two of the most remarkable regions to be found in this or in any other country of the world. I allude, in the first place, to the great volcanic zone in the North Island, stretching for nearly 150 miles from the ever-steaming crater of Whakari (or White Island), in the Bay of Plenty, to Lake Taupo and the burning mountain of Tongariro. Here the traveller admires, under an Italian sky and in an Italian climate, a long succession of panoramas of hot lakes and boiling springs, far surpassing in variety, beauty, and curiosity, the famed geysers of Iceland. In the second place, I refer to Milford Sound and to those other grand and wondrous inlets of the south-west coast of the Middle Island, which, rarely visited by civilised man, and shrouded in almost perpetual mist and storm, combine the snowy peaks and glaciers of Switzerland with the gloomy forests, deep seas, and winding channels of the fiords of Norway.

I.—THE HOT LAKES IN THE NORTH ISLAND.

My visit to the Hot Lakes was made in company with the Duke of Edinburgh and several officers of H.M.S. 'Galatea.' Leaving Auckland, by sea, on the 12th of last December, we landed on the following morning at Tauranga, where the "son of the Queen" (*te tamaiti o te Kuini*), as His Royal Highness is styled by the Maoris, was enthusiastically welcomed by seven hundred chiefs and clansmen of the tribes of the Arawas and of the Ngaiterangis. It will be remembered that the last-named clan fought bravely against the British troops at the Gate Pa,* and elsewhere, in 1864; but they soon afterwards made peace with the Government, and now at the korero (or conference) held to greet the Duke of Edinburgh, they vied with our faithful friends, the Arawas, in expressions of loyalty to the Queen, and of good will to the English settlers. At the conclusion of his speech, Enoka te Whanake, a chief foremost among our enemies during the late war, said; "It is true that I fought against the Queen at the Gate Pa; but I have repented of this evil, and am now living under the shadow of Her laws. As for this Tawhiao, who styles himself the 'King of the Maoris,' let him be brought hither as a footstool for the son of our Queen, whom we welcome among us this day."

From Tauranga we proceeded to Maketu, the principal kainga, or settlement, of the Arawas, and celebrated in their traditions as the spot where their forefathers, some twenty generations back, first landed in New Zealand.

* This pa was three miles from Tauranga, and was so named because it commanded the approach to the inland districts, at a point where the road passes along a narrow tract of firm ground between two extensive swamps.

No Europeans have as yet settled in the inland districts of this portion of the North Island, but the "Queen's son" was as safe among the Arawas in their own country as he would be among the Gordons in Aberdeenshire. We were, however, attended by a guard of honour, consisting of an escort of the clansmen in arms for the Queen. The Duke of Edinburgh and his officers were much interested by the many striking scenes and incidents of life in a Maori camp, especially by the war-songs chanted by the Arawas around the watchfires which they kindled each night in front of our tents. On the other hand, the native warriors were delighted by His Royal Highness's power of enduring fatigue—by his good horsemanship and swimming—by the skill and vigour with which he paddled his canoe across their lakes—and, above all, perhaps, by his constantly wearing the kilt, which is the favourite garb of the Maori as well as of the Scotch Highlanders.

On the 14th December we rode a distance of forty miles, from Maketu to Ohinemutu, the principal inland settlement of the Arawas. It is situated at the north-western extremity of the beautiful lake of Rotorua, and has in front the lofty islet of Mokoia, famous for the legend of Hine Moa, the Hero, and of her lover, the Leander of the Maoris.* The road from Maketu to Ohinemutu, winding along the shores of Rotoiti and Rotorua, presents a succession of lovely prospects. It was spontaneously commenced by the Arawas, the chiefs and clansmen labouring together, for the use of the Duke of Edinburgh when his visit was first expected in 1868.

Ohinemutu still exhibits most of the features and scenes of a Maori pa and kainga of the olden time. The dwellings of the chiefs are surrounded with stockades, while many of them are adorned with grotesque wood-carvings, and are curious specimens of native architecture. The boiling springs—sure signs of the volcanic fires smouldering below—seethe, bubble, and steam on every side;—among the houses, where they form excellent natural cooking places;—and in the tepid waters of the neighbouring lake, in which the natives swim, each morning and evening, as in a vast natural bath. On Sunday, the 18th December, a missionary clergyman, the Rev. S. Spencer, who had accompanied our party from Maketu, read the service of the Church of England, in the open air, on the shore of Lake Rotorua. It was a calm, clear, and sunny day, and the scene was highly picturesque and suggestive; with the little knot of Englishmen surrounding the "son of the Queen," and the large congregation of Maoris repeating the responses and chanting the hymns in their own sonorous language; amid some of the finest prospects of lake and mountain, and near some of the most wonderful natural phenomena in the world; in the very heart, moreover, of the native districts

* See the "Story of Hine Moa, the Maiden of Rotorua," in Sir George Grey's *Polynesian Mythology*, pages 235-245.

of New Zealand, and of the country most renowned in Maori song and legend ;—and on a spot where, in the memory of men still living, human victims were sacrificed and cannibal feasts were held.

From Ohinemutu we visited the neighbouring *geysers* and *solfataras* of Whakarewarewa, which at intervals throw high into the air columns of water, with whirling clouds of steam and showers of pumice stone. Thence we rode over the hills, skirting the deep blue lakes of Tikitapu and Rotokakaki,—both embosomed in overhanging forests and craggy cliffs,—to Tarawera, which surpasses in wild grandeur of scenery all its rival lakes. On the following morning we crossed Lake Tarawera in native canoes, and encamped for the night by the side of one of the famous terrace-fountains* of Lake Rotomahana,—the most striking marvels in this region of wonders, and of which no verbal description can convey any adequate idea. They have been likened to cascades of bright and sparkling water, gently falling from blue basins of turquoise over a succession of natural shelves, and suddenly turned, as they fall, into terraces of white marble,† streaked with soft lines of pink. Many rare and delicate ferns, and other plants usually found only in the Tropics, cling in green clusters round the snow-white margin of the fountains, and flourish in luxuriant growth in the warm and dank air.

From Rotomahana we rode back in two days to Maketu, and thence returned by sea to Auckland. Thus it will be seen that the chief points in the district of the Hot Lakes can even now be visited by active horsemen in an excursion of a week or ten days. The natives alone have hitherto made practical use, for the cure of various diseases, of the healing properties of these waters. But when, through the progress of colonisation, these springs, truly described by Hochstetter as the "grandest in the world," shall have become more accessible, it cannot be doubted that, as multitudes of summer tourists from the cities of the old world now resort to the warm baths of Germany, and to the mountains of Switzerland, so thousands will hereafter flock from Australia, and from all parts of the southern hemisphere, to those regions of New Zealand where nature displays many of her most remarkable beauties and wonders in the most genial and healthy of climates.

I shall not trespass on your time and patience by dwelling at greater length on this part of my subject. The Lake district of the North Island has been fully described in the well-known and elaborate work of Dr.

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* Named respectively Te Tarata and Otukapuarangi. The first of these names is said to signify "the tattooed rock," and to refer to the strange figures and shapes formed by the silicious deposits of the terraces. The second name means "cloudy atmosphere," from the continually ascending clouds of steam.

† The terraces of Rotomahana are encrusted by the overflowing waters with a white silicious deposit, the growth of many years.—See "Hochstetter's New Zealand," chap. 18.

Hochstetter, and by other writers more competent than myself.* Let it suffice on the present occasion to say that all the authorities agree that the *solfataras, geysers, and fumaroles* alike owe their origin to water sinking through natural fissures into the caverns of the earth, where it becomes heated by ever-burning volcanic fires. High-pressure steam is thus generated, which, accompanied by volcanic gases, forces its way up towards the cooler surface, and is there condensed into hot water. It has been further remarked that even the legends of the Maoris correctly ascribe the origin of the hot lakes and springs to the combined agency of fire and water, in connection with the still active craters of Whakari and of Tongariro. The traditions of the Arawas relate that among the chiefs who led their ancestors from Hawaiki† to New Zealand was Ngatiroirangi, whose name, being interpreted, signifies "the messenger of Heaven." He landed at Maketu, whence he set forth with his slave Ngauruhoe to explore the new found land. As they journeyed onward they at length beheld, towards the South, the lofty snow-clad mountain of Tongariro (literally "towards the south"). Climbing to the highest peak to gain a wider view of the surrounding country, they were benumbed with the cold, when the chief shouted to his sisters, who had remained upon Whakari, to send him fire. The sisters heard his call, and sent him the sacred fire brought from Hawaiki. It was borne in the hands of two *taniwhas* or water-spirits, dwelling in the caverns of the earth and ocean, from Whakari, through a subterranean passage, to the top of Tongariro. The fire arrived just in time to save the life of the chief, but the slave was already dead. And so the crater of Tongariro is called, to this day, by the name of Ngauruhoe; and the sacred fire still blazes throughout the underground zone along which it was carried by the *taniwhas.* It burns under the lakes of Rotoiti, Rotorua, and Rotomahana—under the thousand hot springs which burst forth between Whakari and Tongariro. Dr. Hochstetter ("New Zealand," chap. 18) remarks that "this legend affords a remarkable instance of the accurate observation of the natives, who have thus indicated the true line of the chief volcanic action in the North Island."

II. THE SOUNDS ON THE SOUTH-WEST COAST OF THE MIDDLE ISLAND.

I now proceed to give a short sketch of my visit during the months of February and March, in the present year, to the magnificent, but hitherto little known, Sounds on the south-west coast of the Middle Island, whither Commodore Stirling conveyed me in H.M.S. 'Clio.' Dr. Hector accompanied

* See also the graphic and accurate account of the Hot Lakes in "A Ride through the Disturbed Districts of New Zealand," by Lieutenant the Hon. H. Meade, R.N., London, 1871.

† The Hawaiki of Maori annals was probably Hawaii in the Sandwich Islands, or Savaii in the Navigators' Islands.

us; and, had it not been for the disaster which befel us in Bligh Sound, we expected to have been enabled to collect much practical information respecting that part of the Colony, and also to furnish fresh and valuable notices to the Geographical, Geological, and Zoological Societies of London. It may here be mentioned that the best general descriptions of the south-west coast of the Middle Island which have hitherto been published, will be found in the "New Zealand Pilot," compiled chiefly by an honorary member of our Institute, Admiral Richards, F.R.S., the present Hydrographer to the Admiralty; and in a paper by Dr. Hector, printed in the 34th volume (for 1864) of the Journals of the Royal Geographical Society. The notes which I shall now read to you were written while the 'Clio' lay disabled in Bligh Sound, and have been partly embodied in my despatches to the Imperial Government.

We left Wellington on the 4th of last February, but the 'Clio' was much delayed at first by baffling winds, and afterwards by a strong contrary gale with a heavy sea. We reached Milford Sound on the 11th, and remained there, thoroughly examining that extraordinary inlet, until the 17th February.

Admiral Richards has observed* that the only harbours of shelter for large ships along the West Coast of the Middle Island of New Zealand—a distance of five hundred miles—are the thirteen sounds or inlets which penetrate its south-western shore between the parallels of 44 and 46 degrees south latitude, including a space of little more than one hundred miles. They are, counting from the north, and according to the names given chiefly by the adventurous whalers, who alone have frequented these inhospitable regions, as follows:—1. Milford Sound; 2. Bligh Sound; 3. George Sound; 4. Caswell Sound; 5. Charles Sound; 6. Nancy Sound; 7. Thomson Sound; 8. Doubtful Inlet; 9. Daggs Sound; 10. Breaksea Sound; 11. Dusky Bay; 12. Chalky, or Dark Cloud Inlet; 13. Preservation Inlet. As I wrote to the Secretary of State for the Colonies, these arms of the Great Southern Ocean, cleaving their way through the massive sea wall of steep and rugged cliffs, reach far into the wild solitudes of the lofty mountains which form the *cordillera*, or "dividing range," of the Middle Island. These mountains attain their highest elevation further north, in Mount Cook, a snowy peak rising 13,200 feet above the sea level, and visible in clear weather at a distance of more than a hundred miles to the mariner approaching New Zealand; thus forming a noble monument of the illustrious navigator who first recommended the planting of an English settlement in this country. To quote Admiral Richards:—"A view of the surrounding country from the summit of one of the mountains bordering the coast, of from 4,000 to 5,000 feet in elevation, is perhaps one of the most grand and magnificent spectacles it is possible to imagine; and, standing on such an elevation rising over the south side of Caswell Sound, Cook's description of

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* See "New Zealand Pilot," chap. ix.

this region was forcibly called to mind. He says :—'A prospect more rude and craggy is rarely to be met with, for inland appeared nothing but the summits of mountains of a stupendous height, and consisting of rocks that are totally barren and naked, except where they are covered with snow.' We could only compare the scene around us as far as the eye could reach, north to Milford Haven, south to Dusky Bay, and eastward inland for a distance of sixty miles, to a vast sea of mountains of every possible variety of shape and ruggedness; the clouds and mist floated far beneath us, and the harbour appeared no more than an insignificant stream. The prospect was most bewildering, and, even to a practised eye, the possibility of recognising any particular mountain, as a point of the survey from a future station, seemed almost hopeless."

The following extract from Dr. Hector's account of Milford Sound shows the probable mode of its formation :—"Three miles from the entrance of the Sound it becomes contracted to the width of half a mile, and its sides rise perpendicularly from the water's edge, sometimes for 2,000 feet, and then slope at a high angle to the peaks that are covered with perpetual snow. The scenery is quite equal to the finest that can be enjoyed by the most difficult and toilsome journeys into the Alps of the interior; and the effect is greatly enhanced, as well as the access made more easy, by the incursion of the sea, as it were, into their alpine solitudes. The sea, in fact, now occupies a chasm that was in past ages ploughed by an immense glacier; and it is through the natural progress of events by which the mountain mass has been reduced in altitude, that the ice stream has been replaced by the waters of the ocean. The evidence of this change may be seen at a glance. The lateral valleys join the main one at various elevations, but are all sharply cut off by the precipitous wall of the sound, the erosion of which was no doubt continued by a great central glacier long after the subordinate and tributary glaciers had ceased to exist. The precipices exhibit the marks of ice-action with great distinctness, and descend quite abruptly to a depth of 800 to 1200 feet below the water level. Towards its head the sound becomes more expanded, and receives several large valleys that preserve the same character, but radiate in different directions into the highest ranges. At the time that these valleys were filled with glaciers, a great 'ice lake' must have existed in the upper and expanded portion of the sound, from which the only outlet would be through the chasm which forms its lower part."

On account of the great depth of water in these inlets, and of the sudden storms of wind rushing down from the mountains above, vessels are generally obliged to moor to trees or pinnacles of rock, whenever they reach a cove in which an anchor can be dropped. Accordingly, while we were in Milford Sound, the 'Clio' lay at anchor in Harrison's Cove, only a few yards from the shore, and moored head and stern to huge trunks of trees. Immediately above rose Pembroke Peak to the height of nearly 7,000 feet, covered with perpetual snow, and with a glacier reaching down to within 2,000 feet of the sea. The lower slopes of the mountains around are covered with fine trees, and with the luxuriant and evergreen foliage of the tree-fern and the other beautiful undergrowth of the New Zealand forests. Two permanent waterfalls, one 700 and the other 540 feet in height, add picturesque beauty to the gloomy and desolate grandeur of the upper part of Milford Sound. During a storm of wind and rain, mingled with snow and sleet, which, though it was the middle of summer, raged during three days of our stay, avalanches were often heard thundering down, with a roar as of distant artillery, from the snow fields above; while a multitude of foaming cascades poured over the face of the lower precipices, hurling with them into the sea masses of rock and trunks of trees. On the other hand, nothing could exceed the charm of the few fine days which we enjoyed during our voyage. In his work, entitled "Greater Britain," (Part II., chap. 2), Sir Charles Dilke has truly observed "that the peculiarity which makes the New Zealand West Coast scenery the most beautiful in the world is that here alone you can find semi-tropical vegetation growing close up to the eternal snows. The latitude, and the great moisture of the climate, bring the glaciers very low into the valleys; . . . . . . and cause the growth of palm-like ferns on the ice-river's very edge. The glaciers of Mount Cook are the longest in the world, except those at the sources of the Indus; but close about them have been found tree-ferns of thirty and forty feet in height. It is not till you enter the mountains that you escape the moisture of the coast, and quit for the scenery of the Alps the scenery of fairy land." Again, Sir C. Dilke's description of the view from Hokitika at sunrise would apply also to the same view from many other points on the West Coast: "A hundred miles of the Southern Alps stood out upon a pale blue sky in curves of gloomy white that were just beginning to blush with pink, but ended to the southward in a cone of fire that stood up from the ocean; it was the snow-dome of Mount Cook struck by the rising sun. The evergreen bush, flaming with the crimson of the rata blooms, hung upon the mountain side, and covered the plains to the very margin of the narrow sands with a dense jungle. It was one of those sights that haunt men for years."

The neighbourhood of the sea, and the semi-tropical magnificence of the foliage, are features in which the New Zealand Alps excel the highest mountain ranges in Europe. As members of the Alpine Club of England have already scaled the peaks of the Caucasus, it is hoped that they will ere long explore the glaciers and summits of Mount Cook, together with the elsewhere unrivalled scenery of the neighbouring *fiords*. Mount Cook (as has been already said) rises to 13,200 feet above the sea level—that is, it surpasses all but Mont Blanc and one or two others of the highest of the Alps of Europe. But the exploration of this giant of the southern hemisphere probably presents no unwonted difficulty to practised mountaineers, while it could not fail to add largely to the general stock of scientific knowledge. The present Secretary of State for the Colonies (the Earl of Kimberley) has, at my instance, invited the attention of the Royal Geographical Society to this subject. I have also to announce that the Admiralty, in consequence of my representations, intend to publish new and corrected charts, on an enlarged scale, of the West Coast of New Zealand.

The 'Clio' left Milford Sound on the morning of the 17th February, and on the same afternoon struck on her port bow upon a sunken rock, unnoticed in the existing charts, near the middle of the second reach of Bligh Sound. Had the accident occurred amidships, she would probably have at once gone down with all on board. As it was, the ship made water so fast through the leak on the port bow that she was immediately put back, and anchored in Bounty Haven, at the head of Bligh Sound. The pumps kept the water down, while the divers, with two of whom the 'Clio' was fortunately furnished, examined, and the carpenters stopped the leak. I was very glad to be of some service in this emergency, by pointing out, from my knowledge of their foliage, the best timber trees in the forests covering the slopes of the mountains around this harbour. A party of seamen and marines was sent on shore to procure sufficient wood far such repairs as enabled the 'Clio' to put to sea again in the course of a fortnight. Meanwhile, we were absolutely cut off from all communication with the rest of the world; for the repeated attempts made to discover a pass leading directly from the settlements in the Province of Otago to the sounds on its south-western coasts, have hitherto completely failed, owing to the inaccessible character of the intervening forests and mountains. In 1863, Dr. Hector, hoping to discover some mode of communication with the inhabited districts on the East of the dividing range, forced his way up the valley of the Cleddau River, which flows into the head of Milford Sound. After a toilsome scramble of two days, his further progress was barred by almost perpendicular cliffs of some 5,000 feet in height, with snowy peaks rising several thousand feet higher. However, Dr. Hector afterwards found his way by a rugged and circuitous path from Martin's Bay (nearly forty miles north of Bligh Sound), to Queenstown on Lake Wakatipu; and he now volunteered to attempt the same route again, with messages from myself to the Colonial Government, and from Commodore Stirling to the officer commanding H.M.S. 'Virago' at Wellington. Accordingly, on the night of our disaster, he sailed in the launch of the 'Clio,' which returned, after an absence of five days, and reported that Dr. Hector, with two seamen, sent by the Commodore to attend him, had been safely landed on the 19th at Martin's Bay, and had set out forthwith on their journey across the mountains. It may here be mentioned that a river named the Kaduku (or Hollyford), with a difficult bar at its mouth, runs into Martin's Bay from Lake M'Kerrow (or (Kakapo), on the northern shore of which a few adventurous settlers from Otago have lately planted themselves.

On the 27th February we were agreeably surprised by the arrival in Bligh Sound of a small steamer, the 'Storm Bird,' despatched to our assistance by the Colonial Government, with fifty sheep and other provisions for the officers and crew, so soon as Dr. Hector had reached the nearest settlement and made our situation known by telegraph. Shortly afterwards the 'Virago' also arrived to the aid of the 'Clio.' Commodore Stirling then determined to take his ship to be docked at Sydney; so, on the morning of the 1st March, I left Bligh Sound in the 'Storm Bird' for Invercargill. After passing successively the entrances to George, Caswell, Charles, and Nancy Sounds, we anchored at sunset in the secure harbour of Deas Cove, about three miles from the entrance of Thomson Sound. On the following morning we started at daybreak, steamed up Thomson Sound, and returned to the open sea by Doubtful Inlet. After passing the entrance to Daggs Sound, we entered Breaksea Sound, and regained the sea by Dusky Bay, in which Captain Cook remained for several weeks in 1773, and which he has described with his usual graphic accuracy. Afterwards we passed the entrances to Chalky and Preservation Inlets, and then proceeded to the Solander Islets, at the west end of Foveaux Straits. It had been reported that some seamen had been cast away there from a recent wreck; but after a careful examination, no trace of any visitors could be found on these desolate rocks, so we bore up for Invercargill, where I landed on the 3rd March. Here began an official tour of great interest through the Middle Island, where I was received by the provincial authorities and by all classes of the community with a warmth of courtesy and hospitality for which I shall ever feel grateful.

Although Milford Sound, at the extreme north of the thirteen inlets of the West Coast, surpasses the rest in stern grandeur and awful solitude, they all have many features in common. They are everywhere deep and narrow, subject to violent winds and strong tides and currents, and with few safe and sheltered anchorages. A tumbled sea of mountains looks down from above on the long swell of the Southern Ocean, breaking in clouds of snow-white foam on craggy cliffs rising abruptly from the shore, while glaciers and snowy peaks, slopes covered with noble forest trees, gloomy valleys and glittering waterfalls, —all combine to present an ever-varying succession of sublime pictures.

The official tours of a Governor may be made practically useful, for they enable him to point out, from personal knowledge and in an authoritative shape, the resources and capabilities of the several districts of the Colony over which he presides, and the advantages which they afford for immigration and for the investment of capital. I have learned from several quarters that the published reports of my visits to all parts of New Zealand have awakened much interest in the mother country. Time will not permit me, on the present occasion, to discuss the future prospects of settlement on the Sounds of the West Coast, of which I have attempted a general description. It has been proposed to place some Norwegian emigrants on one or more of these *fiords*, but any scheme of this nature will require careful consideration. There are now no inhabitants whatsoever, either European or Maori ;—the few families of natives seen in Dusky Bay in 1773, by Captain Cook, appear to have become extinct ;—and the tales related by the old whalers of thirty years ago, concerning a tribe of wild men haunting these desolate shores, have probably as little foundation as the stories of flocks of moas having been seen, within living memory, stalking over the neighbouring mountains. Nor can I trespass on your patience any longer with remarks upon the fauna and flora of this part of New Zealand. The supply of timber seems almost inexhaustible. Ducks and other wild fowl are numerous. Whales and seals abound, as well as excellent fish of various kinds. We were tolerably successful in shooting and fishing. I may enliven this part of my address by reading Dr. Hector's animated account of one of our seal-hunts, in which, however, we were not fortunate. "On one occasion," he states, "the chase of five seals with the steam pinnace of the 'Clio,' in the waters of Milford Sound, afforded a most exciting and novel sport. The seals, startled by the snorting of the little high-pressure engine, instead of taking their usual dignified plunge from the rocks into deep water, and so vanishing out of sight, went off at full speed, diving and reappearing in order to get a glimpse of the strange monster that pursued them so closely. The utmost speed that we could make barely kept us up with them, until they began to show signs of distress, and, one by one, doubled and dived under the pinnace. Two of the seals held out for a run of three miles, and succeeded at length in getting into safety among the rocks on the opposite shore of the sound. From the experience of this run, the force at which seals can go through the water would seem to be not less than six or seven miles an hour." On the occasion to which Dr. Hector here refers, we, unfortunately, had not our rifles with us, but on subsequent days, as was stated above, I shot several large seals, in addition to a number of wild ducks and other water-fowl.

In conclusion, gentlemen, I beg to thank you for the indulgence with which you have listened to this somewhat desultory address. I am fully sensible that these imperfect remarks on rarely-visited regions of this Colony can claim little merit beyond their fidelity. My original notes were written in full sight of those wonders of nature which have left so deep and lasting an impression on the memories of all who have had the good fortune to behold them.

Third Annual Report by the Governors of the New Zealand Institute.

The Governors met for the transaction of business during the past year on the following dates :—21st July, 15th September, 23rd September, and 1st November, 1870; 6th January and 5th April, 1871.

On the 23rd September, 1870, an additional Statute, forming Section IV., was adopted relative to the election of honorary members of the Institute, in accordance with which the following gentlemen were elected on the 6th January, 1871, from the list of names suggested by the various affiliated Societies, and their election was communicated to them under the hand of His Excellency the Governor, as President of the Institute :—Professor Louis Agassiz, Captain Byron Drury, R.N., Dr. Otto Finsch, Professor W. H. Flower, F.R.S., Dr. F. Von Hochstetter, Dr. J. D. Hooker, C.B., M.D., F.R.S., Dr. F. Von Müeller, C.M.G., M.D., F.R.S., Professor Richard Owen, F.R.S., Rear-Admiral G. H. Richards, R.N.

The following members of the Board were re-nominated to be Governors : —Sir David Monro, Dr. Knight, and J. E. Fitzgerald, Esq.

On the 23rd September incorporation was granted to the Nelson Association for the Promotion of Science and Industry, according to the terms of the Act.

The New Zealand Institute now includes the following incorporated Societies, the total number of members being 553, making an increase of 208 during the past year :—

	Members in 1870.	Members in 1871.
Wellington Philosophical Society ...	80 ...	107
Auckland Institute	106 ...	151
Philosophical Institute, Canterbury ...	76 ...	100
Otago Institute	80 ...	123
Nelson Association	... ...	72

The Governors elected for these Societies for the year 1871 were, His Honor T. B. Gillies, His Honor William Rolleston, and His Honor Mr. Justice Chapman.

The appended report by the Manager, relative to the Museum, shows that, while the progress made by that Institution is satisfactory, great inconvenience is now experienced from want of sufficient accommodation for the proper display of the collections, and to allow of the acceptance of collections which are offered as exchanges. The suggestions made in the last report of the Governors, at the request of Government, with a view to adapting the Museum and Laboratory for the purpose of instruction in technical science, have been carried out so far as to allow of eight or ten students being instructed in the Laboratory. This was done by taking advantage of the alterations required for the introduction of gas into the establishment; but as provision has not been made for lecture-rooms and apparatus, full effect cannot yet be given to the proposed scheme for a regular course of lectures on practical science.

The Governors, therefore, venture to express a hope that the Legislature will see fit to sanction an expenditure adequate to carry out the objects of the New Zealand Institute.

The appended statement of accounts shows the manner in which the endowment to the Institute has been applied during last year; and it will be observed that the receipts include a sum of £49 16s. 9d. for copies of the *Transactions* sold to persons not members of the Societies. It is proposed to devote the funds received in this manner to the illustration of hand-books on the various branches of the Natural History of the Colony.

The Proceedings of the Societies were issued to members in a separate form in July, 1870, and January, 1871; and the volume of *Transactions* for the year was in the hands of members early in May 1871. The latter consists of 351 pages devoted to original articles, as against 348 in Volume II., the total number of pages in the volume, including the Proceedings, being 499. Sixty-eight original articles have been published at length, and it has been found necessary to defer twelve articles for future publication.

Notwithstanding that in several cases illustrations sent with papers have been omitted, when not absolutely necessary to explain the author's views, the number of plates has been increased in this volume to thirty, there being in last year's volume only twenty-three.

There were 750 copies of Volume III. printed, 524 of which have been issued to the affiliated Societies, and 146 presented to Public Libraries in England and other places. The volumes remaining on hand at this date are —of Volume III., 80; of Volume II., 75; and of Volume I., 9 copies.

Under these circumstances the Governors cannot make the same distribution to the affiliated Societies of extra copies to be sold in aid of their funds as they did last year; and in future the spare volumes will be sold for £1 1s. each, which is the annual subscription paid by members of affiliated Societies.

G. F. Bowen, President.

Wellington, 28th August, 1871.

Accounts of the New Zealand Institute, 1870–71.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand	32	3	0	1. Expenses of Meetings . .	7	3	1
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Contribution from Wellington Philosophical Society . .	16	5	4	3. Miscellaneous—Translating, Binding, etc. . . .	20	10	3
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A. Ludlam,
Honorary Treasurer.

23rd August, 1871.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1871.

I.—MISCELLANEOUS.

Art. 1.—*Ethnographical Considerations on the Whence of the Maori.* By J. T. Thomson, F.R.G.S.

(With Illustrations.)

[*Read before the Otago Institute, 22nd November,* 1870.]

Native tradition has indicated the Navigators' Islands as the directly prior home of the Maoris or aborigines of New Zealand, from whence they are said to have migrated through, or by way of Rorotonga, which latter island is still denominated "the road to Hawaiki," an island of the former group. ("Story of New Zealand," by Dr. Thomson). With tradition this paper has little to do, as our object is to examine the ethnographical relations of the Maori with other races of the world, in as far as his physical form, customs, and language will guide us. To enable us to perform our task with any degree of satisfaction, we must give wide scope to our observations by first taking a glance at the map of the old world, tracing thereon the seats of the great divisions of the human family.

The human family may be reduced to three primary divisions—by colour, white, red, and black; or by name, Caucasian, Mongolian, and Negro, between which there are innumerable subdivisions and modifications of shade, and diversity of form, customs, and language. Before the discoveries of Columbus and Vasco de Gama, which gave such wide expansion to the white and black divisions, the seat of the first was confined to that area extending from Iceland over Central Europe to the confines of Hindostan; the seat of the second was over North Europe, North, Central, and Eastern Asia; while the seat of the third was confined to the continents and islands of the tropics, extending from Cape de Verde to Malicolo. Where one division bordered on another at various points they intermingled, and thus graduated one into the other, or the weaker gave way and died out. Yet each leading division had great geographical barriers to separate them; thus, the black and white divisions were separated in a great measure by the Deserts of Zahara and Arabia, and the red and white by the Himalaya Mountains and the arid steppes of Tartary; and it is a remarkable fact that upon one point of the surface of the earth all three divisions had easy convergence—this point is the peninsula of Hindostan. This notable fact has intimate bearing on the enquiry before us, so will be referred to hereafter. In the meantime I must point out how much the physical geography of the world has to do with the spread and currents (if I may so express myself) of the divisions of humanity. It is a fact well known to physiologists that the pure offspring of the white man, when confined to the tropics, dies out in the third generation, and again, much beyond the same limit, we know of no purely black race existing; the red man alone appears to have a constitution fitted to endure in all regions habitable by the other two. Hence, he extends across the Equator, from Cape Horn to North Siberia.

In that dim chaos of pre-historic times, into which reason has enabled us but partially to penetrate, it will appear to have been one of the arrangements of nature that the Negro should have at one era populated the plains of Hindostan, as well as Africa and Papuanesia, and which plains are in the middle distance of his extreme range East and West. Abutting closely on this middle area were energetic hordes of white and red men settled in the mountain valleys of Aria and Thibet. These valleys were situated on the flanks of the highest region in the world. Ethnographical enquiry, while proving the above fact, also traces the descent of these hordes on the fertile plains of India, the former by the valley of the Indus, the other by those of the Bahrumputra and Ganges, driving out or enslaving the simple and unwarlike black inhabitants.

In scanning an ethnographical map of the world, it will at once strike the observer that the Negro division has extended itself only either by the sea coasts or from island to island in close contiguity, thus indicating a rude, primitive, and unskilful knowledge of navigation, and which required vessels little superior to the canoe. The red race, on the contrary, has evinced surprising powers of locomotion both by sea and land, a proof of their superiority. Again, until these latter ages, the white man has been confined to a limited area, and as his skill, boldness, and intelligence, must be acknowledged to be superior to the other two divisions, may we not accept this as one of the proofs of his later development or increase? Otherwise, how are we to account for his tardy intrusiveness on the habitats of the other divisions, and which within the last three centuries have had such mighty exposition.

The relative superiority of intellect, as evidenced by the capacity of the skull, may here be shortly noticed. In a paper that I furnished to the

"Journal of the Indian Archipelago" (vol. i., 1847), I gave the result of measurements that I made on crania of the three divisions. The system of measurement was explained in that journal, being by squares on a central section of the head, the standard line being drawn through the *meatus auditorius* and base of the nose. I then found that the brow of the European equalled 88, of the Eastern Asiatic 71, and of the Negro 60. The ape of the Indian Archipelago, I may add, equalled 44.

The jet black native of Central Africa may be likened to one pole of humanity, and the fair, light-haired native of Scandinavia may be likened to the other, between which there are links innumerable till the chain is joined. Thus, while in physical aspect there are graduations from one race or tribe to another till the most remote are joined, so in language, the same law has been found to appertain. Affinities of language must not only be judged of by glossaries, but by phonetic systems and ideology. On this branch of the subject the late Mr. J. R. Logan (than whom there was no more ardent an enquirer), by a laborious and exhaustive comparison of the various languages of Asia and Polynesia, has drawn the following conclusions. He says ("Jour. E. I. Arch.," vol. vii.) "That there is reason to believe that the strong Africanism of some of the lower South Indian castes is really a remnant of an archaic formation of a more decided African character. In some places Tamil books record that the original inhabitants had tufted hair, and some of their customs were Africo-Papuan. The black Doms of Kumaon have hair still inclining to wool. The phonetic elements of the Dravirian (South Indian) formation are numerous, and some of them have a somewhat African and Australian character." It is probable, therefore, he continues, "after a lengthened analysis of the various languages, and on linguistic evidence alone, that the Dravirians (as above described) occupied the plain of the Ganges and all India before the present Gangetic tribes imported or diffused the ultra Indian and Thibetan elements which are now found in their languages. India, from its position and climate, was destined to receive and not to send out dominant races. It has only been less recipient and passive than Asianesia." Again, "the main affinities of the Dravirian formation point two ways, the linguistic chiefly to Sythic, the physical chiefly to an African origin or fraternity." Of other Asiatic languages, he remarks "that the principle languages, from the Fin and Hungarian in the West to the Japanese in the East, have many phonetic characters in common, particularly that of vocalic harmony. The Sythic languages, as a whole, appear in their earlier form to have embraced the entire range of the simple definitives. In this respect they resemble the Thibetan, Ultra-Indian, Dravirian, Caucasian, South African, and Asianesian systems." He adds "that, ideologically, the Dravirian and Sythic formations have a close agreement, and in some common traits they differ from the Thibetan." The positive results which he sums up, after a most full and laborious exposition, including in the process numerous investigations and examples, are, "that the bases of Thibeto, Ultra-Indian, Dravirian, and Sythic formations are strongly allied to Chinese, not only by their monosyllabic character, but by many structural traits, and it may be added by glossarial affinities also. The three formations are further and more closely connected with each other by syntactic characters which are not Chinese, by the possession of a harmonic phonology—feeble in the Thibeto Ultra-Indian languages, and powerful in the Sythic, and by numerous common roots."

Thus I have endeavored to show, by as short extracts as possible, from the writings of an acknowledged high authority, that there are links of language between Archaic South India and the rest of Asia, which will prepare the mind to pursue other connections from the same region with Polynesia, and which latter is the immediate subject of this paper.

Between the various Polynesian languages a certain degree of relation has been proved to exist, and this extends to Madagascar. Those ethnographers who have given special attention to the subject, amongst the most eminent of whom are Marsden, Humboldt, Bopp, Hale, John Crawfurd, and J. R. Logan, are somewhat divided in opinion on the origin and cause of this phenomenon, one side maintaining a derivitive origin of the various tribes from one common stock, while the other adheres to the primordial theory of rude hordes speaking *ab initio* languages of their own. Into these speculative subjects we need not enter, as they do not materially affect the enquiry before us. Logan, with the view of ascertaining generally the position of the insular languages with reference to others, states (vol. iv. "Jour. E. I. Arch.") "that he compared the structure of those of which he had a knowledge with the Burman, Chinese, Tartarian, Thibeto-Indian, Older Indian, African, and American groups, and made a comparative vocabulary, of little more than 300 words, of 135 of the Indo-Pacific languages." These he partially compared with 150 continental languages that appeared to have connection with them. As a general result of his investigations I may mention the following, that though the enquiries, as a whole, proved far beyond the grasp of one person, after discoursing on the various languages of Africa and Asia, he states, "that if any oceanic language be examined it will be found to have strong resemblances and even coincidences in words and structural traits to one or another branch of all or several of the great linguistic families of Asia, bordering on the ocean or intimately connected with the border natives—Lau, Chinese, Japanese, Tartarian Thibeto-Indian, Burman, Old Indian, Syro-Arabian, Ancient Egyptian, African, and even Iranian and American. The investigation of Ethnic evidence afforded by Oceanic languages is therefore exceedingly complicated. One general conclusion is that the human history of the Indian

Archipelago is of very great antiquity. Amongst the foreign influences tha can be traced, the first is African or Indo-African in character—that is, embracing the Indian Archipelago, Australia, and Papuanesia. The Melanesian languages are still probably Indo-African."

For two, out of many glossarial resemblances given by the author, I would refer the reader to Appendix I. as illlustrative of this part of the subject.

Of insular languages the author goes on to state that "they present contrasts of harsh and soft phonologies such as those that are found in the Continent of Asia and elsewhere, but their prevailing character is vocalic, harmonic, and flowing. These phonologies have largely influenced the languages of Melanesia and Micronesia, and they have degenerated in Polynesia into extreme softness and weakness. In some respects Polynesia has a closer resemblance to Malayan than to Eastern Indonesia. It is greatly distinguished from the latter by its comparatively crude phonology, in its low degree or absence of fluency and adhesiveness. It is nearer the Malay, while it possesses many traits of the E. and N.E. Indonesian ideology, which is not found in Malay, as well as some very striking ones that are peculiar to it."

Mr. Hale has shown that the more eastern dialects of Polynesia have been derived from the western, and have lost or changed some of the forms of the latter. The Samoan group is considered by that authority as the first location of the Polynesian race, from whence it spread south to New Zealand, and east to Tahiti. Again, Logan states that the Australian languages, with many characteristics in common with the insular, yet possess a primary form radically distinct. They have also more modern connections, attributable to the influence of the Indo-Polynesian and Papuanesian languages, exerted chiefly on the East Coast. The eastern or Molluccan languages he affirms to be, probably, the parents of all Polynesia.

Of the Andaman language, which is of great interest, owing to its Negro tribes having been so long preserved separate from surrounding continental nations, Logan observes that it is purely Indonesian, and its words are dissyllabic. At the dawn of our present ethnic light, vocalic languages occupied the Malacca basin, and the fragments of a Negro population still existing in the Andaman Islands and the Malay Peninsula speaking these languages, attest to the fact that the spiral-haired Negro race were in these regions prior to all others. The extensive enquiries of the above distinguished ethnographer have, therefore, led to the conclusion that a Negro race once spread itself over Hindostan and India beyond the Ganges, and whose languages even yet resist extinction by later intruding tribes.

Crawfurd (whose purely speculative views I need not notice) has given a laborious disquisition on the Malayan and Polynesian languages, from which I give several quotations ("Journal of Ethnological Society," London). By an analysis of a Malagasi dictionary, consisting of 8,000 words, he discovered 140 to be Malayan, or 1-57th part of the whole; 60 of the Malayan words were of natural objects, and 13 were numerals. Of the Tagala language (Philippine), in a dictionary containing 12,000 words, he found 77 to be Malayan, 20 to be Javanese, and 150 to be common to both languages. This gives a proportion of 32 words to the 1,000. There were also 24 Sancrit terms. Of the Bisayan language (also Philippine), in a dictionary containing 9,000 words, 72 were Malayan, 17 Javanese, and 197 common to both, making about 30 in 1,000. There were also 13 Sancrit terms. Of the Maori language of New Zealand, in a dictionary of 5,500 words, 107 were Malay, making about 20 to the 1,000. Of the Negro languages of the Andaman Islands and Keddah, or Queda, he remarks that he found in their vocabularies no two words alike; this was also the case with the Papuan language of Wajeou (near New Guinea). This dissimilarity he states to be the case with all Negro and Papuan tribes. Comparing also the languages of the islands in the Torres Straits with those of Malicolo, Tanna, and New Caledonia, no two words were found to be common. Further, he found no Malayan word in any of the languages of Australia; this fact he accounts for by the low social state of the latter.

Crawfurd has scarcely touched on the phonology and ideology of the languages reviewed, which is to be regretted, and he evidently ascribes the possession of common words by various races over so large a portion of the world to Malayan origin, disseminated by tempest-driven proas, and other accidents of the sea, a theory adverse to the conclusions arrived at in this paper.

Having availed myself hitherto of so much of the materials collected by prior writers, I now proceed to a portion that is more peculiarly my own. During my long sojourn in the East Indies I made drawings of various individuals of several tribes, with no intention of ever bringing them to any use further than for the amusement of home friends, but as they serve, in some measure, to illustrate my paper of this evening, I will now refer to them. Commencing at the westerly range of the Negro, viz., Africa:—

Bashier, of Muscat, a native of Central Africa, presents a specimen of the coal-black type.

Furham and Barrahk, of Zanzibar, are of mixed race or Arabo-Negros.

Next are two men and one woman of the Sumnali tribe, natives of the Straits of Babelmandeb, of brown complexion. The men especially are very lanky, figure approaching to the physical form of the Arab, yet otherwise having all the characteristics of the Negro.

Next is a Pariah of the Coromandel Coast of South Hindostan, a nearly black native of the Dravirian type, with curled hair, approaching much to the features of the Negro.

Then comes a Hindoo of the same region, of dark-brown complexion, yet whose lanky hair and oval features prove a further removal from the Negro type, and nearer to the Indo-European.

Next is a Hindoo of Coorg, in the same region, who, having been the son of a chief, has a light brown complexion, sharp features, and small lips and chin, showing a more northern derivation than the two latter, and in whose countenance none of the Negro characteristics are to be observed.

These drawings, as far as they go, give illustrations of the graduations of the human race, from the coal black Negro to the olive-colored, and then the white Arian, Caucasian, or European. Now go to the most easterly range of the Negro. Here are two drawings of Papuans, natives of New Guinea. While exhibiting cerebral contours equally as low as those of the most westerly range, in their prognathous jaws, retreating foreheads, oblong faces, and thick lips, they are of lighter complexion, viz., dark brown, with spiral hair, a feature which distinguishes them from the African type.

Next we have an albino of the same race—mistaken by the credulous for a European—but whose red weak eyes, scaly skin, protruding lips and jaws, small brow, and long thick-jointed fingers, prove him to have had his origin in Papuanesia.

Now we come to the Bajow or Oranglaut, of the Indian Archipelago. Campar, evidently allied to the Mongolian division, but the Negro features in him are slightly apparent, while in his sisters Puteh and Smih (both albinos) the Mongolian features are predominant. This tribe is evidently derived from the Mergui Archipelago, and remotely from the valleys of the Irrawaddy and Bahrumputra. They are strong and muscular, also piratical and regardless of shedding blood. These I would point out as being most likely the descendants of the first intruders on the Negro Equatorial area.

Next are a man, woman, and child of the Seletar tribe of Johore—river nomads—whose closer contact with the present natives of the Malay Peninsula graduates them further into the Mongolian type, as shown by their square faces, small oblique eyes, and brown yellow complexion.

The next in order may be classed together, all having Mongolian or Thibetan features, viz., a Jakun of Johore, Muka Kunings of Battam (mother and son), Sabimba of Johore (man, boy, woman, and child), Mintera of Salangore (man and woman). All these are wild tribes, living solely in the dense forests of the interior of the islands and peninsula of Malacca, evidently deriving their origin in archaic times from the valleys of the Menan and Irrawaddy. These are now popularly known as the primitive inhabitants, but the ethnological researches already quoted prove them to have been preceded by the Negro. Their features being also closely Thibeto-Chinese, their more northerly origin is corroborated. Some of these tribes live in savage freedom within 30 miles of the settlements of Europeans, such as Malacca and Singapore, totally unaffected in habits or manners by the civilisation so nearly brought to them for a period of three and a half centuries—that is, since the advent of the Portuguese in the year 1511.

Next is a Jawee Pakan of Malacca, a man of mixed race, evidently Malayo-Dutch. Thus, in these portraits the graduations or links from the Papuan to the Indo-European are exhibited.

As examples of the pure Mongolian races that now occupy the Indian Archipelago, the following are exhibited:—1st. Two women and a child of the Silat, in the Singapore Straits, claiming to be Malays; 2nd. A man, woman, and child of Waju in Celebes. These claim to be Bugis, and belong to the most enterprising race in the equatorial East.

Last is a Mug of Burmah, who, being nearer to Thibet than any yet shown, has features more closely approximating to the natives of the eastern Himalayan spurs than any other. It will be observed by those acquainted with the images of the Thibetan Buddha, how closely similar the features of the face are to those; the straight nose, round face, and rectangular eyebrows of those people presenting a *beau ideal* of beauty, grace, and symmetry in these regions of the earth. This portrait gives the link between the Thibet and Indonesian races. (Copies of these drawings are necessarily excluded from this work.)

Thus, while the language of these tribes or nations have been shown in the preceding part of this paper to graduate one into the other, so have their physical forms, colors, and complexions been proved (imperfectly, it must be admitted, for want of more drawings) also thus to graduate. Now to the question before us—which of these approach nearest to the general type of the Maori? On this point Dr. Thompson, in his "Story of New Zealand" (a very competent authority) describes "the Maori males as averaging 5ft. 6¼in. in height and 10 stones (without clothes) in weight, their body being longer than that of an Englishman, while their legs are shorter. The head hair is abundant, and generally black, but some have a rusty red tinge. A few have lank head hair, a few frizzly, but the majority have dark hair with a slight wave in it. Their beard and whiskers are occasionally considerable, but on the trunk it is scanty; few become bald, although many are grey; the skin is olive-brown, with many shades, some so fair that blushes in their cheeks can be seen, while others are so dark that the tattoo marks can scarcely be detected; the mouth is coarse, the face broad, and the upper lip long, the forehead high, narrow, and retreating. *They are a mixed race*, and may be divided into brown, reddish, and black. In different tribes the numbers of each complexion vary."

To compare for ourselves the correctness of this description, we have not far to go, for we have the prisoners of the North Island in Dunedin, and the Maoris of the Lower Harbour to contemplate, and we have also Chinese now in our streets. Though the countenances of the Maoris will be found to differ widely, yet the general cast will be admitted to approach none of the three great distinctive divisions of mankind. They are clearly a cross, whose affinities are Dravirian or South Indian of the oldest class. On this subject I may be allowed to speak as one who has had experience, having resided in countries where both races were to be daily seen; and while I would ascribe the affinities of the Maori physiognomy to be nearest to the Dravirian, yet I would also support an hypothesis that the race was also affected by an archaic connection with some of the first off-shoots of the Thibetan and ultra-Gangetic races, such as are now represented by the Bajow or Oranglaut, to whose physiognomy there is a striking approximation in many individual Maoris whose countenances have been scanned by me. This tribe are sea nomads, and frequent all waters and islands of the Indian Archipelago. The above opinions would indicate a more remote and westerly origin to the Maori than has yet, as far as I am aware, been enunciated by prior writers; but, before dealing with this hypothesis, it will be necessary to examine into the grounds of the generally received opinion of their Malay origin.

The idea of the Malay origin seems to have been accepted by various writers, owing to partial glossarial resemblance and great similarity of phonetic system and idiom; but the Malay is only one dialect amongst 300 or more spoken over the wide area of the Indian Archipelago, many of which have nearer resemblances to the Maori than the Malay has. Before, therefore, we can proceed, the hitherto accepted hypothesis of the Malay origin of the Maori requires refutation.

The original seat of the Malays is ascribed to Malayala, on the Malabar Coast, as the Javanese to the Yavanas, of Central Asia. This may be fanciful or true; I would rather adhere to the more practical theory, that the name of Malay was derived from the river Malayu, the highway to their Menangkabau territory in Sumatra, this being the common mode of naming tribes in these regions at the present day—such as Orang Johore, the people of the river Johore; Orang Ache, the men of the river Acheen, etc. So I would also derive the generic term for the inhabitants of Java, from the fact of the island being called by the natives Tannah Jawa—literally, the land of rice fields—and as such it is pre-eminently the granary of the Archipelago, hence by surrounding tribes, the inhabitants are called Orang Jawa, which we translate into the term Javanese.

According to the "Sijara Malayu" or "Malay Annals" (a copy of which is on the table) the Malay Rajas descended from no less a personage than Alexander the Great, through issue by his Queen Shaher ul Beriah, daughter of Raja Kida Hindee (Porus). A descendant of these, named Raja Suran, carried an Indian army (of Klings or Dravirians) as far as Tamasak, the ancient name of the south part of the Malay Peninsula. This Prince or Raja married Putri Onang Kiu, a daughter of the King of Klang Kiu. Again, a descendant of this royal race, named Sangsapurba, was miraculously translated to Paralembangan (ancient Palembang) in the country of Andelas (Sumatra), where he is related to have married a princess of the Malay race, and was elected king. His son, Sang Nila Utama, was in due time united to Wan Sri Bini, the beautiful daughter of the Queen of Bentan (Bintang), and remained to rule that country. The father, Raja Sangsapurba, after visiting various countries, at length proceeded to Menangkabau, to the throne of which country, the principal seat of the Malays, he was elected. An illustrious princess of renowned beauty, named Nila Panchadi, was affianced to his son, Sri Tribuana, to whom she was duly married. Sang Nila Utama remained at Bentan, but after a while was seized with a desire to visit Bemban (modern Tanjong Bomban), from whence, viewing the white sands of the beach of the shore of Tamasak, he crossed over the strait and settled there, giving the new country the name of Singapura (Singapore). Here the Malay annalist remarks that Singapura was a very extensive country, and its populous parts became much frequented by merchants from all parts.

Such is a very abridged native account of the descent of the Malay race from the interior of Sumatra, on the Straits of Singapore, and lands adjacent, the date of which is given by Crawfurd as A.D. 1160, and probably this is very nearly correct, for Marco Polo, the renowned Venetian traveller, passed through the Straits in the year 1291, when he remarks of the settlement then existing as being governed by a king, the people having a peculiar language of their own, the town being large and well built, a considerable trade being carried on in spices and drugs, with which the place abounds, but nothing else presenting itself to notice. Shortly after the latter date the Malays were driven out of Singapore by the Javanese, after which they founded Malacca, from whence also their princes were driven out by the Portuguese in the year 1511.

It will thus be seen that the Malays had but a comparatively modern and short possession of ancient Tamasak, whose straits hold the key of the Indian Archipelago. So their influence in prior and archaic waves of migrations passing through this great water-way of Asia and Polynesia must have been null. Having personally visited all the capitals of their so-called empires, viz., Bintang, Singapore, and Malacca, I can state that none of them even showed any proofs of former power and grandeur, there being no ancient monuments, nor the remains of structures such as are to be so amply discovered


EUROPE
ASIA
AFRICA
Negroes
Madagascar
Asia
Thibet
Mangi
Barata
Tamasa
Micronesia
Papuanesia
AUSTRALIA
Sandwich Id
Marquesas Id
Navigators
Tahiti
Tongataboo
Kermadic
N. Zealand
Easter Id
INDIA
Sumatra
Borneo
AUSTRALIA
Malay Settlements.
Caucasian migration thus + + + + + + + +
Mongolian " o o o o o o o o o
Tamil Australian " -o-o-o-o-
Polynesian " >>>>>>>>>>
SECONDARY ERA

J.B. lith.


EUROPE
ASIA
NORTH AMERICA
AFRICA
AUSTRALIA
Caucasian
Aria
Mongolian
Thibet
Mangi
Region of the Race
Expansion of the Barata Nero
Barata
Tamasak
Micronesia
Papaunesia
Madagascar
Sandwich Id
Marquesas Id
Navigators
Tahiti
Tongataboo
Kermadic
Easter Id
N. Zealand
J.B. lith.
Printed at the Gen. Gov. Lith. Press

PRIMARY ERA

in Java. It is rather from the accident that the Malays were found in power in the Straits of Malacca at the time of the first advent of Europeans to these regions, that their name has been so largely associated in European ideas with predominance in the Indian Archipelago. On mature enquiry it will be found that, with the exception of the small interior state of Menangkabau, the Malays had no real hold on any other territories. Beyond that small area they extended themselves only as traders or holders of river entrances, and this only over part of Sumatra, Borneo, and the peninsula of Malacca. The interiors of these countries were peopled by other tribes, alien to their dialect or language, customs, and religion. Map, Appendix I., will show this more plainly.

During the era of their power, viz., between the twelfth and sixteenth centuries, no doubt their language or peculiar dialect had spread as the *lingua franca* of the East, from Malacca to Ternati, but this only affected merchants and dealers, and in no way the local dialects and languages of the indigenous populations. Even in Sumatra, their native island, their language was confined to but a small area, not exceeding one-sixth of the whole. The other tribes or nations, such as the Achinese, Battas, Lampongs, Korinchees, etc., having languages of their own, and in two cases also distinct alphabets.

The descent of the Malays from the mountains of Sumatra, on some of the islands and coasts of the Indian Archipelago, has therefore been of too modern a date to have specially, or in any degree, affected the languages of Polynesia in general, or of New Zealand in particular. All that can be admitted of them is that they, in common with other tribes of the Archipelago, possess the same roots of one archaic language, whose influence not only extended over that archipelago, but was also carried westerly to Madagascar, and easterly over all Polynesia.

Had the pioneer European navigators first found their way to Celebes, and there encountered the Bugis—a nation of traders, with a different language and literature, a nation more bold and enterprising than the Malays—no doubt they would have held the place in European estimation that the latter now occupy; and to them alone would the possession of the Archipelago be popularly ascribed, and also, with equal appearance of truth, for their settlements are as numerous, as widely diffused, and native history attests that their power was as great.

Lyell, in his work on the antiquity of man, remarks that the historical period is quite insignificant in duration when compared with the antiquity of the human race. The earliest reliable date recorded by literature being the first Olympiad, 776 years B.C., and the monumental records of Assyria and Egypt are asserted only to go back 1500 B.C. The most modern geological formations are calculated with considerable precision, and extend at least

100,000 years back, such as the alluvial deltas of great rivers, and in these the remains of man have been found in strata, whose date carries us far into the above period. The science of ethnography may, therefore, be said to form a link of connection between the records of the rock and the records of the book, or, in other words, between geology and history. Hence, in considering the subject before us, we must cast our minds back to times anterior to history, and, using the materials provided for us by the labours of ethnographists and philologists, evolve a theory in accordance with their facts and teachings.

It is now a generally accepted axiom that to understand the past we must know the present, and to apply this rule we must enquire as to how modern transmutations of humanity over the globe affect races and languages. Take the Jews for instance, within the period of history a race once speaking one language, now scattered over the world—black as the darkest of Indians on the coast of Malabar, where they have been settled for ages, and there speaking the language of the country only—white, in many cases, as the whitest of Europeans, in Europe, and there again speaking only the language of the nationality amongst whom they have intruded themselves. Then a later example have we in the Portuguese, who formed settlements in various parts of the world in the fifteenth and sixteenth centuries. Dark as the Bengalee of the Sunderbunds, or as the Jawee Pakan of Malacca, and retaining only a few of the roots of the language of their European ancestry, and which they enunciate with the idiom of the race amongst whom they have been settled. Of the descendants of the English and Dutch, whose tropical colonies were fully a century later, the same remark applies in equal ratio. Then the crossing of northern nations with tropical indigenes tends to the gradual disappearance of the features or languages of the intruders, and the uneducated progeny more and more perpetuate the features and idiom of the mothers. Thus the modern incursions of the northern races in the area of the Indian Archipelago have likewise had no impression on the roots or idioms of the languages and dialects.

To illustrate this important fact I have carefully analysed Marsden's Malayan Dictionary, consisting of 5,624 words, and in a few cases only have I been able to discover that primary words have been engrafted in it, though the influence of surrounding races are abundantly apparent. Thus, the Sanscrit speaking race (the Arians), whose intercourse with the Archipelago dates at least 3,000 years back, have given 306 words of the above; the Persians, whose intercourse may have extended over 2,000 years, have given 110; the Arabs, in probably an equal period, have given 568; the Portuguese, whose intercourse commenced three and a half centuries ago, have given only 34; the English, with 200 years, 9; the Dutch, coeval with the last, 4; and the Spanish, 2. The above, it may be noted, are all northern nations, possessed of energy, literature, and science. Again, in the case of nations on a level with, or a little superior to the Malays, how little they have engrafted on their language may be seen by the following examples, and this after an intercourse even more ancient than any previously mentioned. The Javanese have given 40 words ; the Chinese, 3 ; the Japanese, 3 ; and the Tamilians or Klings, 2 ; but here also no primary words have been engrafted. Thus, the Arabic words are expressions connected with religion, law, and science ; the Sanscrit with war, literature, and mythology, with a few words expressing primary wants ; the Persian with commerce and medicine ; the Portuguese and Javanese with titles, customs, and articles foreign to the social wants of the Malays. Such may be said of the few others, as, for example, in the English words adopted are found, general, order, sloop, etc.

The above facts indicate how tenacious a tropical language is of its roots ; they may be said to be eradicable only with the extinction of the tribe. It cannot have escaped the notice of those who have made ethnography their study, that conquering nations eradicate the languages of weaker nations only in their own zones of latitude, or rather in the iso-thermal lines ; when they overcome tropical people, they neither extrude the natives, nor in any degree expunge the roots of their language. As their northern energy dies out, or as their intercourse ceases, the remnant of their dominion is only shown by partial intermixture of blood and a slight glossarial adoption of words expressing abstract ideas or foreign necessities. Thus, the Angles planted their blood and language over the middle portion of Great Britain, extruding the Celtic population and their language ; and the Saxons over the southern, in a parallel line. So also the Franks over the northern portion of France, again parallel, to both of these movements. The Vandals forcing their way South as far as Barbary, effected no permanent change on the conquered races or languages. Again, in more modern times, the British have overrun North America, extruding the natives, eradicating their language, and planting themselves and their own. Equally have they overrun Hindostan, but with no visible effect on the races or languages. Northern nations may cross the tropics, and implant themselves and their languages in their respective opposite zones, but if they intrude beyond the iso-thermal lines of their original habitat, they degenerate, and their languages deteriorate or die out. Thus, the Portuguese have affected the natives and languages of equatorial Brazil but partially, while the Spaniards on the La Plata, in a climate congenial to them, have spread out and extruded the indigenous inhabitants. So it is in the region more immediately under discussion, viz., the Indian Archipelago.

The Chinese, Thibetan, and Ultra-Gangetic natives have had intercourse with the Indian Archipelago from time immemorial, and from whence a constant flow of population has proceeded, so much so that over a large area once solely populated by the Negro, as proved in the preceding part of this paper, the people have now pure, or nearly pure Mongolian features. A Chinese in a Malay dress cannot be distinguished from a Malay, the features and stature being so similar. From the Indian Archipelago the blood of the Negro has almost entirely disappeared, yet the roots, phonology, and ideology of his language remain an indelible proof of his former sole occupation of the region. How this has occurred modern experience also provides a plausible theory, if not a complete solution.

Slavery is inherent in tropical customs and manners, and is but slightly interrupted by the exertions towards its suppression by European powers—thus slave hunting is as great an institution to-day as it was in the times of Nimrod, the more skilled thus prey on the weaker, and the Negro is not alone the victim to the vice, as the European would say, or to the social necessity, as the Asiatic would express himself. Thus, during my day, and under my own experience, I have listened to the relations of the personal encounters of the Keddans with the Negros of the Andaman Islands, to which parts the former tribe proceeded annually in search of edible birds' nests. Here frequent skirmishes took place with varying results, the victors bearing off the vanquished as slaves. This constant system of bloodshed or capture little affected the increase of the more numerous Mongolian race (the Keddans), but gradually thinned out the ranks of the Negro. Such has been the case from time immemorial, but under this slow process of extinction, how has the Negro language been preserved and perpetuated by his conquerors? It is accounted for in this way.

The traditional and invariable policy of Eastern Asiatics has been to prevent the emigration of women. Thus, even in modern times, though thousands of Chinese annually migrate to the Indian Archipelago, no women accompany them; so those of the emigrants that settle to agricultural or trading pursuits (and this a large portion do) take wives of the indigenous inhabitants, and whose children remain in their own countries even though the fathers return to their original homes. These children acquire the language of their fathers but partially, but of their mothers completely, and the grandchildren lose knowledge of the former entirely. Thus, the tropical language remains intact, while the race is suffused with new blood and impressed by foreign physiognomy.

Again, where slavery and polygamy prevail universally, a large portion of the lower orders, by these institutions, remain unproductive, and the superior orders, in this case Chinese, in a great measure increase the race. Thus has the aboriginal Negro gradually, and by slow process in the course of many centuries, been extirpated from that portion of the Indian Archipelago that has been most easily accessible from China and Ultra-India. Hence, the Negro is supplanted in Sumatra, Java, Borneo, Celebes, etc. Physiognomists inform us that Negro features disappear in the fourth remove; thus, though the mothers of the present natives of these regions have been Negros, their forms and colour are now no more. The partial remnants of this race are only to be found in sequestered spots, such as in the mountains of Keddah and Cochin China, and in the Andaman and Philippine Islands, as collateral proofs of their former wide extension and pre-occupation.

Now, applying the same process to a similarly situated region, viz., the peninsula of Hindostan, whose aboriginal inhabitants have also been proved to have been of the Negro race, we have only to trace the descent of the energetic races of the trans and sub-Himalaya mountains on the tropical plains of Coromandel and Malabar, where the Negro mother would transmit her language through her offspring, till the mixed race had decreased, by the pressure of superior races, to the few fragments of which indications only are now to be discovered, as before stated.

Again, why have the races of the Indian Archipelago, while modified so much in physical form by the inroads of the Mongolian, accepted so much of literature and language from the advanced hordes of the Caucasian—such as form the Arian and Semitic tribes. This may be answered from present and historic experience. The language of China is harsh and monosyllabic, and its literature hieroglyphic, totally adverse to the genius of the soft dissyllabic and polysyllabic tongues of this part of the Tropics; while, on the contrary, the language and literature of Hindostan and other western parts accord with the system. Another cause may be adduced, in the case of which we have given examples, which makes a people borrow from the higher rather than the lower adjacent races. Hence, since archaic times, the most advanced races of the Archipelago have borrowed from the west, nothing from the east of Asia. Further, their politicians, historians, accountants, and arithmeticians, were of Hindoo or Arabic origin. Thus we account for the large impress of the literature of these races in the Indian Archipelago as formerly demonstrated. Indeed, in the histories and traditions of the Malays, their kings and princes have always been derived from Roum (Persia) or Hindostan; while the Chinese in the same histories, when noticed, are done so with contempt and derision. Thus, in the Sijara Malayu it is related that for certain diseases with which the Emperors of China were afflicted the most effectual cure was the *urina regis* of Malacca. Further, the superstitions implanted in the minds of the Asianesians are Hindoo—that is, so far as they have not been put down by Mohammedanism.

Under the light of the above facts and deductions we may now be said to be prepared to enter into the prime inquiry of this paper, viz., the Whence of the Maori. The two theories on the origin of Man, maintained by separate Schools of Ethnography, viz., the primordial and derivative, as stated before, affect the question but little. Crawfurd, who supports the former, amongst other arguments adduces, on the authority of Cook, "the ape-like inhabitants of Malicolo, the diversity of tongues spoken in Polynesia, the entire glossarial independence of the Negro tribes of the Andamans, Keddah Wageou, Malicolo, Tanna, New Caledonia, and Torres Straits;" yet he neglects the more important fact of their near approximation in their physical form, and the common phonology and ideology of their languages; and when we consider that some of these tribes can only count so far as two, others no more than six; also, that some are so low in their social wants as only to covet a spear, a fire-stick, and an eel hung over their backs, as warlike material, household goods, and larder; we need not wonder that the whole expression of their few wants require no more than 300 words to enunciate the same; so glossarial analogy (except in purely primary words), to which the above authority has principally given his attention, is of less consequence than the other two characteristics. To show how glossaries may alter in ages, I may remark that it is common for some tribes to drop words on the death of chiefs, or on the occasion of certain calamities, and others have artificial dialects besides the vulgar one, all tending to change. Thus, the Malays have the common colloquial as well as the Basadalam or Court language, unknown to the vulgar; but besides this they have the curious Basa Cappor or Camphor language, used by and confined to the searchers of that valuable product. Three languages in one people. Hence very rude tribes are acquisitive of words though tenacious of the original ones, but, as their wants increase, they borrow largely from more powerful neighbours. Thus, without attempting to reach a beginning, which the most abstruse science only clouds in unprofitable speculation, I am led to the following opinions:—1st. That primary terms are the most certain indications of connection in race. 2nd. Wanting primary terms, a connection is also indicated by common phonology and ideology. 3rd. That in the Tropics, as between the black and the red man, language is more permanent than race; in other words, the obliteration of an intervening race does not destroy the ethnographical links between two distant regions where language remains.

This leads us to the ethnographical connection between the large island of Madagascar and Polynesia, a proper understanding of which is necessary to the ends of this paper. The theory of the Malay origin, common to the Maori and Malagasi, so generally accepted, has, to my mind, certain difficulties attached to it that may have escaped the notice of its supporters. Thus, on a careful examination of thirty-three vocabularies of the Indian Archipelago, collected by Wallace, this fact becomes very patent—that of all the dialects those of the Molucca group (including both Papuan and Asianesian races) have the greatest affinity to the Maori—this glossarially as well as phonetically, and in comparison with which the latter is very remote from the true Malay, as spoken at Singapore and Malacca. So, if the origin of the Maori was to be sought in the Indian Archipelago, it is in the Molucca group it would be most reasonably placed. Yet, even if this determination were accepted, the affinities of the language of Madagascar to those of the Indian Archipelago are again to be accounted for before it could be acceptable to the unbiassed inquirer. The theory of Crawfurd, that the Malagasi were planted on their island from Sumatra by storm-driven proas, is contrary to all experience, for in no place have we confirmatory examples of such. Thus, the ocean space between Africa and South America, a distance of only 1,560 geographical miles, had been insuperable to the natives—equally so from North America to the Sandwich Islands, a distance of 2,400 geographical miles. How, then, could a large nation, such as the Malagasi, have been implanted by distressed and storm-driven natives over an open ocean distance of 3,000 miles?

So the broad fact yet remains that the language of Madagascar is not only glossarially allied to the dialects of the Indian Archipelago, but Humboldt (the most eminent authority on the subject) attests to its identity of construction, phonologically and ideologically; thus, these distant races, notwithstanding the insuperable barriers to direct intercourse, have had one focus of origin. To find this focus we are forced by the above arguments to seek for another region, and South Hindostan geographically stands alone as that possible common parent. Proofs of the archaic Negro blood and language of this region, already quoted, also lead to this supposition. If, then, in the first place, South India be accepted as the focus of such extensive migrations, we must see what proofs there are to support this new aspect.

Looking first to the earliest historical data that I have had access to, Marco Polo, writing in the 13th century, says of Madagascar, "Leaving Socotra, and steering a course south and south-west for 1,000 miles, you arrive at the great Island of Madagascar, which is one of the largest and most fertile in the world. The island is visited by many ships from various parts of the world, bringing assortments of goods, consisting of brocades and silks of various patterns, which are sold to the merchants of the island and bartered for goods in return, upon all of which they make large profits. The vessels that sail from the *coast of Malabar* (South India) for this island, perform the voyage in twenty to twenty-five days, but in their returning voyage are obliged to struggle for three months, so strong is the current of water which constantly runs to the southward."

Thus there seems, prior to the advent of the Europeans, to have been constant and intimate intercourse between Madagascar and South India, and that by well equipped merchants and navigators, for he (Marco Polo), in the same chapter, speaks in high terms of respect of their "mariners and eminent pilots." No small compliment this to their skill and enterprise, when issuing from the pen of one of the most renowned travellers going forth from Venice in the height of its power and splendour.

Independent of the above authority, the natives of Malabar and Coromandel have been known from time immemorial to be skilful navigators, and whose voyages, while extending westerly to Madagascar, also reached easterly as far as Java, Bali, and Ternati. Their system of docking vessels, sometimes exceeding three hundred tons in burden, and raising them high above the influence of the tide, has even claimed the praise of the Anglo-Saxon engineers of modern times—not only for the simplicity of the process, but for its high effectiveness and trifling cost.

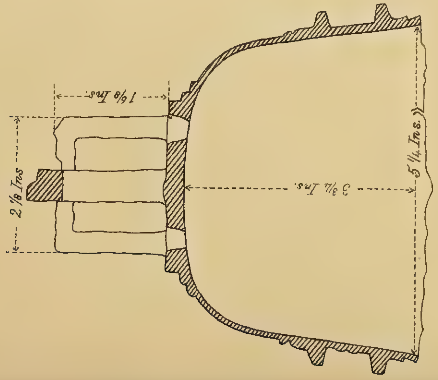
I may here now notice a material proof of connection between South India and New Zealand in the Tamil bell belonging to Mr. Colenso, F.L.S., and found by him in the interior of the North Island. The owner informs us that the relic has a history, so I trust he will have it duly recorded. When I first saw it displayed in the New Zealand Exhibition of 1862, I must confess that I looked upon it with feelings of interest amounting almost to enthusiasm, so much so that, with the permission of the owner, I had the same photographed, and copies of which were forwarded by me to various parts of India. The photograph, when shown to the Klings or Tamils, was at once recognised by them as exhibiting the upper part of a ship's bell, such as is commonly used by them at the present day, and I had translations of the inscription returned to me—one from Ceylon, by the favour of Mr. Edward Cargill, the other from Penang, by favour of a lady friend in that settlement; both gave the same translation, viz., Mohoyideen Buks—ship's bell; and the Crannies or Tamil writers of Penang favoured my friend with what they termed to be the modern written language, thus implying that the character of the specimen was ancient. On examining both it is seen that the ancient inscription has twenty-three letters, the modern twenty-one, while there is great difference in the forms of several of the letters, the modern being inclined, and the ancient having no punctuation. The Ceylon Crannies declared the grammar of the inscription to be bad, but may not this be owing to the obsolete style. The bell had been beautifully cast, so no doubt the best language of the times would be engraved on it. For instance, let us select two or three sentences of the good old English from Chaucer, and judge what a modern schoolmaster would think of them. "Bet is (quod he)" "Ne shud he not have daunted" "For al so siker as cold engendereth hayle." These sentences, as they stand, would certainly be declared to be bad English. The style of letters also differs as much as old English does from the modern. When exhibited the bell had all the appearance of being

FAC-SIMILE OF INSCRIPTION ON BELL, ½ size.

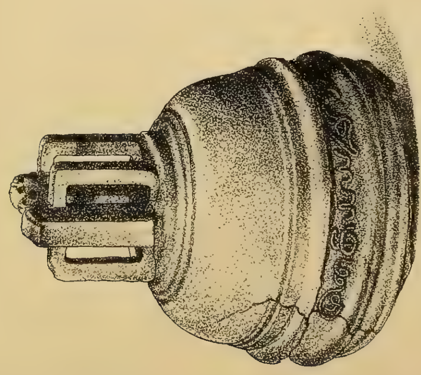
SAME IN TAMIL AS NOW WRITTEN IN PENANG.

முகைய்யத்தீன் பாகஉ டையகப்பல் மணி

TRANSLATION. MOHOYIDEN BUKS SHIPS BELL.



SECTION



UPPER PORTION OF AN

ANTIQUE TAMIL BELL.

(see page 40.)

J. Buchanan lith.

an ancient casting, so might easily have been brought from Tongataboo by the first Maori immigrants, as noticed in the preceding part of this paper, and the great expansion of the South Indian navigation prior to the advent of Europeans on the scene would favour this view. At the same time, as no doubt the vessels of the natives of India were not only captured in great numbers by the Portuguese, Dutch, English, and Spanish, but used by them within these last three centuries, the wreck to which the bell had belonged may have been navigated by any of these natives, and been cast away on the shores of New Zealand. The degree of interest which the Tamil bell brings to the subject before us must evidently rest in its age, and of this we yet have too little evidence to warrant strong opinions. Under the eye of a learned and expert numismatologist of Indian experience, such as Prinsep, the relic would have its value ultimately and correctly defined. If it proved to be as ancient as I suppose it to be, then it would have an intimate connection with the migrations of the Maori, and so hold a very high value.

I would now ask attention to a map of the primary era (Map II.) which defines the three main divisions of mankind in their special areas. Humanity may be likened to clouds on the face of the earth, having different colours; where the clouds intermingle, the colours graduate; where one cloud overshadows the other, then the latter disappears. The dark colour shows the original boundary of the Negro division, the yellow that of the Caucasian, and the red that of the Mongolian. For the sake of perspicuity, we must now call South India or Hindostan by its ancient name of Barata; the south point of India beyond the Ganges in like manner Tamasak; and also South China, Manji. The influence of the Arians and Thibetans on south coastal regions has already been shown on an originally Negro population, and the wide expansion of a language whose basis was Negro has also been shown, extending from Barata to Madagascar on one side, and to the Moluccas on the other. Under the ethnological experiences already detailed, what power could have given to the Negro so wide an expansion? The power is not in himself, for he has never been known to increase beyond the limits of a petty and disjointed tribe. The Barata expansion can only be ascribed to the first infusion of the energy drawn from Central Asia, and from whence there has been a constant flow, or tides of migration, if they may be so called. The Negro controlled, propelled, and directed by such infusion, now named the Barata, was then quite capable of issuing forth from the teeming plains of his native country (always exuberant of life), and planting his race and language east and west amongst a sparser and simpler cognate people. So wide an expansion as that mentioned would be the work of centuries, and is properly called the primary or opening era—the age when the Negroloid Barata was permitted undisturbed to obtain the privileges of civilization—that is, to overrun and extrude other less expert nations of his own colour.

I have already shown that the focus of the original energy could have been in none other than Barata. Tamasak, the only other possible point, has always, owing to unfertility of soil, had a sparse population.* But as ages rolled on, so circumstances altered—the ever restless waves of migration continued their flow from the regions of Aria and Thibet, and ultimately absorbed the Barata on his own soil, expunging his race and language. Thus, the link between the east and west branches of a great aboriginal race was broken.

We must now look at the map of the secondary era, which shows (see Map III.) the clouds of the Caucasian and Mongolian races to have extended themselves, descending on the southern coast line of Asia and the Indian Archipelago, mixing with or obliterating the dark shadow of Negro races. The Thibetan, Arian, and Semitic races have overspread Hindostan and Arabia, and the Mangians are occupying the islands. Thus, at the commencement of the secondary era, we find the western Baratas cut off in Madagascar, where we may now leave them, and have our attention engaged solely with the eastern migration. These, also, are cut off from the parent focus, and now extend themselves from Tamasak to Ternati, the latter point being, probably, the original extent of their expansion. Beyond this, as traders, they would have no incitement to go, for here were the coveted spices, nutmeg and clove, to be obtained, which, no doubt, ministered to the fastidious palates of the Barata heroes, as they do now to those of the modern epicures of Europe. Here, also, were to be had the gorgeous plumage of the birds of Paradise, which might deck the heads of the chieftains, as they now crest the imposing turbans of our noble duchesses. Thus for an age, it might be many centuries, we have the Barata maintaining his influence and race through the whole extent of the Indian Archipelago—following in his course the present great sea highway—and insensibly and gradually undergoing modifications of colour, physiognomy, and language, through the descent and migrations of the Mangians and Annamese on the same region—the modern process and effects of which have already been described.

We must now leave him for a little to notice a parallel movement, as it supports the argument by its collateral proof. While the eastern branch of the

* If other proof of this were wanted, it may be here stated that none of the tribes of the Indian Archipelago have been known now, or in historic times, to have extended their voyages west of Sumatra. All their trade westerly is, and has been, in the hands of the Hindoos, Arabs, or Europeans. Marco Polo, writing in the thirteenth century, also gives one or two facts in support of this view. He was one of an expedition engaged in carrying a Chinese princess to be married to the Shah of Persia, and in his voyage he notes the countries touched at. Amongst many others, he gives the names of Ferlak and Fanfur, which is the Arabic pronunciation of Perlak and Panchor, towns in Sumatra, thus showing that he derived his information from Arab navigators, and not from the Malays.

Barata was maintaining its existence easily amongst the rude and weak tribes of the Indian Archipelago, their parent state was being overrun, and almost extirpated, by energetic and bold northern races, now filling up Hindostan, and the Tamilian race gradually spread itself over South India. These, again, sent off waves of migration in the direction in which they would have least opposition, viz., as shown by Logan, along the volcanic chain of Sumatra and Java to Timor, whence they extended to Australia—the native languages of which yet maintain strong Tamilian affinities, while the physiognomy may be said to be identical with the lower castes of Dravirian. That the second systems of migration should have taken this direction may be accounted for in the barriers formed by the descending Mangian on the central part of the Archipelago. Also, a westerly migration would be opposed by the Semitic migrations in South Arabia.

Thus, our ethnographical inquiry proves two great eastern systems of migration out of archaic South India. The first we have traced to the eastern part of the Indian Archipelago, the second to Australia. We must now follow the further advance of the former, which we left in the region of the Moluccas. No doubt many succeeding migrations from the same fecund soil have taken place, the most notable amongst which is due to the Arian energy. Its effect on the glossaries of the Indian Archipelago has been already shortly noticed, and I would not have further alluded to it had an eminent authority, so often quoted (Crawfurd), not indicated the range of the influence of their language, even as far as New Zealand, by similarity in two words, viz., *apiti*, to join, and *taboo*, to forbid. These, I think, may be rejected, as *apet*, in Malay and Sanscrit, signifies to press or squeeze, and *tapa*, in Sanscrit, means religious penance; the analogy is, therefore, too remote to require consideration. No doubt the ruder tribes of the Indian Archipelago have the institution of the *taboo*, under the name of *pantang*, and their sacred spots are as numerous, though not so rigidly guarded, under the name of *berhalla*, at, or before which superstitious rites are enacted. But this only goes to prove the very archaic connection, which it is the business of this paper to illustrate.

The next question then is, how did the descendants of the Barata reach New Zealand? As the first step to answer this, we must have recourse to present observation in similar tribes and circumstances. To bring the propriety of this home to ourselves, I may cite the stone age of Europe as being over three thousand years bygone, but the stone age of New Zealand cannot be reckoned as more than thirty, for have we not the remains of chert saws, files, and axes, of almost yesterday's manufacture, in the interior of Otago, abounding over the valleys of Manuherikia and Taieri. Thus, by personal observation, we know the habits of the modern Maori who used them, and thus we may discern the habits and modes of life of similar races in pre-historic ages. Then, looking at the main causes that incite the dispersion of human families in the tropics (the zone of our enquiry), we have—1st. Slave-hunting expeditions. 2nd. Over-population. 3rd. Storms and drifting from loss of course. And 4th. Mercantile adventure. That the first is the most fertile source, may be surmised from observation in the Indian Archipelago in the present era. Most of the sea tribes are notoriously addicted to this pursuit, and pre-eminently so the Bajow and Illanuns, the former by petty expeditions, the latter by large fleets. Both range over the whole Archipelago, capturing trading vessels, and making raids on villages on the coasts, ravishing the inhabitants and carrying them off to distant parts for sale. This piratical system extends from one end of the Archipelago to the other, neither the people of Nias, on the extreme west, nor those of Timorlaut, on the far east, being beyond the reach of danger, and the inhabitants of which are transported to known marts. Even at the present day large importations of slaves are clandestinely made into the settlements of European Governments. Thus, the first cause of dispersion of races above-mentioned, at the present day, viz., slave-hunting, extends over 2,400 geographical miles of longitude, and 1,500 geographical miles of latitude. Both these races of habitual pirates and man-hunters are as unlettered as the Maori of New Zealand; that they are not cannibals, though unlettered, is saying little, as the Battas of Sumatra, notoriously given to man-eating, possess a literature and alphabet of their own.

The Illanuns, who are the more formidable of the two, construct vessels 91 feet in length, 26 feet in breadth, and 8 feet in depth. These carry ninety fighting men, and row forty oars on each side, and they advance with the speed of five to six knots an hour. Thus they can make over a degree a day, at which rate a voyage from Ternati, in the Moluccas, to Hawaiki, in the Navigators' Islands, could be made in forty-nine days, which is no longer, nor in any way more difficult than those annually taken in their usual pursuits. It may also be mentioned that the whole distance is studded with islands, seldom more distant from each other than a day's sail. These numerous piratical expeditions are often ended by shipwreck, or by the pirates settling on various salient points suitable for further operations. Thus, I have met individuals of the race settled on the east coast of the Malay Peninsula left there from one or other of these causes.

Very recent and modern European sentiment differs on this subject from the tropical; to the latter, the practice is innate and irresistible, and without a critical knowledge of the habits and condition of the people, their impulses are not to be understood. As it is, slave-hunting is the most powerful incitement to roving that I know—it is the same in nature and effect as sent our illustrious navigator, Dampier, all over the world as a pirate, and so much does he appear to have been imbued with the habit, that when he actually visited the haunts of these very Illanuns that I now mention, he did not consider the subject worthy of notice.

The next cause is over-population and wars of extrusion caused by this. The worsted party, or remnants of such, are too frequently the subjects of tradition or history to require illustration. Æneas fled to Latium; and even in New Zealand here we are not without examples, though humble and obscure. Thus Reko, well known to old Otago settlers, fled from the bloody inroad of Rauparaha, in his native place, Kaiapoi, to Tuturau, a distance of 240 miles—thus, with his family and followers, founding a new settlement in one generation, at a distance from his birth place of one-third the whole length of New Zealand. This is a very small distance compared with the modern migrations of the whites, yet to a savage people such are more difficult than passages by sea, and in the distance between South India and New Zealand via Hawaiki, supposing such was the measure of migrations in each generation, it would require only thirty-three to carry them; so counting a generation thirty years, the time would be 990 years. The traditions of the Maoris, as related in the "Story of New Zealand," by Dr. Thomson, set forth that they left Hawaiki owing to civil war causing a chief named Ngahue to flee the country. His accounts of the new country on his return incited others to migrate, and the names of the canoes that carried the expedition were even given. These were of the double construction now long disused; yet they were held in use till the time of Van Diemen, who encountered them in the year of his discovery of the islands, 1642, and they appear, from his account, to have been very formidable. The date of the first landing of the Maori in New Zealand, as given by Dr. Thomson, is about the year 1419.

The third cause, viz., storms, drifting, and loss of course, though very frequent, cannot have had the extensive influence that the two preceding have had, especially on distant points.

The fourth cause, viz., mercantile adventure, would not affect a rude tribe, though it may be mentioned that the Bugis extend their voyages from North Australia to Sumatra, a distance equal to that from Ternati to Hawaiki, and from the latter place to the extreme islands of Polynesia.

The only place in Polynesia in which American remnants have been found is Easter Island; these consist of huge images, but the people who constructed them have passed away, and have been succeeded by a race having a common origin with the Maori, Sandwich, and Marquesas Islanders, all referable to Hawaiki. The distance of the Sandwich Islands from Hawaiki, as the crow flies, is 1,440 geographical miles, and between which there are such frequent intermediate islands as to present favourable resting places, and for wooding and watering. Looking at the prevailing winds, however, the course taken by the native emigrants was most probably more circuitous, and as far easterly as the Marquesas, from whence the prevailing wind is favourable. On the subject of winds the natives are practically even more observant than Europeans; their notice of physical phenomena is also acute and discerning. Thus, the arrival of drift or pumice stone from windward, such as might occur from Owhyhee, on the groups to the leeward, would to them be sure indications of land, as I have known of the natives of the Indian Archipelago remark of the volcanic drifts of Tamboro, which were carried more than 1,000 miles distant.

The present piratical and mercantile voyages taken by natives of the Indian Archipelago, who are not more bold, and only a little more expert, than the Polynesians, will, I think, prove to the candid inquirers that the distances reached are in no manner insuperable, and as doubts by various writers have been cast on the possibility of the Southern Asiatic, though eminently maritime, finding his way in the course of ages to all parts of Polynesia, these doubts must evaporate when we call to recollection the tiny barks of early European voyagers, such as those with which Megallhaen, Drake, Cavendish, Frobisher, and others conquered space, and braved death in its grimmist forms of scurvy and starvation. Compared with the deeds of these heroes, the voyages that dispersed the descendants of the Baratas over the calm waters of the Pacific from island to island were but pigmy child's play. Then the ease of the accomplishment of the dispersion from point to point easterly supports the ethnological connection already given.

Looking, then, at this branch of our inquiry, we are surprised at the great periods required for the dispersion of barbarous races, as called for by the ethnographist, and whose periods are acquiesced in by the geologist, and were our conclusions made independent of these two sciences, that dispersion might well be begun and ended with the time spanned by written history.

As the knowledge of numbers is one of the first wants of mankind, they form one of the roots of his language; a table of these, extending over the area of the world that we have had in review, will, with the other branches of information, not be unacceptable. (See Appendix II.) It will be at once seen that Tamil, or modern South Indian, bears no resemblance to the numerals of any other of the languages, though, in the middle of the two extremes, the cause of which has been already explained. Then, taking Malagasi as a standard, it will be seen that nine out of ten in the Maori are radically similar, which is also the case with the languages of Enohee, Owhyhee, and Tahiti Islands; three out of five in Malicolo (Negro); nine out of ten in Papua, New Guinea; all identical in Mindanau and Lampong, while in modern Malay there are only five out of ten identical. Thus, as there is one law or principle in everything, even by this very confined system of comparison, it will be seen that the Malays, who are nearest to the Malagasi by position, are yet most distant by ethnology, and, on the contrary, the most distant tribes are yet, by language, the nearest—in other words, the earlier the migrations from the parent state, the nearer are the similarities, the more intimate the connection. Referring to New Guinea and Malicolo, this principle applies to Negro as well as mixed races. Thus, if we may be allowed to reason on the above narrow basis, there seem to have been periodical waves of migration emanating from the focus of energy—South India or Barata—the first and most distant wave reaching far Polynesia, the second Madagascar, Sumatra (interior), and Mindanau; a subsequent wave carried a new language to Australia, and between that and modern times the Sanscrit impulsion has been by far the most notable, in giving letters, arts, and science to a large portion of the Indian Archipelago.

That the archaic language of the South Asian Negro was highly vocalic may also be indicated by the following comparison, corroborative of the above principle. Thus, the most distant and earliest waves of migration have the fewest consonants in their alphabets, viz., Sandwich, six; Marquesas, seven; New Zealand, eight; Tahiti, nine; Awaiya of Ceram, ten; Malicolo, twelve; Tanna, thirteen; Malagasi, twelve; Wugi (Celebes), fifteen; Mindanau, sixteen; and Malay, eighteen. In other words, those races who have been nearest and most in contact with the modern or historic consonantal languages of Asia, have in the course of ages borrowed most.

In order to give an idea of the comparative time taken in the changes of roots of languages, I have drawn up a short vocabulary (Appendix III.) of the English and Saxon, in juxtaposition to the Malay and Maori, with intermediate tongues. I regret that I have not had access to a Sanscrit dictionary, so I have been only able to obtain three words of this. Over 800 years of separation has had no radical effect on the European languages, and of the Polynesian words given, with immensely longer separation, this might almost also said to be the case.* It will require further to be remarked that a modern English dictionary contains about 80,000 to 90,000 words, of which

* "Maori Races of New Zealand, by Wm. Colenso, F.L.S." "Its grammar is peculiar as compared with those of western languages, having neither declension of nouns by inflection, nor conjugation of verbs as there obtains, all such being clearly done by simple particles affixed or suffixed. Its singular is changed into the plural number by prefixing a syllable. There is no auxiliary verb "*to be*," but the particle *ano* often supplies its place. Every verb has a causative as well as active and passive meanings. Intensitives, superlatives, and diminutives, abound. It has double dual pronouns, and also a double plural, both of which may be termed inclusive and exclusive, allowing of great grammatical precision when speaking."

Such might be the description used in writing of the languages and dialects of the Indian Archipelago, of which the Malay is now the best known to the European.

not more than 3,000 to 4,000 can be attributed to Saxon origin ; while the Maori Dictionary contains 5,500, of which upwards of 100 are Malay.

Sanscrit and Hindu are the connecting links between European and Polynesian languages, but not as regards their roots, only abstract or secondary terms having been imprinted in the latter. Yet it is notable that the number *two* runs through all, and in several cases there are analogies. The strong analogies between Hindu and Greek cannot have escaped the notice of even those but partially acquainted with them.

Summing up the evidence, therefore, before us, we are led to conclude:—1st. That Hindostan, as well as the Indian Archipelago, at one time contained a Negro population. 2nd. That waves of migration issued from the South Peninsula, or Barata, east and west. 3rd. That no western emigration ever proceeded out of Tamasak, or the south part of the Peninsula of Malacca, or Sumatra, so as to affect Madagascar. 4th. That the progress of the Barata is traceable eastward by language to the Moluccas, of which Ternati is the principal settlement. 5th. That the race was modified in colour and physiognomy by the incursions of the Mangians and Anamese, but not in language. 6th. With the Moluccas as a basis, a stream of the mixed race flowed eastward, from island to island, over Polynesia—one branch finding its way to New Zealand, via Tongataboo. 7th. Barata, or South India, was, therefore, the Whence of the Maori.

APPENDIX I.

Hog.—The two most wide-spread words for hog in the Indo-Pacific Islands are:—1st. *Puaka, buaka, phua'a;* and 2nd. *Wi, wawi, wawe, bawi, a'bei, babi, baboi, babo, babu, bui, bawi, bafi, fafi, bavu.* The first is only found in Polynesia, and is of Thibeto-Indian origin—*phak* Thibet, *phag* Bhutan, Limbu, Kiranti, Mikir, etc.; *wok*, Kyen, Champhung, etc.; *wak* Magar, *vak* Naga, Garu; *piak*, Chepang. The second is the most prevalent in Indonesia, and is distinguished in all its variations from the first by the absence of the *k*, or its substitute *t*, and is found on the continent in Suahili (Africa) and Bonju (Trans-India) *wai.* Another African form—*babalade*, Fulah; *bule*, Serakoli;—apparently joins this to another root, and has also its direct Indonesian derivative in *bulali*, Buol. The same word, with the vibratory form of the second consonant, is found in Suahili, *burui*; to which corresponds the *burum* of Erob (Torres Straits), which is also the nearest of all the known Indonesian and African to the inverse form of the Malagasi, *lambu.* A fourth African form—*gru*, Suahili, *gulu*, Kwilimani, *korio*, Kwamamyl, *galgal*, Galla—appears also to have its Indonesian derivative in *gir*, Besisi (Malay Peninsula), *Kis*, Rajmahali, and in *kuis* in Batan. The Indian, *suar surka*, etc., Kambojan, *chur, cheruk, charuk*, is found in Viti, *sara*, and apparently in Java, Bawian, and Bali, *cheleng.* It results from the above that the hog is chiefly known in Indonesia by African names. That the prevalence of these names, and the existence of the animal in the wild state, prevented the permanent engraftment of the Thibetan on the Indonesian vocabularies, but that the Thibeto-Annamese, who proceeded to the eastward at an early period, carried the Thibetan name with them. I doubt not, however, that the Thibetan form will be found in the Archipelago also.

Bird.—The Malagasi *vorona, vurune*, has been preserved in the *burong, burung, urong*, of the Malay, Sandal (Borneo), and Sumba; but this, and other African words that previously existed, have in most of the languages been displaced by the *nok* of Ultrai, with the common prefix *ma* (*manok*), New Zealand Maori, *manu.* The few other Indonesian forms are also Thibeto-Indian, or Ultra-Indian. Thus, the *janga* of the Bima is the *jhango* of the Himalaya, Kiranti, and Mewar. The *chim* of the Besisi is the widely prevalent word found from the land of the Gonds in India, *sim* to Anam, *chim.*—"Jour. I. Arch.," Vol. IV.

APPENDIX II.

Comparison of Numerals.

English.	Madagascar.	Tamil, South India.	Malay, Malacca.	Lampong, Sumatra.	Mindanau, Philippine.	Papua, New Guinea	Papua, Malicolo.	Sandwich and Otaheite.	Easter Island.	Maori, New Zealand.
One	Esser	Uru	Satu	Sye	Isa	Tika	Tsi Kai	A Tahay	Ko Tahai	Tahi
Two	Rua	Rundé	Dua	Rowa	Daua	Roa	E Rai	E Rua	Rua	Rua
Three	Talu	Muno	Tiga	Talo	Tulu	Tola	E Rei	Toru	Toru	Toru
Four	Efad	Narlé	Ampat	Ampa	Apat	Fata	E Bats	A Haa	Haa	Wha or T'Fa
Five	Limé	Anjé	Lima	Lima	Lima	Lima	E Reem	E Rima	Rima	Rima
Six	Oné	Aré	Anam	Anam	Anom	Wama	—	A Ono	Hono	Ono
Seven	Heitu	Yulé	Tuju	Pitu	Pitu	Fita	—	A Heitu	Hidu	Whitu
Eight	Varlo	Urté	Delapan	Ualu	Walu	Wala	—	A Waru	Varu	Waru
Nine	Seve	Umbathé	Sambilau	Siwa	Siau	Siwa	—	A Eva	Hiva	Iwa or Iva
Ten	Furu	Paté	Sapula	Pulu	Sanpulu	Sang a Fulu	—	A Huru	Ana Huru	Nga huru *or* A nga huru

APPENDIX III.

Comparative Vocabulary.

English.	Saxon.	Latin.	Greek.	Hindu.	Sanscrit.	Malay.	Maori.
Two	Twa	Duo	Duŏ	Do	Dui, dwega	Dua	Rua
Five	Fif	Quinque	Pĕntĕ	Panch	—	Lima	Rima
Six	Six	Sex	Hĕx	Che	—	Anam	Ono
Ten	Tyn	Decem	Dĕka	Dus	—	Sapuloh	Ngahuru
I or me	Ic or me	Ego or me	Egō	Hum or me	Agam or me	Aku	Ahau
Fire	Fyr	Ignis	Pur	Aag	—	Api	Ahi
Fruit	Brucan	Fructus	Karpŏs	Pul	—	Buah	Huah
Hair	Hær	Pili	Thrix	Bal	—	Bulu-bulu	Huru-huru
Fish	Fisc	Piscis	Icthus	Muchili	—	Ikan	Ika
Drink	Drincan	Potio	Pinō	Pina	—	Minum	Inu
Stone	Stan	Lapis	Petrŏs	Putta	—	Batu	Kohatu
Louse	Lus	Pediculus	Ptheir	—	—	Kutu	Kutu
Load	Lade	Onus	Acthŏs	Bari	—	Pikul	Pikau
Hill	Hyl	Collis	Pagŏs	Par	—	Bukit	Puke
Sky	—	Æther	Aithēr	Asman	—	Langit	Rangi
Weep	Wepan	Lacrimare	Dakruō	Rota	—	Menan-gis	Tangi
Bury	Byrian	Humare	Thaptō	—	—	Tanum	Tanu
Split	Spillan	Fissura	Schizō	Pharo	—	Titta	Tata
Land	Land	Terra	Gē	Zumeen	—	Benua	Whenua
Deaf	Deaf	Surdus	Kŏphŏs	Byra	—	Tuli	Turi
Wife	Wif	Uxor	Gunē	Juroo	—	Bini	Wahini
Water	Wæter	Aqua	Hudōr	Pani	Udum	Ayer	Wai
Ear	Ear	Auris	Ous	Kand	—	Telinga	Teringa
Tree	Tree	Arbor	Dendrŏn	Jhar	Taru	Kayu	Kai

Art. II.—*Notes upon the Historical Value of the "Traditions of the New Zealanders," as collected by Sir George Grey, K.C.B., late Governor-in-Chief of New Zealand.* By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 16th September,* 1871.

In the following notes I propose to inquire how far the "Traditions of the New Zealanders," as collected and published by Sir George Grey, are to be relied upon, *taken by themselves*, in any investigations into the history of the race, either before or since the commencement of their occupation of these Islands. I think it desirable, however, before entering upon the proposed inquiry, shortly to discuss the nature of the rules by which we ought to be guided, in giving or in refusing credit to narratives of this kind in relation to a savage people, who possess no other materials from which we can arrive at a knowledge of their history. It may be assumed that a narrative of events which have not come under the actual observation of those to whom they are communicated, receives credence, amongst civilized people, in direct proportion, not only to the faith of the hearers in the truthfulness of the narrator, but also to their own experience as affecting the probable occurrence of the events narrated; and that, even then, the narrative has no higher value, so far as the actual knowledge of those to whom it is communicated is concerned, than a plausible fiction, against which they are either unable or unwilling to raise any presumptions, and which they accordingly accept, without further proof, solely on account of their faith and experience. But if the narrative in any degree conflicts with a knowledge on their part of circumstances which, in the ordinary course of things, must have so controlled the possible occurrence of the events narrated as to render the narrative at all improbable, then faith in the truthfulness of the narrator will not prevent doubt or disbelief, unless the alleged occurrences are supported by independent proofs sufficient to remove such doubts. Educated men refuse, in such a case, to accept any speculative theory, however otherwise plausible, until they have received some positive testimony in support of it. With uneducated people, on the other hand, with whom I should class such an intelligent savage race as the New Zealanders, the acceptance or rejection of such narratives rests on a different basis, and the credit given depends upon a different class of feelings. In such cases imagination takes an active part in inducing belief, and the delight with which narratives involving the marvellous are usually received, if the events narrated be sufficiently removed either in point of time or of distance, indicates not only a less critical judgment, but also that faith is but little controlled by the teachings of experience, and *that* even in cases which, to the educated mind, would appear very glaring and absurd. I take the following illustrations of these positions from Chambers' "Book of Days":—"Hasted, in his History of Kent, states that the popular belief as to the two female figures, side by side, and close together, impressed upon the Biddendon cakes, is, that they represent two maiden ladies, named Preston, who, at a remote period, were born twins, and in the close bodily union represented on the cakes; whereas he ascertained, beyond a doubt, that the impression in question was of quite recent origin, and that the figures were meant to represent 'two widows as the general objects of a charitable benefaction.' The story of the conjoined twins—though not inferring a thing impossible or even unexampled—must, says the writer, be set down as one of the cases of which so many are to be found in the legends of the common people, where a tale is invented, by a simple and natural process, to account for appearances after the real meaning of the appearances is lost. In this way, too, a vast number of old monuments, and a still greater number of the names of places, come to have grandam tales of the most absurd kind connected with them, as the history of their origin. There is, says the same writer, in the Greyfriars' Churchyard in Edinburgh, a mausoleum, composed of a recumbent female figure, with a pillar-supported canopy over her, on which stand four female figures at the several corners. The popular story is, that the recumbent lady was poisoned by her four daughters, whose statues were placed over her in eternal remembrance of their wickedness; the fact being that the four figures are those of Faith, Charity, etc.—favourite emblematical characters in the age when the monument was erected, and the object in placing them there was purely ornamental." But where intrinsic presumptions can fairly be raised against the truth of a narrative, however plausible it may be on a cursory view, we are entitled to require that it be supported by some independent and positive testimony, which shall raise it to the undoubted dignity of a truth. In this, however, lies the chief difficulty in dealing with the case of Traditions of the class now under consideration; for, it being manifestly impossible to support them by any positive testimony, we must be content to arrive at an estimate of their value, for historical purposes, by a careful and reasonable criticism, and then to accept them as narratives of fact in proportion, but in strict proportion only, to the probabilities by which they can be supported.

Under any circumstances, indeed, the origin and history of a savage race, possessing neither written nor pictorial records, must be a difficult subject to deal with, but more especially so when the race in question has, for some period of unknown duration, occupied a position of quasi-isolation from the rest of mankind. Those who have attempted to investigate the origin and history of the races which occupied Western Europe before the Roman conquests, have experienced and commented upon this kind of difficulty, and have found it impossible to arrive at any conclusions which can be treated as demonstrable, notwithstanding the material assistance derived from the accounts of ancient writers, the examination of monuments of various kinds, and the careful analyses which, of late years, have been made of the languages spoken by the descendants of those races. They have been obliged, in effect, to adopt a course very similar to that which I propose to follow in the present inquiry, and have ultimately accepted such only of the Traditions still extant, relating to the races in question, as do not conflict with probabilities still ascertainable. In this connection it must be manifest that the term "Tradition," applied to narratives of the class under review, at all events when presented to us in the character of historical tales, ought to have some definite meaning, and I shall assume that, for the purposes of criticism, they must be provisionally accepted as "oral records of past events," but that they are entitled to be received as such, only in so far as they bear the test of reasonable criticism, and can be supported by probabilities arising from the character, position, and circumstances of the people to whom they are applied. In the present inquiry I propose to act upon the rules which I have thus ventured to lay down, and so to ascertain to what extent the "Traditions" in question (using the term provisionally) may fairly claim to come within the foregoing definition.

It will have been observed by those who have perused these "Traditions," that the ancestors of the present race of New Zealanders are invariably represented as having migrated, at a comparatively recent period, from a place called "Hawaiki," the locality of which, however, is utterly unknown to the present people, and has, certainly, been equally unknown to their ancestors for very many generations. Now, if the migrations mentioned in the "Traditions" had taken place at periods so recent as those which are assigned to them, the loss of all knowledge of the actual position of Hawaiki by so enterprising a race as the New Zealanders, would be extremely singular, it appearing, if we are to credit the narratives in this respect, not only that the voyage from Hawaiki to these Islands and back again, had more than once been undertaken without hesitation, and performed without difficulty, but that on one occasion, at least, it had been successfully performed by persons who had not made it before, guided solely by instructions from a previous explorer. Still the fact of migration is insisted upon in all the narratives, and although, in our present state of geographical and nautical knowledge, the possibility of any such migrations as those which are narrated, is scarcely admissible, we should not, for reasons which will appear in the sequel, be justified on this ground alone in rejecting the "Traditions." A precisely similar difficulty presents itself in regard to the inhabitants of Madagascar, who, even in a higher degree than the natives of New Zealand, offer an exception to the ordinary rules by which we are guided in fixing the origin of Island populations. Madagascar lies at a distance of only 300 miles from the Eastern Coast of Africa, and, in accordance with observed rules, we should, in the absence of proof to the contrary, unhesitatingly assume that the affinities of its Flora and Fauna, including man, as well as of its language, would lie with those of that continent. But this is not the case as regards its people, who belong to the same branch of the Polynesian races, to which the inhabitants of these Islands, lying 130° to the eastward, and between the 35th and 40th parallels of south latitude, and the inhabitants of the Sandwich Islands, lying 155° to the eastward, and in the 23° of north latitude, also belong. Now the nearest land to Madagascar, which is occupied by people allied to its inhabitants, is nearly 3,000 miles distant, *without any intervening station*, making the peopling of that Island, if it was effected by migration, a greater difficulty than the peopling of New Zealand from the supposed centre of dispersion of the common race. The case of Madagascar has, in effect, been long treated as an ethnological mystery, and I think that the case of New Zealand will, when the "Traditions" now under discussion are reduced to their true value, be looked upon as involving little less difficulty. Comparing the manners and customs of the inhabitants of Madagascar with those of the New Zealanders, we find that the former are almost entitled to the position of a civilized people, and yet, so far as I have been able to ascertain, they possess neither historical records, nor monuments of any kind calculated to throw light upon the time or the manner in which they first occupied that Island. Baron Humboldt, brother of the great traveller, thus expresses his opinion on the subject:—"There is no doubt that the Malagasi belongs to the family of the Malayan languages, and bears the greatest affinity to the languages spoken in Java, Sumatra, and the whole Indian Archipelago, but it remains entirely enigmatical in what manner and at what period this Malayan population made its way to Madagascar." Mr. Ellis remarks, however, that it has been generally admitted that there is reasonable evidence that the vessels of the Polynesian races were formerly much larger than they are at present, and that we have sufficiently well authenticated accounts of voyages, long in point of duration and of distance, having been performed by people of these races in recent times, to raise a fair presumption of their former ability to spread themselves over even the widely extended regions which they now occupy. It would, indeed, be even more singular than the actual occurrence of such migrations, that a people occupying a country at such a distance as New Zealand from any other land, and so entirely out of the ordinary line of the navigation of the Polynesian races, should possess traditional accounts of such events, unless they were founded upon some long antecedent fact. But whilst this circumstance gives weight to the proposition involved in the "Traditions," that the ancestors of the present people migrated to these Islands from some part of Polynesia, then inhabited by the same race—and justifies us, more especially when taken in connection with the case of Madagascar, in accepting migration as a fact—it affords us no clue whatever to the locality of "Hawaiki," or to the probable date of the events in question. My own belief is, that the whole of the narratives based upon this recollection, are, so far as they pretend to give historical accounts of contemporaneous events, pure fictions; and that, so far as they represent actual events at all, they only represent comparatively recent occurrences, which have been engrafted upon the leading idea by some imaginative minds. Accepting migration, however, as a fact, I will now proceed to inquire to what extent we are aided by the "Traditions" themselves, in fixing either the locality of Hawaiki, or the probable dates of the various migrations referred to in them.

It is noteworthy, in regard to the latter question, that the migrations recorded are all supposed to have taken place within a comparatively limited time, and, in effect, the narratives in question, when reduced for the purposes of criticism, to their simplest elements, give the following as the sequence of the events leading to, during, and immediately after the alleged migrations.

1st. That the intention to migrate was formed in consequence of dissensions in Hawaiki, followed by long and sanguinary wars, in which the tribes to which the intending emigrants belonged had already suffered severely, and apprehended further disasters.

2nd. That the first person who undertook the voyage to New Zealand with the intention of migration was Ngahue, who went forth, as the story tells us, "to discover a country in which he might dwell in peace," and that "he found, in the sea, the North Island of New Zealand," which he named Aotea-roa, or the long day.*

3rd. That Ngahue returned to Hawaiki, and reported his discovery to his people, commenting upon the beauty of the country, and that a migration was at once determined upon, and soon afterwards undertaken.

4th. That, for the purposes of this migration, a number of canoes were constructed, amongst which the 'Arawa' and the 'Tainui' are specially mentioned.

5th. That, when the canoes were completed, the emigrants started for New Zealand—the 'Arawa' under Tama-te-Kapua; but the actual commander of the 'Tainui,' which was to have sailed under the charge of Ngatoro-i-rangi, is not mentioned.†

6th. That during the voyage the 'Arawa' and the 'Tainui' separated, the former narrowly escaping shipwreck.

7th. That the 'Tainui' arrived first, followed almost immediately by the 'Arawa,' and that both reached the East Coast nearly at the same point.

8th. That the immigrants, though in comparatively small numbers, soon separated, and, in different parties, occupied stations on both coasts of the North Island.

9th. That the whole of the northern tribes are descended from these immigrants.

10th. That this migration took place not more than 350 years ago.

I propose to examine the above points very much in the order given, and

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* The name of Aotea-roa is remarkable as indicating that the people by whom it was given had previously occupied a tropical country, in which, of course, the summer days were much shorter than they are in the latitude of New Zealand.

† The 'Arawa' evidently made the voyage only once, for we find that Raumati, one of the chiefs of the people who had come over in the 'Tainui,' and who had settled at Kawhia, hearing that she was laid up in a creek at Maketu, went across the island and maliciously burnt her.

I think we shall find that the proposition I have already laid down, namely, that the narratives in question are not entitled to be regarded as records of events contemporaneous with the original introduction of the New Zealanders into this country, is well founded.

I may at once say that I do not propose to offer any speculations of my own as to the locality of "Hawaiki." Those who are curious upon this subject may consult the pages of Dieffenbach, Colenso, Shortland, Ellis, Captain Erskine, and others who have inquired into the matter, and particularly the writings of the Rev. Richard Taylor, who has solved all difficulties in connection with the alleged migrations and the locality of Hawaiki, in a manner highly satisfactory to himself, if not to those who may be indisposed to put faith in speculations unsupported either by reasonable conjecture, or by the faintest testimony. In effect, a perusal of the writings of the several authors referred to (except, of course, the Rev. Mr. Taylor) will show that, apart from any other question touching the origin of the New Zealanders, the locality of Hawaiki is involved in great mystery and difficulty, and when I have called your attention to certain passages in the narratives under consideration, we shall find that they afford us no assistance whatsoever in solving the mystery or in dispelling the difficulty.

From an examination of the various legends, we find the following persons mentioned as principal actors in connection with the original discovery of these islands,—in the alleged dissensions and wars at Hawaiki,—and in the various migrations which resulted from these dissensions:—

Uenuku, a great *ariki* or high-priest.

Manaia, a chief, married to Kuiwai, the sister of Ngatoro-i-rangi, and supposed ancestor of the Ngatiawa tribes.

Houmai-tawhiti, father of Tama-te-Kapua, who commanded the 'Arawa' in the great migration.

Tama-te-Kapua, himself.

Ngatoro-i-rangi, who was to have had charge of the 'Tainui,' as before mentioned.

Ngahue, alleged to have found the North Island when searching for a new abode.

Kupe, a previous discoverer of the Islands, and claimed by the Muaupoko as their ancestor.

Turi, the supposed ancestor of the Wanganui tribes; and others, whom, for my present purpose, it is not necessary specially to refer to.

As I before mentioned, Ngahue was the first who visited New Zealand with the intention of making it his future abode, but we are informed, in the legend of the Emigration of Turi, that both islands had previously been discovered by Kupe (a contemporary of Turi), in a canoe called the 'Matahorua,' which, as well as the 'Aotea,' had been constructed by Toto, the father-in-law of Turi, from a log of timber obtained on the banks of a lake (I presume in Hawaiki), named Waiharakeke. This canoe (the 'Matahorua') had been given by Toto to his daughter Kumararotini, the wife of Hoturapa, Kupe's cousin. Kupe killed this cousin, and carried off his wife, and is said, whilst flying in the 'Matahorua' from the vengeance of Hoturapa's relatives, to have discovered the Islands of New Zealand, and to have circumnavigated them without finding any inhabitants.

A curious circumstance is mentioned in connection with this supposed voyage, namely, that near Castle Point the voyagers saw a huge cuttle fish, which fled before their canoe in the direction of Cook Straits, and which was afterwards killed by Kupe in Tory Channel. It is somewhat strange that, in the course of last year, accounts reached us of an enormous cuttle fish, nearly seven feet long, having been found dead on the beach near Castle Point.

When Turi, in dread of the vengeance of Uenuku, for having killed and eaten his infant son, determined to leave Hawaiki, he obtained from his father-in-law, Toto, the 'Aotea,' the sister canoe to the 'Matahorua,' and having received from Kupe, who, in the meantime, had returned to Hawaiki, full instructions (the singularity of which will appear in the sequel) how to reach New Zealand, started on his voyage, accompanied by some of his people in another canoe, named the 'Ririno.' We are told, in the legend, that the voyagers took with them, in the 'Aotea,' "sweet potatoes, of the species called Te Kakau, dried stones or berries of the Karaka tree, live edible rats in boxes, tame green parrots (I suppose the Kakariki), pet Pukekos *(Porphyrio melanotus)* and other valuable things."

In this account of the "'Aotea's' valuable freight," as it is termed in the legend, we have not only a very remarkable instance of early labours in acclimatization, but an invaluable clue to the identification of "Hawaiki," and it will certainly be an interesting surprise when some island is discovered in the Polynesian group, producing the Karaka, the Kiore, and the Pukeko, and in which the two former are used as food by its human inhabitants. Returning to our voyagers, we are told that they halted on their way at a small island named Rangitahua, where they rested for some time and refitted their canoes. During their stay at this island, they are said to have killed two dogs, (of which they are said to have brought several as being valuable stock, though not mentioned in the 'Aotea's' manifest), and one of which was devoted to the gods as a propitiatory offering, to insure the continued success of the voyage. It appears that when the ceremonies attending this sacrifice were ended, "a very angry discussion arose between Poturu (who had charge of the 'Ririno),' and Turi, as to the direction they should sail in. Turi persisted in wishing to pursue an easterly course, saying, 'Nay, nay, let us *still* sail towards the quarter where the sun first flares up;' but Poturu answered him, 'But I say nay, nay, let us proceed towards that quarter of the heavens in which the sun sets.' Turi replied, 'Why, did not Kupe, who had visited these Islands' [speaking of the Islands, it will be observed, in the present tense] 'particularly tell us, now mind, let nothing induce you to turn the prow of your canoe away from that quarter of the heavens in which the sun rises?" Poturu, however, appears to have prevailed, and having started from Rangitahua, the party followed his lead in the 'Ririno,' but soon came to grief, the 'Ririno' being wrecked. The 'Aotea' then changed her course according to Kupe's original instructions, and ultimately reached Aotea, on the West Coast of the North Island, Kupe himself having first made the land on the East Coast.

All the particulars of this voyage, and the acts of Turi and his people on their arrival at Aotea, are related in the narrative with great exactness and detail, but the sailing directions given by Kupe are evidently quite different from those which could have led him to the East Coast, and from those which were used by the 'Arawa' and the 'Tainui,' which, as will shortly be seen, arrived from the eastward. It would, indeed, be difficult to conjecture, from Kupe's sailing directions, the locality from which Turi and his people had started, no land lying to the westward or north-westward of New Zealand, except Australia, from which, it is very clear, the New Zealanders did not come.

Nor do some of the other circumstances stated with respect to this voyage add to the credibility of this particular narrative.

As I have before observed, the "Traditions" give us accounts of at least two independent discoveries of these Islands by voyages from Hawaiki, before any of the "migrations" took place, namely, that by Ngahue and that by Kupe, and we are led to believe that in both cases the discoverers found no difficulty in performing the voyage here and back. We are further told that the instructions for the voyage were so simple, that Turi and his people, as well as the commanders of the 'Arawa' and the 'Tainui,' were enabled, by following those instructions, to make their land-fall with as much certainty as the most experienced navigator of the present day could do. All this becomes the more astonishing when we know the great straits to which shipwrecked Europeans, even with the aid of the compass, have been reduced in attempting to reach land far less distant from the scene of their disaster, than New Zealand is from the nearest land which can possibly be looked upon as Hawaiki.

Turning now to the migration of Tama-te-Kapua, and those who accompanied him in the 'Arawa,' the 'Tainui,' and other canoes, we are informed, by the legends, that on the return of Ngahue to Hawaiki, he found the people all engaged in war, and that when he reported his discovery and the beauty of the country, some of them determined at once to emigrate to it. The chief of these was Tama-te-Kapua, son of Houmai-tawhiti, whose people had suffered severely in war with Uenuku, and who dreaded further reprisals for some unjustifiable acts of cannibalism which they had recently committed. Having constructed several canoes, amongst which the more celebrated were the 'Arawa' and the 'Tainui,' they left Hawaiki for New Zealand, and in due time arrived on the East Coast, the 'Tainui' first reaching the land. In consequence of disputes as to the ownership of a dead whale, the immigrants soon separated, some going to the northward, some to the southward, and some, crossing the portage at Otahuhu, proceeding to occupy the country on the western side of the Island. It is evident that the incident of the dead whale mentioned in the account of this principal migration, is the same which is referred to in the "Legend of the Emigration of Manaia," for we find the 'Toko-maru,' the canoe in which Manaia is reported to have made the voyage from Hawaiki, amongst those which were dragged across the portage at the time above referred to.

It is not necessary for my purpose to go any further into the particulars attending the alleged voyages, but I think I have shown, that although we may accept as a fact, singularly preserved, that the ancestors of the present New Zealanders came to this country from some other land, the accounts given of the incidents which occurred during the voyages are in themselves too improbable to justify our treating them, in any degree, as records of contemporaneous events.

I will now proceed to inquire into the date assigned by the legends to these migrations, and the result will, I think, strongly confirm the above position.

Amongst the persons who are said to have arrived in the 'Tainui,' with the great migration was Hotunui, who, after the separation of the people consequent upon the disputes about the whale, went and settled at Kawhia. Here he had a son born to him, named Maru-tuaha, whom, however, he never saw until the latter had reached man's estate, for it appears that on account of some false accusation of theft, Hotunui had, before the birth of his son, abandoned his family and his settlement at Kawhia, and gone to live at Whakatiwai, in the Gulf of Hauraki. Here he married a sister of a chief named Te Whata, by whom he had another son, whom he named Paka. When Maru-tuaha reached man's estate he went to seek his father, and on his way across the island, and when close to his father's new settlement, was met by the two daughters of Te Whata, the elder of whom at once fell in love with him. The account of the meeting of the father and son is very interesting, as well as that of the circumstances under which Maru-tuaha and his half-brother Paka afterwards married the two daughters of Te Whata, the former, however, marrying the younger and more comely of the two. Maru-tuaha appears to have settled at Whakatiwai, with his father, Hotunui, and to have engaged in wars with neighbouring people, in which he was successful, adding greatly to his father's territory. We then learn that Paka, the younger son of Hotunui, had a daughter named Te Kahureremoa, famed for her beauty, and whom her father was desirous of uniting in marriage to a son of the then chief of the Great Barrier Island, in order that the ultimate possession of that island might be secured for his own family. Now this project did not suit the fancy of Te Kahureremoa, who, with the caprice common to beautiful women, had chosen to fall in love with another, in the person of Takakopiri, chief of Otawa, whom she had seen and admired during a visit he had paid to her father, and whom she had made up her mind to marry. We are not informed, in the legend, whether any understanding on the subject existed between Te Kahureremoa and the young chief of Otawa, but it is probable that he had expressed some admiration of her during his visit, and that she felt pretty sure of her ground, for we find that when her father broke his wishes to her respecting the Barrier Island chief, she at once made arrangements for flight, and, accompanied only by a single female slave, actually fled towards Otawa. Having nearly reached this place, she fell in with Takakopiri, who was out upon a hunting expedition, and the result was that they were shortly afterwards married with great pomp and ceremony.

Now, Te Kahureremoa is said to have borne a daughter to Takakopiri, named Tuparaheke, "from whom," in the words of the legend, "in eleven generations, or in about 275 years, have sprung all the principal chiefs of the Ngatihaua tribe, alive in 1853." Adding the lives of Tuparaheke, of Te Kahureremoa, and of Paka, the son of Hotunui, who is said to have accompanied the first great migration from Hawaiki, to these eleven generations, we have only fourteen generations, or about 350 years ago, as the assigned date of that event.

It will thus be seen that the "Traditions," if entitled to be taken as narratives of events contemporaneous with, or immediately following the alleged migrations, would lead us to the following conclusions, namely :—

1st. That these islands were twice discovered, within a limited period, by voyagers from Hawaiki.

2nd. That upon the visit of Kupe, the supposed first discoverer, and who expressly reported that he had circumnavigated the islands, they were found to be uninhabited; whilst Ngahue, being silent on this point, may be said to have affirmed the same fact.

3rd. That the migrations consequent upon the reported discoveries of Kupe and Ngahue, though successive, all took place within a very limited period, and were not followed by any further arrivals from Hawaiki.

4th. That although the number of persons who emigrated was not large their increase must have been extraordinarily rapid, for we find, from the legends themselves, that very soon afterwards the people were settled in great numbers in various parts of both islands, and were often engaged in sanguinary wars.

Indeed those parts of the "Traditions" which purport to give accounts of events immediately subsequent to the migrations, depict the habits and customs of a long-settled people, well acquainted with the topography and with the natural productions of the country, affording, in my opinion, irrespective of any outside considerations, conclusive evidence that the whole of the tales, founded upon the bare recollection or tradition of a foreign origin, are in the nature of historical novels, in which a few real and comparatively recent events are made the ground work of a large amount of fiction, suited to the imaginative and speculative character of the people to whom they were addressed.

It is unnecessary for me to go any further into detail in criticising these tales in order to satisfy those who choose to peruse them with a reasonable appreciation of the questions which they purport to solve, that so far from solving these questions they are calculated either to check inquiry, or to envelope the matters in point, in deeper mystery and confusion. But whilst I do not hesitate in stating this opinion, we must not therefore assume that these tales are, or rather must necessarily continue to be, without value in connection with the history of the New Zealand race. Indeed, we are under great obligations to Sir George Grey for having recorded them, and if the same care is bestowed in preserving the legendary tales of other branches of the race in other places, we may possibly arrive, in the future, at some reasonable idea of the circumstances which led to their dispersion over the enormous area which they still occupy, and of the means by which that dispersion was effected.

And now, in closing these remarks, I cannot do better than refer those who are desirous of fuller information on the general question, to Mr. Colenso's valuable "Essay on the Maori Race" (published in the first volume of the *Transactions* of the New Zealand Institute), in which the foregoing arguments have been anticipated, but only in general terms, and which embodies opinions in which I entirely coincide; and I have no doubt that, even when all the facts which can properly be used in elucidating the mystery in which the origin of the New Zealanders, as a branch of the Malayan race, is at present shrouded, have been collected, and carefully and honestly digested, we shall be obliged to conclude, with the writer of that Essay, that the first occupation of these islands by the race whom we found here, is a very old story indeed.

ART. III.—*Notes on the Chatham Islands, extracted from Letters from Mr. H. H. Travers.* By W. T. L. TRAVERS, F.L.S.

[*Read before the Wellington Philosophical Society, 25th November,* 1871.]

I BEG to communicate to the Society the following notes, extracted from letters from my son, who is now on a visit to the Chatham Islands, and is engaged in collecting objects illustrative of their natural history. He started from New Zealand in the beginning of July, experiencing very severe weather on the passage down. During the voyage he saw considerable numbers of Mollymawks (*Diomedea melanoptorys*), Cape Pigeons (*Procellaria capensis*), and other kinds of Petrel, but very few Albatrosses. Unfortunately, the want of hooks prevented his obtaining any specimens of these birds. The vessel first made the land near Manganui, the residence of a German family (whose name he does not mention), by whom he was received and treated with great kindness. Their place derives its name from a picturesque volcanic hill, at the foot of which the house is built. This hill is clothed with bush on its lower slopes, from which it emerges, as it were, in nearly perpendicular crags, full of small caves and fissures. He searched these caves for traces of raised beaches, but observed none. He, however, found in them considerable numbers of birds' bones, but whether any of them are of extinct species does not appear from his letter. The beach near the house is strewed with dead shells, chiefly *Turbo Cookii*, *Elenchus*, *Iris*, a large *Triton* (the specific name of which is not given), with quantities of bivalve shells, which he describes as generally similar to those on the beach at Waikanae heads. Manganui is near Tuponga, which, before the Maoris' late departure from the Chathams for Taranaki, was one of their most flourishing settlements. This settlement appears to have been nearly destroyed by the tidal wave of 15th August, 1868, by which many of the huts were broken to pieces, the fragments being carried for a considerable distance inland. He next visited Wangaroa, the only harbour in the islands. It has the appearance of a small lake, the shores of which were formerly covered with bush, which has since been destroyed. In walking from Manganui to Wangaroa, he passed one of the places in which the peat (which covers a large part of the main island to a considerable depth,) has been on fire for time out of mind. Mr. Engst, by whom he was accompanied, pointed out where, thirty years before, the road crossed a place now occupied by a deep hole, resulting from the burning of the peat, and my son observed that, since that time, the entire space burnt does not exceed an acre in extent, showing how very slow is the process of destruction. Some of the burnt-out holes are now filled with water to the depth of ten or twelve feet. From Wangaroa he proceeded to Waitangi, where the late New Zealand convicts were kept. He expresses little surprise at their escape, and describes the so-called redoubt as a most miserable affair. In every respect the utmost looseness appears to have been observed in regard to them, and their moderation on the occasion of their departure is still a matter of wonder. The tidal wave did much damage to this settlement also, and the sea has since been encroaching rapidly on the narrow strip of level land between the hills and high water mark. He was fortunate enough to obtain here an ancient Moriori stone club, of which he has sent a drawing. These weapons are now extremely rare, only one or two having previously been obtained. He describes it as having been manufactured from stone found on the island, rather rough in finish and peculiar in form. He also obtained one of their primitive fish-hooks, made from the Pope's-eye bone of the seal. These implements are also now very rare. In the latter part of July he left the main island for Pitt's Island, which he reached on the 29th. Here he was most kindly received by Mr. Hunt's family. He noticed that wherever the tidal wave had impinged on the beach the old accumulations of sea-sand had been completely washed away, and that a great number of slips had since taken place in the hills adjoining the shore. At Waikari he found a considerable quantity of fossils and plant impressions, but of what age he does not mention. He has, however, collected largely, and no doubt these collections will enable the age and character of the deposits to be determined. In August he again visited the main island, chiefly for the purpose of inquiring into the traditions of the Moriori inhabitants. They are now very few in number, and he found that, with the exception of four or five old men, they were utterly ignorant on the subject of their origin. The information he obtained leads him to believe that the Morioris are a mixed race, descended from the union of Maoris, who had reached the islands many generations ago from New Zealand, with an aboriginal race by whom they were then occupied. These aboriginal people are represented as having been taller and more robust than the Maoris, but seeing that the latter are themselves a robust and powerful race, I think this may be doubted. As my son is collecting a large number of skulls from old burying places on the islands, no doubt some opinion on this point, and also as to any difference between the aboriginal and the mixed race may be arrived at. He also states that the present people represent that their Maori ancestors came originally to New Zealand from Hawaiki, wherever that may be; that when they came to the Chathams they brought with them the *kumera (Ipomœa tuberculata)*, and *karaka (Corynocarpus lævigata)*, but that the former did not thrive, owing to the moistness of the climate. He finds the *karaka* growing abundantly in the immediate neighbourhood of the various old settlements, but not in the general bush of the islands, which gives colour to the statement of its comparatively recent introduction. They further state that their

Maori progenitors arrived in two separate batches, at considerable intervals of time, and that it was not until the arrival of the second batch that wars and cannibalism were introduced amongst them. These habits, however, were not long persisted in, having been brought to an end through the wisdom of a chief, who saw that the inevitable result would be the extinction of the people. After this they continued to live in profound peace until invaded by the Maoris, as detailed in my son's account of his former visit. At the date of his last letter to me he was still in communication with some of the older people, and hoped to gather fuller accounts than have yet been published of their habits of life before the invasion. I may here mention that the report of Mr. Rolleston on the condition of the existing remnant of the Moriori race indicates that it had undergone great deterioration in physical character, as the result, no doubt, of close inter-breeding for many generations. My son's observations on the general fauna and flora are necessarily at present incomplete, but I gather from his letters that he expects to add largely to the number of plants collected on his former visit, especially amongst the cryptogams, although he has also found several new and interesting phanerogamous plants, all, however, closely allied to, if not idetical with those of New Zealand. As on his former visit, he finds it extremely difficult to preserve his specimens, owing to the dampness of the climate, and he had already lost two large collections of sea-weeds through mildew. He states that the undergrowth on both islands has been greatly destroyed by pigs and other animals, rendering it difficult to obtain specimens of ferns, etc., in anything like good condition, and leading him to suppose that many of the species will soon become extinct. Amongst the birds he has obtained are several which he believes to be new to our fauna. He particularly mentions a large and beautifully crested Cormorant, which he shortly describes as follows: Head and crest jet black; back black, except a patch between the wings, which is pure white; throat, neck, and breast also white, and over the nostrils caruneulated patches of naked skin. He also mentions a small bird, entirely black in plumage, and having much the habits of *Petroica albifrons*; a Dotterel, differing from the common Dotterel of this country, which he also found; a sea-bird, called by the whalers the "Blue Billy," the beak of which is singularly shaped, and of a blue colour, whence its trivial name; the Nelly *(Ossifraga gigantea)*, of which he has obtained some very large and fine-plumaged specimens, and several other birds which, though not new, are rare and interesting. He has obtained the skeletons of two species of seal, and one of a species of *Berardius*, of which a tooth is preserved in the Colonial Museum. He noticed a considerable number of peculiar fish, both marine and fresh water, and many beautiful molluscous animals, but was unfortunately short both of bottles and spirits for preserving them. He has not found any lizards on the main island, and has been assured, both by the European residents and by the natives that they had never seen any. He obtained one specimen at Pitt's Island, and saw several more. He is informed that these reptiles are numerous on the Star Keys, a small rocky islet some few miles from Pitt Island, which he hopes to be able to visit. He mentions, too, the probable existence of a native rat, mentioned by the Morioris, but has not yet seen any specimen. From the tenour of his letters I believe that his collections will add greatly to our knowledge of the fauna and flora of the islands, and may probably help in determining the period at which they were cut off from land communication with New Zealand.

Art. IV.—*Moas and Moa Hunters. Address to the Philosophical Institute of Canterbury.* By Julius Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 1st March,* 1871.]

Gentlemen,—When I had the honour to deliver to you last year the usual anniversary address, I earnestly hoped that you would elect for the next session another of your members as your President, but although I repeatedly acquainted you with my wishes in this respect, I had to give way to your urgent request to keep for this year the honourable position assigned me, for which, no doubt, many of the members of our Institute are, in many respects, much better qualified than I am.

In my address of last year, I pointed out how very desirable it would be to have scientific and technical education introduced among us to further the sound advancement of the Province; and the members of the Philosophical Institute, by petitioning the General Assembly, and by several other means, have shown their anxiety for the same object. Hitherto, however, no further steps have been taken by the authorities of the Province, with the exception of the opening of the Canterbury Museum in a building of its own; but I have no doubt that the desire for the progress of the colony, and the wise liberality of the Provincial Council will, in due course of time, bring about the desirable improvement and addition to our educational machinery.

In a country like ours, with its resources only partly developed, with a great variety of fine and useful raw material, with a large and daily increasing agricultural population, and with magnificent and never failing water power in every direction, every step tending to teach its inhabitants to make better use of their dormant resources is in the right direction, and New Zealand can only become great and truly independent when its growing population will have the means to obtain all those advantages which older countries now offer to their youth. Not that I wish for a moment to assert that scientific and technical education would offer a panacea for all shortcomings we have to contend with, because it is self-evident that many causes must combine advantageously to advance a nation, but it is one amongst others of which, I can truly say, that it has produced good results in other countries; and I am not going too far in stating that the advantages gained just now by one great nation over another, to the utter astonishment of the whole civilized world, have, in many respects, only been obtained by the daily improving system, of which scientific and technical teaching forms a portion, through which all classes of the German Empire have become more highly educated, whilst the French nation has remained comparatively stationary.

I should like to dwell somewhat longer upon this very important subject did I not fear I should weary you with it. I shall therefore devote the space of time allotted to me to some other subjects which have for a considerable number of years occupied my attention.

When a French savant in Amiens, Boucher de Perthes, announced to the world in 1847 that he had discovered, in the gravels of the valley of the Somme, rude flint implements, together with the bones of the mammoth, woolly rhinoceros, lion, cave bear, etc., an incredulous smile, if not more, passed over the faces of scientific men, geologists as well as archæologists. Both considered it a settled point, that the huge *pachydermata* which at one time inhabited the European continent, were so long extinct, and the human race of such recent origin, that it was impossible they could be contemporaneous. However, further researches in almost every European country have proved beyond a doubt that the French savant was right, and that these gigantic animals, although having been extinct for such a length of time that we have no means of calculating it even approximately, were nevertheless hunted and used as food by man, and were thus connected with the present age, showing conclusively that Europe has been much longer inhabited by the human race than was formerly supposed or admitted. If we turn now to the southern hemisphere, and especially to New Zealand, we have to overcome the opposite difficulty, it having been generally asserted that the extinct gigantic birds formerly inhabiting these islands, and doubtless representing the huge *pachydermata* and other gigantic forms of the same geological period in the northern hemisphere, have only recently become extinct, that there were no original inhabitants in these islands, and that the different species of *Dinornis* only became extinct by the exertions of a race of new comers, who, not many hundred years ago, landed as immigrants on the coast of New Zealand. With your permission, I shall devote the next portion of my address to these interesting questions, which are so full of suggestive matter.

The pre-historic people in Europe have been divided into four great divisions, according to the nature of the tools they employed:—1st. To the

Palæolithic period belonged those oldest inhabitants who used only flint and stone implements roughly chipped, without any attempt to polish them. 2nd. To the Neolithic, those who had already advanced a considerable step in art, and whose stone implements of well selected forms were more or less finely polished. 3rd. The Bronze age included those nations who used bronze implements. And lastly—4th. The Iron age, those who, after the introduction of iron, almost exclusively employed this ore for the manufacture of their weapons and tools. Europe has been for many centuries in the last-mentioned age, whilst New Zealand at the time of the arrival of the Europeans was only in the neolithic period, or that of polished stone implements, but there is ample evidence that the palæolithic period, and with it a people most probably belonging to a different race from the present native inhabitants of these islands, had passed away together with the different *Dinornis* species, long before the Maoris settled here. I shall endeavour to prove these propositions by laying before you the main evidence I have been able to collect, but I shall give you only the general results, leaving for some other occasion all the details in proof of my hypothesis, for which drawings, sections, and maps are necessary.

Our first step must be to inquire what geological evidence we have of the age of the Moa, or *Dinornis*, because if we are able to settle that important point satisfactorily, the age of the moa-hunting population, of which I shall speak more fully in the sequel, is also fixed with the same degree of certainty. Moa bones occur first in beds which have been formed during the glacier period of New Zealand, and the era immediately following it. The principal strata in which they are imbedded are either lacustrine or fluviatile beds, situated between or immediately above the large morainic accumulations which mark the former extension of our enormous glaciers in post-pliocene times. Some localities, such as the banks of the river immediately below Lake Tekapo, an old glacier bed surrounded by enormous moraines, have been always favourite resorts for obtaining moa bones in a good state of preservation. Similar beds in the neighbourhood of Lake Wanaka have also yielded them occasionally. Following down our large river courses towards the sea, these remains sometimes occur in their banks, either water-worn amongst the shingle, or in more perfect condition where they were preserved in silt, probably deposited in back-waters or similar localities. It is evident that an enormous period of time must have elapsed, first to enable these large shingle masses to be deposited, forming our large plains; and afterwards, when the rivers retreated to higher sources and dwindled to smaller watercourses, to be cut through to such an extent that their contents became exposed to a depth of several hundred feet. From the observations we were thus able to make, the conclusion has been forced upon us that these gigantic birds must have been able to sustain life over a long period, because the same species which occur in the lower lacustrine and fluviatile deposits are again found in the bogs and swamps, in the fissures of rocks, and in the kitchen middens of the moa-hunting race, which latter evidently mark the end of the *Dinornis* age.

As before observed, boggy grounds are also frequent localities for the preservation of moa bones, of which, amongst others, the comparatively small swamps near the Glenmark home station have yielded the richest harvest, and where, as it appears from observations made during my excavations, a great portion of the birds may have perished by becoming entangled in the swamp, either by accident, or, what seems to me more probable, from having been driven by fire or man into it in endeavouring to cross the valley. Another portion of the bones, together with driftwood of large dimensions, which had evidently been carried by floods into the swamp, were doubtless still connected by the flesh and ligaments when deposited, as no water-worn bones were found amongst them. Thus in some spots a complete leg of one specimen is found without any bones of the same individual near it, whilst the neck of another, or the *pelvis* of a third, each belonging to different species, lie close to it. However, I intend to lay before you at a future meeting a detailed account of the results obtained during the Glenmark excavations, for which hitherto more pressing work has not afforded me the necessary time. I may be permitted to state here only a few of the facts bearing upon the subject under review. The Glenmark Swamp lies in a hollow of the post-pliocene alluvium, skirting the hillsides. Its formation dates only from the end of the post-pliocene period, when the alluvial beds were already existing. The Glenmark Brook having afterwards cut a channel through these deposits, the whole mode of formation is well exposed. Close to the swamp in question, fluviatile deposits of a thickness of thirty feet, mostly silt and shingle, are laid bare, with here and there a small layer of peaty matter interstratified, pressed together by the superincumbent mass into a much smaller compass, and containing great quantities of moa bones. Thus we have here ample evidence that the different species of *Dinornis* existed already when the valley was first filled with *debris* brought down during the glacier period from the higher regions, and that they continued to flourish till not only was the valley filled with alluvium, but also, in their turn, the hollows in the latter became levelled by marsh vegetation, and by extraneous organic substances, such as drift timber and animal remains, washed into them by floods. Immediately below the Glenmark Swamp I obtained moa bones down to the water's edge of the brook, at least thirty feet below the level of the former, so that this alone convinces us that a long period must have elapsed between the formation of the first and last deposits. Higher up the little valley the excavations of the rivulet have been on a still larger scale. Two miles above the homestead, in a cliff about 100 feet high, water-worn moa bones occur near the water's edge, amongst the post-pliocene shingle; and in another locality, about twenty feet from the summit of the cliff, in a peaty layer, a nearly complete skeleton was obtained. The hill-sides above Glenmark station are covered with silt, looking like a lacustrine formation, which, in many cases, is also studded with moa bones. I may here observe that since my first excavations in Glenmark, and after the articulation of the different *Dinornis* skeletons in the Canterbury Museum, I have been so fortunate as to obtain single skeletons of almost every one of these species, some of them nearly complete, the bones lying still *in situ*, which, in every instance, have fully confirmed the correctness of these articulations. Moa bones are found abundantly in other localities, such as fissures or caves in limestone rocks, the neighbourhood of which appears to have been a favourite resort of the *Dinornis*, and the hills formed of drift-sands, which, from their nature, are well adapted to the preservation of the osseous remains of these gigantic birds.

We come now to another and more difficult question in connection with their extinction. It would appear, at least at first sight, that the different species of *Dinornis*, and even some of the largest, must have been living in comparatively recent times, owing to the fact that moa bones have been found on the ground, amongst the grass on the plains, or between rocks and *debris* in the mountains. I must confess I have never observed any in such positions, except when it could be easily proved that they had been washed out either by heavy freshes from older deposits in cliffs, along river beds, or by the disappearance of the luxuriant virgin vegetation, consisting of high grass or bushes, the soil having been laid bare, so that its upper portion would speedily be washed away by the rain water. I have been repeatedly informed that in the neighbouring province of Otago, some plains, when first visited by Europeans, were strewed with moa bones. This account reminded me of a passage in Darwin's "Journal of a Naturalist," pages 167 and 168, where he mentions having observed on the plains of Patagonia, near the banks of the Santa Cruz river, masses of bones perfectly intact, of the Guanaco or wild Llama, which, he supposes, must have crawled before dying beneath and amongst the bushes, as it were to a common burial ground; and that distinguished naturalist adds the following pertinent remark:—"I mention these trifling circumstances, because in certain cases they might explain the occurrence of a number of uninjured bones in a cave, or buried under alluvial accumulations, and likewise the cause why certain animals are more commonly imbedded than others in sedimentary deposits."

However, on further thought, I do not consider that a similar explanation could be offered for the occurrence of the moa bones on the plains, as I am led to believe that their exposure may be more properly traced to the agency of man, whose appearance in these islands, as everywhere else, must have brought about some very important physical changes on the face of the country. The burning or destruction of the luxuriant vegetation in valleys and on hills and plains, the diminution or even drying up of swamps, which formerly retained the produce of the rain or of the melting snow much longer than at a later period, have, as we could quote numerous instances to show, brought about many considerable alterations on the surface and drainage of the country. One of the principal results of this action is the occurrence of much larger floods than those formerly experienced, the waters running off far more rapidly than they did when the thick virgin vegetation, together with the swamps and boggy grounds, acted, as it were, like a sponge, retaining the moisture for a longer period. Another argument in favour of this supposition, that the *Dinornis* must have become extinct much earlier than we might infer from the occurrence of bones lying amongst the grass, is the fact proved abundantly by careful inquiries, that the Maoris know nothing whatever about these huge birds, although various statements have been made to the contrary, lately repeated in England; however, as this question stands in close relation to the age of the moa-hunting race, I shall leave it until I proceed to this portion of my task.

The testimony that moa bones have been found lying loose amongst the grass on the shingle of the plains, together with small heaps of so-called moa stones, where probably a bird has died and decayed, is too strong to be set aside altogether, or to be explained by the assumption that the bones became exposed, as I suggested before, through the original vegetation having been burnt so extensively. We are, therefore, almost compelled to conclude that the bones have in some instances never been buried under the soil, but remained lying on the surface where the birds died. I can, however, not conceive that moa bones could have lain in such exposed positions for hundreds, if not thousands, of years without decaying entirely. Even if we assume that the birds have been extinct for only a century or so, it is inconceivable that the natives, who have reliable traditions extending back for several hundred years, and of many minor occurrences, should have no account of one of the most important events which could happen to a race of hunters, namely, the extinction of their principal means of existence. At the same time, the pursuit of these huge birds to a people without firearms or even bows and arrows, although they might have possessed boomerangs or a similar wooden weapon, must have been so full of vital importance, excitement, and danger, that the traditions of their hunting exploits would certainly have outlived the accounts of all other events happening to a people of such character.

The Rev. J. W. Stack, with whom I repeatedly conversed upon this subject, fully agrees with me that the absence of any traditions places an almost insurmountable obstacle in the way of our supposing that the moa bones found lying on the plains or hillsides are of such recent origin as their position at first might suggest. Some moa bones, broken or otherwise injured, but excavated in good condition from the Glenmark Swamp, were left by me on the banks, where in a short time they became bleached by the sun. After a few years, when again visiting that locality, these bones had entirely disappeared, and only small decayed fragments indicated in a few places where the larger specimens had previously lain. Of course I am aware that these semi-fossil bones have not the same power of resistance as fresh ones, but nevertheless this rapid destruction ought to show us that, were they fresh bones, they would not resist for any number of years the agencies at work—heat and cold, rain and frost,—without becoming totally destroyed. I do not know how long the bones of cattle and horses remain on the plains exposed to the atmospherilies without becoming entirely destroyed, but I imagine they would not last for a number of years. On the other hand, if we assume that all the bones which became exposed had been subjected to the action of fire, and were thus in a calcined state, which would have prepared them to offer better resistance, I do not think that this could have preserved them for such a long period as we are obliged to believe that the *Dinornis* has been extinct. I may here add that at present moa bones and moa stones in the Canterbury plains are found only by digging ditches and ploughing, and that, as far as I am aware, no instance has occurred lately where they have been of superficial occurrence, so that the bones which were exposed sixteen to twenty years ago have all disappeared.

From the occurrence of moa bones amongst morainic accumulations, it might appear that the Moa existed in New Zealand only when the climate was different from that we at present enjoy in these beautiful islands, so much favoured by nature in this respect. In some other publications I have already treated of this subject, pointing out that at the present time in the morainic accumulations forming below the Francis Joseph glacier at the West Coast, and less than 700 feet above the sea level, the trunks and leaves of large pines and arborescent ferns are imbedded, together with the bones of *Apteryx*, *Strigops*, *Nestor*, and *Ocydromus*, from which the investigators of future days might conclude that these species had existed in a much colder climate than that of the West Coast of New Zealand at the present time. In the same way, having this interesting fact of the present day before us, we are debarred from believing that, from the former larger extent of the New Zealand glaciers, the climate was much colder in similar positions, as far as regards aspect, altitude, and general orographical features, than it is at present. If we look, for instance, at the country at the southern base of Mount Cook, between the Tasman, Hooker, and Mueller glaciers, the outlets of which form the Tasman

River, a luxuriant vegetation delights our eye, where certainly throughout the whole year the *Dinornis* would have found ample nourishment even close to the ice. I say so with more confidence, knowing that the locality referred to is now used as a ram paddock, always assuming that the sheep is not of a more hardy nature than those former inhabitants of the country.

Judging from the structural character of the different species of *Dinornis*, they must have inhabited the open country where such existed, and not the forest regions, where not only innumerable impediments to locomotion would have stood in their way, but where they also would probably have found little food suitable to them. In the term 'open' I include plains and hill sides in the low lands covered with grass, fern, tutu *(Coriaria ruscifolia)*, flax *(Phormium tenax)*, and cabbage trees *(Cordyline Australis)*, and the subalpine regions, with bushes—Spaniards *(Aciphylla)*, wild Irishman *(Discaria toumatou)*, and snow grasses. It has often struck me that to all appearance the greater portion of the luxuriant vegetation of New Zealand is of comparatively little service to the present fauna, whilst it would produce more harmony in the household of nature if we imagined that the seeds of the *Phormium tenax* (the New Zealand flax), of the *Cordyline Australis* (the cabbage tree), of the large species of *Aciphylla* (spear-grasses), the different species of *Coprosma*, and many other plants, had been at one time the favourite food of the *Dinornis*, whilst the roots of the *Aciphylla*, of the edible fern *(Pteris esculenta)*, and several other plants, might have provided an additional supply of food when the seeds of the former were exhausted. Moreover, I have no doubt that the different species of *Dinornis*, like those of the *Apteryx*, were omnivorous, so that they did not despise animal food, and thus lizards, grasshoppers, and other insects might also have constituted part of their diet.

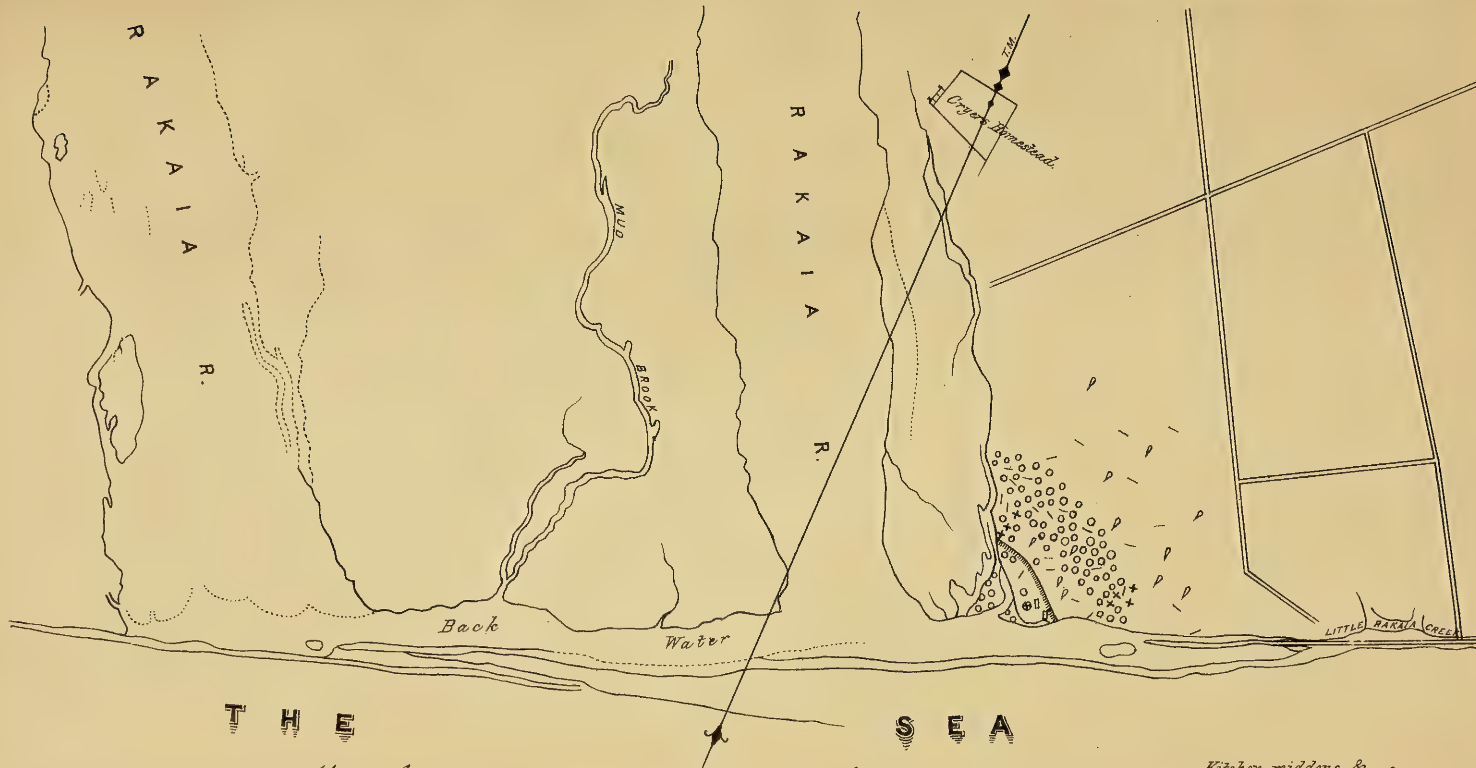
Another observation which I have been enabled to make convinced me that the *Dinornis* species remained generally in certain localities, being of stationary habits and not roaming over the country, and crossing rivers and mountains in quest of food. In collecting the crop-stones lying with the skeletons, I invariably observed that they must have been picked up in the immediate neighbourhood. Thus, to quote only a few instances. In the caves of Collingwood, all the moa stones are derived from the quartz ranges close by, in the Malvern hills from the amygdaloids of the same zone, and in Glenmark only from the chert rocks in the neighbourhood.

It has been the fashion to assert that the present native inhabitants of New Zealand, the Maoris, are the race who have hunted and exterminated the Moa, and there are even natives who declare that their fathers have seen the Moa and eaten its flesh. If such assertions could be proved, our researches would have been much simplified. It will therefore be my duty to examine the *data* upon which such statements rest, and to bring in my turn what I consider overwhelming evidence to the contrary, namely that the forefathers of the Maoris not only have neither hunted nor exterminated the Moa, but that they knew nothing about it.

The main authority quoted for the former assertion, that the *Dinornis* species are not long extinct, are the writings of Dr. Mantell, the illustrious geologist, who, in his various works, when speaking of the subject under review, gives his son's (the Hon. W. Mantell's) statements. Thus in "Petrifactions and their Teachings," London, 1851, p. 93, the following passage occurs :—"The Maoris, or natives, were acquainted with the occurrence of such bones long ere this country was visited by Europeans ; and traditions were rife amongst them that a race of gigantic birds formerly existed in great numbers, and served as food to their remote ancestors. They also believed that some of the largest species had been seen alive within the memory of man, and that individuals were still existing in the unfrequented and inaccessible parts of the country. They called the bird Moa, and stated that its head and tail were adorned with plumes of magnificent feathers, which were worn and much prized by their ancient chiefs as ornaments of distinction. The bones were sought for with avidity, and were used in the manufacture of lures for fish-hooks and other implements."

Again, Dr. Thompson, surgeon, 58th Regiment, in a letter to Dr. A. Smith, as quoted by Dr. Mantell, when writing of the discovery of several caves containing moa bones, speaks of the same subject, page 104 of the same work :—"During the month of September, 1849, Servantes, the interpreter to the General here, was told by a native that he had discovered a cave in which were many bones of Moas. I accompanied him in search of this place, and was rewarded by getting many curious specimens and several skulls with mandibles. The beak very much resembles that of the ostrich or emu. This cave is on the west side of the North Island, in the limestone formation which extends along the coast. The country around is wild, and there are many similar caves, which, we were told, also contained bones. The popular opinion is, that the country has been set on fire by an eruption of Tongariro, and that all the Moas fled to the caves for refuge, and there perished. From traditions and other circumstances it is supposed that the present natives of New Zealand came to these islands not more than 600 years ago. However this may be, that the Moa was alive when the first settlers came, is evident from the name of this bird being mixed up with their songs and stories. One of the bones I obtained bore marks of having been cut or chopped, perhaps to get at the marrow."

It is evident that the statements of such observant scientific men as Messrs. Mantell and Thompson deserve all attention and credence, the more so as both had such favourable opportunities to collect native traditions, and consequently



Map, shewing Moa hunter encampment at the Mouth of the Rakaia.

To accompany Dr Haasts papers on Moas & Moa hunters.

J.B. lith.

Printed at the Gen. Gov. Lith. Press.

it was generally considered an undeniable fact that the Maoris had not only been cotemporaneous with the *Dinornis*, but had hunted it, and had also reliable traditions about it.

When I first observed the geological position of the moa bones *in situ* I began to doubt the accuracy of such statements, because it became clear to me that the huge birds were the representatives of the gigantic quadrupeds of the northern hemisphere in the post-pliocene period. I mean to say that they have lived as far back from the present as the mammoth, the rhinoceros, the cave lion, and cave bear, the bones of which are found in similar deposits in Europe. And as even the highest civilized nations in Europe have no traditions of the occurrence of these huge animals, it seemed to me highly improbable that a far inferior race, having advanced only to the state of those people representing the neolithic period in Europe, could have retained traditions extending over such an immeasurably long period. The discovery of a fossil bone of *Dinornis Australis* in New South Wales, also in post-pliocene beds, and resembling very much the *Dinornis crassus* of New Zealand, offers additional evidence of the great antiquity of these huge birds.

Being occupied in examining the contents of the large encampment of moa hunters at the mouth of the Rakaia, I applied to several of my friends in the Colony, who, by their knowledge of Maori lore, had ample opportunity of forming an opinion upon the matter. I wrote to the Rev. William Colenso, who, as far back as 1838, or 33 years ago, began to devote much attention to the subject, and requested his assistance. He kindly forwarded to me a copy of the "Annals and Magazine of Natural History" of August, 1844, which contains an exhaustive paper, written by himself, bearing the title "An account of some enormous fossil bones of an unknown species of the Class Aves, lately discovered in New Zealand," and with which I was not previously acquainted. In this paper the author gives an excellent description of the moa bones in his possession, assigning to them their correct place in the classification of the avifauna. Mr. Colenso also relates in the same publication the principal traditions of the natives respecting the Moa—that there was still one specimen in existence which lived in the Wakapunaka mountains, guarded by two Tuataras, gigantic lizards; that it was like a huge cock with the face of a man; that it lived on air and had wattles. The author, from the latter assertion, is inclined to believe that the Maoris, of Malayan origin, had still some tradition of the Cassowary, the only struthious bird having fleshy appendages. I cannot refrain from giving from that important paper the following passages bearing upon the subject, page 89:—"From native traditions we gain nothing to aid us in our inquiries after the probable age in which this animal lived; for although the New Zealander abounds in traditionary lore, both natural and supernatural, he appears to be totally ignorant of anything concerning the Moa, save the fabulous stories already referred to. If such an animal ever existed within the time of the present race of New Zealanders, surely to a people possessing no quadruped, and but very scantily supplied with both animal and vegetable food, the chase and capture of such a creature would not only be a grand achievement, but one also, from its importance, not likely ever to be forgotten ; seeing, too, that many things of comparatively minor importance are by them handed down from father to son in continued succession from the very night of history. Even fishes, birds, and plants (anciently sought after with avidity as articles of food, are now, if not altogether, very nearly extinct), although never having been seen by either the passing or the rising generation of aborigines, are, notwithstanding, both in habit and uses, well known to them from the descriptive accounts repeatedly recited in their hearing by the old men of the villages." And again, further on—"In fact, unless we suppose this bird to have existed at a period prior to the peopling of these islands by their present aboriginal inhabitants, how are we to account for its becoming extinct, and, like the Dodo, blotted out of the list of the feathered race ? From the bones of about thirty birds found at Tauranga in a very short time, and with very little labour, we can but infer that it once lived in considerable numbers ; and from the size of those bones we conclude the animal to have been powerful as well as numerous. What enemies then had it to contend with in these islands, where, from its colossal size, it must have been paramount lord of the creation, that it could have ceased to be ? Man, the only antagonist at all able to cope with it, we have already shown as being entirely ignorant of its habits, use, and manner of capture, as well as utterly unable to assign any reason why it should have thus perished. The period of time, then, in which I venture to conceive it most probable the Moa existed was certainly either antecedent or cotemporaneous to the peopling of these islands by the presentrace of New Zealanders." In his masterly essay "On the Maori Races of New Zealand," Mr. Colenso briefly alludes to the same subject, affirming that he has not changed his opinion concerning the age of the *Dinornis*, and that he has never been able to obtain any reliable traditions concerning it.

The Rev. James W. Stack, who has also made careful inquiries in both islands, has come to the conclusion, after sifting the so-called traditions of the aborigines, that beyond the fact that the Moa was a bird, and that its feathers resembled those of the Kiwi or *Apteryx*, the Maoris do not possess any information about it. They, moreover, attribute its extinction to a great fire, called the fire of Tamatea, which they assert swept over the Canterbury Plains about 500 years ago, the smouldering remains of which, as they think, may still be seen in the gorge of the Rakaia. The so-called smouldering remains are, however, seams of brown coal in combustion, and this fact alone proves the legendary character of the tradition. The proverb "He moa kaihau" (a wind-eating moa) is the only trace which Mr. Stack can discover in the sayings of the ancient inhabitants, relative to the existence and habits of these birds. If it is true, as I have been informed, that it is a favourite habit of the African Ostrich to stand with its beak wide open towards the wind, such a coincidence in the habits of two allied terrestrial birds would be very curious, and would clearly show that although all other traces have been lost, the proverbial saying has outlived all past generations. Moreover, it would compel us to believe in its correctness. We might, however, trace it to the Cassowary, as suggested by Mr. Colenso in respect to the wattles.

Mr. Alexander Mackay, Native Commissioner, who enjoys excellent opportunities of obtaining accurate information upon this and other subjects in reference to the natives, has also made diligent researches. This gentleman informs me that there is not a single tradition amongst the natives respecting the Moa; in fact, that they know nothing about it. It seems evident to me that the present native race, unable otherwise to account for the huge remains of the Moa found sometimes washed out from the post-pliocene alluvium, occurring in caves, etc., had recourse to miraculous legends. On comparing the Moa bones with those of other living species of birds, they undoubtedly found that in their principal characteristics they most resembled those of the Kiwi or *Apteryx*, which were sometimes mixed with them, and which fact may account for the tradition concerning the similarity of the feathers. But a still greater proof of the long extinction of the *Dinornis*, is the fact that all early voyagers, who had ample opportunities for observation, who assiduously collected specimens of the fauna and flora of both islands, and noted down carefully the traditions of the natives, never allude to the existence of the Moa, nor do they speak of its osseous remains. Thus I looked in vain through the accounts of the three voyages of Captain Cook, of those of Captain Vancouver, Admiral d'Entrecasteaux, and of Captain King, but in all of these no trace of such traditions can be detected. Captain Cook, that admirable observer, who gives us such a faithful account of the animal life of New Zealand, made inquiries through his interpreter, Tupia, during his first journey, concerning the native traditions; on his second visit he obtained further intelligence from a native chief in Queen Charlotte Sound, which is of such interest that I wish to transcribe it. Thus he says, in the "Voyage to the Pacific Ocean," vol. i., p. 142: "We had another piece of intelligence of him (Tawaihurua), more correctly given, though not confirmed by our own observations, that there are snakes and lizards there of enormous size. He described the latter as being eight feet in length, and as big round as a man's body; he said they sometimes seize and devour men, that they burrow in the ground, and that they are killed by making fires at the mouths of the holes.

We could not be mistaken as to the animal, for with his own hand he drew a very good representation of a lizard on a piece of paper, as also of a snake, in order to show us what he meant." I cannot stop now to inquire what animals Tawaihurua may have meant, but it shows us clearly that he was an intelligent man, whose drawings were so well executed that the animals could be readily recognized. Queen Charlotte Sound, being in easy communication with the more southern portion of this island, and in close proximity to the Wairau Plains, where moa bones have been found repeatedly, must we not assume that the natives of those days had no traditions of the Moa, or this chief would certainly have spoken of it, and drawn it also, as the most wonderful animal of New Zealand? In any case, this is certainly very important negative evidence in support of my opinion.

Proceeding now to an examination of the traces left by the moa-hunting population, I believe that it was also the Hon. W. Mantell who first drew the attention of scientific men to the fact that there was ample evidence to prove convincingly that man had been co-temporaneous with the *Dinornis.* He describes the occurrence of small circular beds of ashes with charcoal very ancient, and such as are generally left by the native fires that have long been burning on the surface. They contained calcined bones of men, dogs, and Moas. Fragments of obsidian, flint, two fishing-line stones, and a small whalebone *mere* were also dug up. The Maoris informed Mr. Mantell that the sand-flat of Te Rangatapu, where he obtained these relics, was one of the first spots on which their ancestors located.* A similar account is given by the Rev. J. Taylor, who has examined some localities in the valley of the Wanganui river abounding in old cooking places. If further investigations of these interesting localities would prove beyond a doubt that really the bones of man, moa, and dog, with flint chips and true Maori implements, occur together, and have not been mixed up accidentally, the present indigenous race having chosen the same favourable spots for their camping grounds as the moa hunters did before, the question, as far as the Northern Island is concerned, would soon be settled. However, I venture to assert that more careful and systematic researches than Mr. Mantell, owing to the troublesome interference of the natives, was enabled to make, would prove that the Moa kitchen middens are quite distinct, and that where Maori ovens with indications of cannibalism occur, they have been formed over, near, or within those of the older race. In the course of this address it will be my duty to show why I believe that such a result would be gained, and which would confirm my observations made in this province upon the subject.

Another important question which remains still to be answered is, whether the human skeletons found amongst the sandhills, which, by the shifting of

* "Petrifactions and their Teachings."

the sands, become exposed, as well as those from ancient burial grounds, are all of Maori origin, or if, at least, some of them do not belong to a race distinct from the present aborigines. Unfortunately, I never found any human bones in or near the moa hunters' encampment, to which fact I shall again call your attention in the course of this evening, otherwise they would have offered valuable material for comparison. However, one authority, and that one of the highest we could desire, has already pronounced that some of the skulls found in these sandhills are not derived from the Maori race. In the year 1868 I sent to Professor Dr. C. G. Carus, the President of the Imperial German Academy of Naturalists, two skulls, which I considered belonged to the Maori race, and which were obtained from some sandhills near the Selwyn. That eminent physiologist, upon examining them, informed me that I must have made some mistake, as these skulls could not be of Maori origin, but must have belonged to some other race. Unfortunately, before my answer arrived in Dresden, the illustrious octogenarian had in the meantime passed away, but I may expect to receive shortly, from some other reliable source, drawings of these two skulls, together with measurements, descriptions, and a careful determination of the question as to which human family they approach nearest in their principal characteristics. As Mr. Alexander Mackay, the Native Commissioner, informed me, the natives assert that in the interior of the North Island a race had existed called Maero, which they described as wild men of the woods, and somewhat like Australians. According to the Wellington natives, a member of this race should have lived in a comparatively recent time on the island of Kapiti. It is foreign to the scope of my address to enter upon a discussion as to the manner in which these islands have been peopled. This has been done already by eminent men amongst us, as well as by distinguished *savants* in Great Britain, Germany, France, and America, without, however, deciding the question; on the contrary, the matter remains more uncertain than ever, and it will be long before it can be definitely settled.

My next object will be to ascertain how far back we can trace the occurrence of polished stone implements, which, in this province at least, the moa hunters did not appear to have become possessed of. Passing over the well-known localities, such as old Maori pahs, battle-fields, burial and camping grounds, these tools have been found under the roots of huge trees, and in cutting deep drains through bogs in the Wellington province, which may be taken as a proof of their great age. In this province the plough has disinterred many on the plains, buried to a depth of several inches with soil or silt. But another instance of still greater antiquity has come under my notice, namely, the discovery of a well-polished stone adze, together with a grinding stone, at the West Coast, about fifteen feet below the undisturbed surface, over which a luxuriant pine forest was growing at the time. In a paper published in the *Transactions* of the Ethnological Society of London, I have described these interesting specimens of pre-historic human workmanship, which, two years ago, I had the satisfaction of laying before you, accompanying their exhibition by a verbal description. I shall therefore not repeat what I then stated, but proceed to the description of the principal locality in which I discovered a moa-hunter encampment of considerable extent.

A great and almost insurmountable difficulty in the way of the foot traveller in this island is the presence of large torrential rivers, coming down from the central chain, since they can only be crossed by him when they are very low, over long fords, and even then not without considerable danger. It is therefore not surprising that the aboriginal population should have searched from the earliest times for any spots where the necessity for crossing on foot could be dispensed with. They observed that all these rivers, before entering the sea, expanded into still-water lagoons, often of considerable extent, which they could easily cross with canoes, or on rafts, or even by wading, and thus the native paths, of which in many localities the traces are still quite distinct, were always found upon the coast. The Rakaia being one of the most dangerous of these rivers, it is natural that the northern side of the river, near the sea, should always have been a frequented spot. Here, also, the lagoon extends along the coast, affording the natives a secure resting-place for their canoes or other means of conveyance, and, at the same time, a favourable fishing ground. Thus it was to be expected that we should find near the mouth of the river numerous remains of Maori occupation in the form of ovens, signs of former huts, and occasionally a Maori implement; but this locality, on being more closely examined, proved to be of still greater interest, having at one time been the camping ground of a moa-hunting population, and covering an area of more than fifty acres. It is to this remarkable encampment that I shall devote the next portion of this address. However, before proceeding, I wish to offer a few general remarks on the topography of the spot, in order to show how well this pre-historic people had selected their habitations.

Between the mouth of the Rakaia and Banks Peninsula, and even as far as Sumner, all round the western foot of that volcanic system, a succession of lagoons, of which Lake Ellesmere is by far the largest, swamps and deep boggy creeks exist, through which, in former years, before the original vegetation was destroyed and better drainage introduced, this portion of the country must have been kept in an almost impassable state. Looking over the country between Banks Peninsula and the mouth of the Rakaia, we observe, first, Lake Ellesmere, covering a large portion of that region, and between it and the river several lagoons, surrounded by impenetrable swamps, from the outlets of which, and from several springs a little higher up the plains, a creek is formed, now called the Little Rakaia, which, after a short southerly course, empties itself into the Rakaia lagoon. Consequently, a large triangular block of country, surrounded on two sides by ground almost impassable to man or beast, is formed, whilst a similar block exists on the southern side of the river, with this difference, that the sea coast forms one of the sides, which was also available for hunting purposes.

Referring more especially to the encampment under consideration, we find that here the Canterbury Plains run without any break to the banks of the Little Rakaia, where they form cliffs ten to twelve feet high, whilst towards the main river two terraces occur of an altitude of eight and four feet respectively. It is chiefly on the lower terrace that proofs of Maori occupation are to be found, but ovens of the moa-hunters also occur in the same locality. On the plains above the terraces, distant about sixty yards, both from the first terrace and from the bed of the Little Rakaia, Mr. Cannon, the owner of the land, to whose courtesy and kind permission to collect and to make further excavations I am much indebted, in ploughing the ground uncovered a mass of former cooking-places and kitchen-middens, the latter consisting mostly of broken moa bones, and extending over an area of about fifty acres. When on a visit to Mr. Edward Jollie, whose property is in the neighbourhood, I was accidentally informed of this interesting fact, and in his company I devoted several days, with the active co-operation of Mr. F. Fuller, to a careful examination of this remarkable spot. The old ovens, generally covered by three to six inches of silt and vegetable soil, are found all over the ploughed ground, but most of them are situated near the centre of the field, where also the greatest amount of kitchen-middens occur. They are about 150 yards from the banks of the Little Rakaia, and nearly an equal distance from the first terrace sloping down towards the main river. This circumstance is more surprising, as the moa-hunters had to carry stones and water for their cooking ovens a great distance, a labour they might have avoided had they selected some locality close to either of the two watercourses. When passing, however, along the perpendicular banks, ten to twelve feet high, of the Little Rakaia, before it joins the Rakaia lagoon, we obtained in the silt, four to six inches below the surface, a large piece of flint, about seven inches long and three to four inches broad and thick, from which pieces had evidently been chipped for knives. In other spots, in the same layer, moa bones, either broken or entire, occurred, but isolated, suggesting that they had more probably been thrown away by man in passing, or dropped by dogs, than that they were the remains of a regular kitchen-midden. No moa bones, as before stated, were found by me anywhere on the surface. All of them had been covered by silt, or at least by thick layer of vegetable soil; but I have been informed that the very same locality was covered with moa bones, but whether broken or entire I could not ascertain.

As previously observed, the principal ovens and kitchen-middens are situated some distance from the banks of the rivers; about twenty acres are more or less covered with them, so that in some instances they must have offered some difficulty to the plough. Although now mostly disturbed, I could readily recognize the form and diameter of these cooking-places. Some of them were of an oval shape, eight feet long and five feet broad, others more circular and about eight feet in diameter. Generally covered by three to four inches of soil at the border, they are about eighteen inches deep in the centre. The outer rim is generally built up by larger stones, smaller ones fill the interior, piled in four to five layers upon each other, of which, of course, many by the intensity of the heat have been split into angular fragments. Occasionally, small pieces of charcoal are still found lying between them. From five to eight of these ovens are usually in close proximity, with intervals of about twenty yards between them and the next group; the ground between having probably been the camping ground of the moa-hunters. I may here add that these pre-historic people without doubt cooked their food in the same manner as the aborigines of the present day, which has been so often described that I need not repeat it here. There are seldom any moa bones or other remnants of their meals amongst the stones of the ovens; these are generally situated a few feet from them, where the offal has been thrown in a heap, together with the chips of their rude stone implements. Large flat stones, ten to twelve inches long and six to eight inches broad, are sometimes found near them, together with a roundish long boulder, also of large dimensions, which I have little doubt have been used for breaking the bones in order to extract the marrow, or for pounding other materials. All these stones, without exception, had to be carried from the rivers or sea-shore to the plains, and their great quantity testifies that for a long time this locality must have been a favourite resort of those inhabiting the country at that distant period.

I assume also that this spot was to them very important in a strategical point of view; the natives, after crossing the lagoon with their rafts or canoes, being out of the reach of their enemies, who, without the same means of conveyance, could only cross with difficulty and loss of time. Scattered over the ground an enormous quantity of pieces of flint are strewed, proving that the manufacture of rude knives or flakes must have been carried on upon the spot for a considerable period of time. The most primitive form of stone implement, and of which a great number is found lying all over the ploughed ground, consists of fragments of hard silicious sandstone, broken off apparently with a single blow from large boulders, and for the manufacture of which considerable skill must have been necessary. The boulder was always selected in such a form that if fractured in the right way it would yield a sharp cutting edge. These rude sandstone flakes are very different from pieces detached by heat in the ovens, where the natural joints of the rocks are always exhibited, while here the rough surface of the broken side attests clearly that the specimens have been obtained artificially. These primitive knives are mostly three to four inches long and two to three inches broad, possessing a sharp cutting and sometimes serrated edge; but there are also some of larger dimensions, being six inches long and nearly four inches broad. Some of them have evidently been much used. They were probably employed for cutting up the spoil of the chase, and severing the sinews. Similar specimens have been obtained in abundance in the Northern Island. Their frequent occurrence may be accounted for by the rapidity with which they were manufactured, and consequently they were of small value.

The really properly worked or chipped flints are so very rare that I obtained only a few of them, although of chips and flakes I could collect several hundreds, of which many show that they have been used. Before entering upon a description of the former, I wish to speak of the material which has been selected for the manufacture of the greater portion of them. The principal regularly shaped implements consist of a greyish greasy-looking peculiar flint rock, the original bed of which is not known to me. If it should exist in this part of the South Island, the only locality might be in the neighbourhood of Gebbie's Pass (Banks Peninsula), where so many varieties of silicious deposits occur. Another reason for believing that the rock has been brought from a great distance is its scarcity, which shows that unlike the sandstone knives or flakes, the ancient inhabitants took greater care of it. From specimens received from Dr. Hector and Captain Frazer, it appears that it has also been extensively used in the interior of the Otago province. There is in the Otago Museum a series of fine specimens manufactured of the same rock, collected in a short time in or near the Manuherikia plains by the last-named gentleman, so that there is no doubt that we must seek in that neighbourhood the original workshop whence they were derived. There are also, but far less frequent, smaller implements and flakes made of chert, porcellanite, and a few of chalcedony, semi-opal, cornelian, and agate, probably collected for their hardness in the neighbourhood. But the most interesting objects were small pieces of obsidian, in lithological character identical with that obtained near Tauranga. It is thus evident that a race so remote from our own times must have had communication with the Northern Island, and as the different species of *Dinornis*, as far as I can judge from Professor Owen's drawings and descriptions, are identical in both islands, it forces us to the conclusion that in the era of their existence Cook Straits did not yet exist, but that both islands formed part of a larger island, or even continent, over which the wingless terrestrial birds could roam at will. In no other way can we account for the existence of the same species of *Dinornis* over the whole of New Zealand. We might even assume that the human race made its appearance when this communication still existed, entirely, or at least partially, because it is rather difficult to conceive that a people in such a low state of civilization could have built canoes sufficiently large and strong to cross the boisterous strait now existing between the islands. In any case, we may safely conclude that the human races in the southern hemisphere are of far greater antiquity than might appear at first sight, and, instead of migrations, possible and impossible, to explain the peopling and repeopling of New Zealand, geological changes might afford a more satisfactory explanation. If we admit the former existence of land in the Pacific Ocean, either as a continent or large island, where now the boundless ocean rolls, and if we further suppose this land inhabited by *autochthones*, of whom we find remnants all over the islands, either still existing or extinct, and only proving their former existence by their works of art, the whole problem is solved. Such an explanation is, moreover, in better accordance with the present state of geological and ethnological science.

It appears to me that the flakes, which have generally a sharp-cutting edge, have also been used by the moa-hunters for the purpose of cutting, perhaps, also, as small scraping knives to prepare their meals, or, what is still more probable, to assist them in eating their food, because doubtless they would have required some instrument to cut through the sinews and ligaments, or to otherwise divide the meat after being cooked in the large ovens, which from their size would easily have contained a whole bird. The principal specimen of flint implements which I obtained from the locality in question, is of the so-called spear-headed pattern, closely resembling those found in the post-pliocene beds of France, and in many other spots of the same geological age in Europe. It is four and a half inches long and two inches at its broadest parts. There is, however, one great difference between this antipodean tool and those of Europe, namely, that the former is flat on one side, all blows having been struck on the other. That their form and peculiar manner of manufacture are not accidental is proved by similar specimens collected by Captain Frazer and now in the Otago Museum, to which I alluded already. There are at least half a dozen amongst them which have exactly the same form, being at the same time only chipped on one side.

Two other specimens found at the Rakaia are flint implements, manufactured in the form of a chopper, about six inches long and three inches broad, and three-fourths of an inch at its thickest part. They are also flat on one side with a ridge near the centre on the other, whence they have been worked towards the edges, which are both sharp. At one corner a piece has been removed so as to form a kind of handle, or for fixing it to a piece of wood. A similar specimen is also in the Otago Museum. As far as I am aware no implement resembling this curious tool has been described from Europe. There are some flint implements of the so-called oval-shaped hatchet type, presenting the same peculiar characteristics, and again some smaller flint knives resembling those found near Abbeville, in France. I may here observe that I also found two smaller spear-head implements, which in every respect resemble those of the mammoth and rhinoceros beds in Europe; intermediate forms are also present.

As I stated previously, this locality shows traces of having been afterwards inhabited, from the fact that true Maori ovens, for ordinary cooking as well as for the preparation of the cabbage tree, are not unfrequent; moreover, the Maori track leading to the south passed over the same ground. It is, therefore, not surprising that a few greenstone adzes, and some other well polished Maori implements, should have been turned up by the plough.

Another more interesting discovery was made by Mr. Cannon; a cache, containing twenty-two pieces of roughly chipped Palla, a green silicious rock, occurring only on the northern side of the Gawler Downs, between the forks of the Hinds. They had evidently been brought a distance of over fifty miles to be shaped into the proper form by polishing them. They had already been prepared to take finally the more recent forms adopted by the Maoris, which at once distinguishes them from the moa-hunter implements. This is the more evident, since, in many localities, polished Maori adzes have been obtained manufactured from this peculiar green silicious rock. When I first found it on the Gawler Downs, about seven years ago, I was struck by the large amount of chips lying about, which led me to believe that somebody struck by the flinty appearance and fine colour of this rock, which besides this spot, occurs only in Transylvania, had amused himself by making specimens. I am now satisfied that the Maoris visited the spot in question to obtain this rock for their stone implements, carrying it away such long distances. Mr. John Davies Enys found some of the Palla adzes in the Upper Waimakariri country.

I searched for a long time, anxious to obtain any other relic which might show that the pre-historic race had used any durable ornament made of stone or bone, such as ear or nose ornaments, amulets to wear round the neck, bracelets, or needles and pins made of bone. At last we discovered two pieces of the *ulna* of the wandering Albatross (*Diomedea exulans*), which, at their proximal end and below the condyle, had evidently been bored through by the hand of man. Both, however, were broken in the middle of the shaft, the lower portion of both being missing, and they had therefore probably been thrown away. Of course it is impossible to say for what purpose these neat holes had been bored; but, belonging to such a majestic bird, is it not possible that they might have been worn as charms or amulets, or used in connection with some religious rite?

Amongst all the stone implements, there was not a single one from which we might draw an inference how the moa-hunters killed their prey, but as the birds lived doubtless in droves, they were probably driven by men or dogs towards the apex of the triangle either to be killed with heavy wooden implements or stone spear-heads fixed to staves, to be snared, or to be caught in flax nets. Another method of killing them, if we assume that the moa-hunters were allied to the Australians, may have been by the use of the boomerang or a similar wooden weapon, to be hurled at their prey.

Proceeding to an examination of the kitchen-middens or refuse heaps, we observe that by far the greater portion consists of moa bones, belonging to several species, identical in every respect with those the skeletons of which we excavated in the Glenmark Swamp. In the first volume of the "*Transactions* of the New Zealand Institute," page 89 and sequel, I have given a list of the *Dinornis* bones found in Glenmark, arranged according to the species they belonged to, and showing the number of each. From that list, it will appear that of all these species, *Dinornis casuarinus* is the most numerous, being represented by bones belonging to at least forty-five specimens, while *Dinornis didiformis* follows with thirty-seven, *Dinornis crassus* in the third line, and then *Dinornis elephantopus.* The other species, *Dinornis gracilis, struthioides, robustus, giganteus, and maximus,* are of much more rare occurrence, and *Palapteryx ingens* is only represented by one single specimen. I ventured to draw the conclusion, that the smaller and more numerous species had been living in droves, whilst the larger ones were of solitary habits and of much rarer occurrence. During the examination of the kitchen-middens, and while in the act of collecting their contents, I was at once struck by the curious fact that the more or less frequent presence of the bones coincided closely with similar observations made concerning the skeletons imbedded in the Glenmark Swamp, and which showed that the frequency of the different species in that locality was not accidental. It also became evident to me that all the species, except perhaps the largest ones, had been co-temporaneous, affording ample food to the aborigines of the country. Of the remains of *Dinornis casuarinus,* the leg-bones are the most plentiful. A few only of the *tarsus-metatarsus* were intact, by far the greater portion broken on both extremities, the *tibia* was always broken on both ends, the shaft of the bone smashed to small fragments, with the exception of a few pieces which were left uninjured. This additional trouble had doubtless been taken in order to extract the medullary contents for food; also the *epiphyses* both of the proximal and distal ends were generally partially destroyed, having been scooped out to get at the marrow. The *femur* appeared generally broken in the centre, but a few were also fractured on both ends. Of *Dinornis didiformis*, which with *D. crassus*, was next in number of individuals, only one *tarsus-metatarsus* was intact; the *tibiæ* were either broken in the centre or more frequently on both extremities. Of the *femora*, a few were collected, broken in the middle, but generally they had been left entire, so as to suggest that the medullary contents, which must have been very small, were not thought worth the trouble of extracting. *Dinornis crassus* seems also to have occurred in large numbers on the plains, judging from the great quantity of bones belonging to it. The *metatarsus* is only rarely broken, the *tibia* always at both *epiphyses*, and the *femur* in the centre. Of *Dinornis elephantopus*, bones belonging to a few specimens were collected, of which the *tibia* is invariably broken, whilst the *femur*, and, in a few cases, the *tarsus-metatarsus*, have been fractured in the centre. Of *Palapteryx ingens* I obtained remains belonging to at least three specimens. They are, however, a little smaller in size than that figured by Professor Owen. All the three principal leg bones, without exception, are broken at both extremities, and the intermediate portion fractured to small fragments. The *epiphyses* also show clearly how they have been scooped out to obtain the marrow.

No bones of other species came into my possession, such as those of *Dinornis gracilis*, *struthioides*, and the more gigantic forms, which, considering that they are very rare in comparison with the species enumerated above, is not surprising, and does not prove that they did not exist. Further excavations in the same locality will doubtless afford us more information on the subject. Of *Cnemiornis*, a bird with well developed wings and of the size of the bustard, and of which I also collected some portions of the skeleton in Glenmark, a few bones were also found at Rakaia. Small pieces of moa bone, mostly derived from the leg bones, are very numerous, and lie generally upon the refuse heaps. Occasionally they are burnt, so that it appears that the moa-hunters generally threw the refuse of their meals upon the middens, and only accidentally into the fire, unless we assume that they used the bones occasionally as fuel. *Phalanges* of all the species already mentioned are present, and in the same proportions; they are generally intact. Of the pelvic bone only one large piece of *Dinornis didiformis* was obtained, but otherwise its fragments were of frequent occurrence. They were probably broken up to get more easily at the meat. The same observation also applies to the *sternum*, of which only small pieces were found. Ribs and intercostals, generally broken, are not rare. A great many *vertebræ*, and occurring in the same proportion as the leg bones, mostly in a good state of preservation, were collected. It is remarkable that only in a few bones cuts or other marks could be observed; the reason may be that the larger bones, as already pointed out, were probably broken with stone mallets. However, some of the smaller bones show clearly the marks of the rude stone knives.

The fact that the *vertebræ* and other smaller bones, such as costals and intercostals, were quite uninjured, and that I never found any sign of gnawing on any of them, either large or small, would imply that the dog was not domesticated by the moa-hunters, but lived in a feral state, and was hunted by them like the Moa. Several of the skulls of *D. casuarinus* and one of *D. didiformis* were obtained, some of them in a very fragmentary condition, and each of them having been scooped out from below to obtain the brains. Of minor bones were collected the upper and lower mandibles, tympanic bones, and tracheal rings of most of the species named, which, with the rest are now exhibited in the Canterbury Museum; also a good selection of moa stones could be made, consisting either of pebbles of quartz, agate, etc., such as we obtain in the Malvern Hills, or of silicious sandstone, and of chert. It was in vain that we searched for egg-shells; if once existing, they must have decayed. Of the bones of smaller birds we were able to distinguish those of the New Zealand Rail *(Rallus pectoralis)*, the Black-backed Gull *(Larus dominicanus)*, the Swamp Hen *(Porphyrio melanotus)*, the Mollymawk *(Diomedea melanophrys)*, and the Godwit *(Limosa uropygialis)*. *Apteryx* bones were missing, but this may be easily explained by the distance of timber-covered country from the encampment; but a more striking feature is the total absence of bones of the Weka *(Ocydromus Australis)*, which is at present found all over the island. Could this bird have been confined during the *Dinornis* era to the forest region, kept there by the attacks made by the large birds upon it? Another interesting fact is the frequent occurrence of tympanic bones of whales; there is, however, not a single specimen amongst them belonging to the *Caprerea antipodarum*, nor of any of the other large right whales visiting the coast of New Zealand; all the specimens belong to smaller species, such as *Berardius Arnuxii*, etc. These bones are mostly in a fragmentary state, having been broken in such a way that the interior cavity or lower surface remains intact. It is difficult to understand why these bones, of which we picked up more than a dozen, should have been collected and brought up to the encampment; they could not have been used for ornaments, as they are always broken too unevenly for such purpose; or can they have been used for drinking cups or ladles? Some of the pieces were charred. There were also a few pieces of larger bones, belonging to the skeletons of cetaceans of the smaller dimensions. Seals must have formed also a favourite article of food, as many bones, belonging to at least two species, are found frequently in the kitchen-middens.

The dog is also represented in these refuse heaps. We obtained parts of a few lower jaws, belonging to several individuals, some *vertebræ*, part of the *pelvis*, *sternum* and of the skull. It was of the size of a shepherd's dog, the canine tooth longer and more slender in comparison with the other teeth than is generally the case with the present varieties of the same size. These remains are, however, rare, which might suggest that the dog was only exceptionally eaten, either when its owner was short of provisions, or perhaps when some of these animals were killed by the Moas during the chase. I have, however, already given some reasons why we are almost compelled to believe that the dog was not domesticated by the moa-hunter. Some few shells were also found between the bones, consisting of freshwater mussels (*Unio*), and of a large *Mytilus*.

Bearing in mind what the Hon. W. Mantell states in respect to the occurrence of the bones of men, together with those of the *Dinornis*, dog, and seal, in the kitchen-middens of the Northern Island, I concluded that the moa-hunters must have been cannibals; however, the most careful search, continued for a number of days, has never brought to light the smallest portion of a human bone at the Rakaia. And, although this evidence is merely of a negative character, it is strong enough to induce the belief that the moa-hunters were not addicted to anthropophagy, as Mr. Mantell's observations might suggest. Had the inhabitants of the Rakaia encampment been cannibals, there is no doubt, in my mind, that amongst the thousand fragments of bones passing through my hands, at least some of the human skeleton should have appeared to bear witness. Mr. F. Fuller, who lately discovered a small moa-hunter encampment in Tumbledown Bay, near Little River, found close to it, amongst some sandhills, the traces of a cannibal feast, but there was nothing to connect the one with the other.

Some other localities, in which the ancient population has left evidence of its presence, are the flat near Moa-bone Point, on the road to Sumner, another near Mr. Joseph Palmer's former residence among the sandhills near the Avon, and on the opposite side below Mr. Wright's property. Here, moa bones, broken in the usual manner, associated with those of the seal and tympanic bones of whales, are exposed by the sands having been shifted by the wind. Similar flakes, manufactured of flint and sandstone, occur also there, together with great quantities of pipi shells (*Venus intermedia*) and of *Amphibola avellana*. The contents of the ovens consist of common river shingle, but also of rough pieces of volcanic rocks, derived from Banks Peninsula, and which must have been brought all the way, unless we admit that during the time of the moa-hunters the sandhills in question were still close to the sea shore, or at least fringing an arm of the sea, running round Banks Peninsula. Another locality, where Mr. John D. Enys has collected flint implements of the same type as those described previously, is situated on the western flanks of Mount Torlesse, about 3,000 feet above the sea level.

From all these observations I am led to the conclusion that the moa-hunters have left their traces in many localities in both islands, of which only a very few are at present known to us. I have no doubt that further search will bring to our knowledge many more large camping places, and will offer us more ample material to draw conclusions as to the character, life, and manners of that pre-historic people whose implements, so far as we know, are of the same character throughout both islands.

Fragmentary as my researches have been, so are necessarily my notes on this important subject, but I trust that they will be at least the means of procuring more attention to the matter amongst my fellow colonists, many of whom, I have no doubt, can assist me materially in more fully investigating it, either by collecting specimens, describing their own experience, or pointing out to me where similar encampments may be examined. I need scarcely observe that I am far from considering the inductions drawn from the observations I have been able to make as final, or that I claim for the different hypotheses I venture to propose more than a simply suggestive character.

Every day, especially if other observers will give us the result of their labours, new vistas will be opened before us, and our ideas become enlarged and modified. I should feel quite satisfied with the result of my labours, even should some of the views expressed to-day prove erroneous, if by this means I shall have been instrumental in extending our acquaintance with the ancient inhabitants of this country, and thus promoting the advancement of knowledge and truth.

Additional Notes.

[*Read before the Philosophical Institute of Canterbury, 5th April,* 1871.]

In the address I had the honour to deliver to you at our last meeting, I omitted some points of importance concerning Moas and moa-hunters ; I trust, therefore, that you will allow me to supplement the information then given by returning once more to the subject. However, before doing so, I wish to observe that it has never been my intention to attempt to deal exhaustively with the subject, in so far as alluding to all former publications upon it, for the simple reason that most of those writings were published in newspapers, or in the *Transactions* of scientific societies not accessible to me, my principal object being to allude to those of a few well qualified authors, who were the first to collect traditions concerning the Moa amongst the natives. This I did in order to inquire how far my own researches into the geological position of the remains of *Dinornis* confirmed or contradicted those so-called native traditions. I selected principally the oldest writings, such as those of the Rev. W. Colenso and of Dr. Mantell, because the old natives with whom Mr. Colenso and Mr. W. Mantell conversed, and who now have, doubtless, passed away, were still in full possession of the traditions of their ancestors prior to the arrival of the Europeans, and were consequently more reliable than those of the present Maori generation. When writing that address I was well aware that Mr. Mantell had delivered, only a few years ago, a lecture on the Moa, but it had entirely escaped my memory that an extract of this lecture had been printed in the first volume of the *Proceedings* of the New Zealand Institute. However, as I remembered having seen somewhere a notice of it, I searched amongst some cuttings from Wellington newspapers which I kept by me, but in vain. Consequently I had to fall back on Dr. Mantell's works, containing, as far as I knew, the most authentic information of the views and statements of his son. Dr. Hector, on his late visit to Christchurch, pointed out where I could find the desired information. In reading the interesting extract of that lecture in the first volume of the *Proceedings* of the New Zealand Institute, it became apparent to me that since the publication of Dr. Mantell's works the Hon. W. Mantell had somewhat modified his former views, because, when speaking of the extermination of the Moa, he is reported to have expressed himself to the following effect:—"That this must have taken place within a short period after the appearance of man, adducing the only slight and obscure allusions in the most ancient Maori traditions to their existence as proof of this." It appears also that Mr. Mantell is inclined now to believe that the Moa owed its destruction to a different race, and prior to the arrival of the Maori race in New Zealand, a conclusion at which I also arrived by comparing the tools of the moa-hunters at the Rakaia with those of the Maoris. The same gentleman is also reported to have stated that there was evidence that cannibalism prevailed at the time the Moas were used for food, but only in the North Island, confirming my observations made at the Rakaia and elsewhere, that the moa-hunters in this island were not *anthropophagi.* However, I still doubt very much whether the inhabitants of the North Island, in the same era, were cannibals, as I believe that the same favourable localities, formerly selected by the moa-hunters, were also used by the Maoris as camping grounds, by which the mixture of the kitchen-middens of both races has been produced. Even were we to admit that the inhabitants of each island had belonged to a different race, or that they had not had communication with each other, so that different habits of vital importance had become formed in each of them, the discovery of obsidian in the kitchen-middens of this island clearly proves that such arguments would be fallacious. The pieces of obsidian being of such frequent occurrence, we are obliged to assume that regular communication existed between both islands, and it is difficult to conceive that, under these circumstances, the one island should have been inhabited by cannibals and not the other. Nor could different races have inhabited the two islands during the extermination of the Moa, and the southern race have gone to the North Island to obtain the much coveted obsidian without fear of being devoured by the more savage tribes inhabiting it. Such a case seems to be improbable. I regret very much, and every lover of science will agree with me, that Mr. Mantell has not allowed the publication of his lecture *in extenso*, as, no doubt, much valuable information and sound speculation would have been placed before us. I have been told that the present race inhabiting New Zealand must have been co-temporaneous with the *Dinornis*, because the word Moa forms part of the designation of several localities in New Zealand, but this occurrence might be explained in several ways. In the first instance, it is very possible that the word Moa in those names is only the alteration of another word in course of time, because words having the same, or nearly the same sound, are not unfrequent in the Maori language, such as *moa*, a bed in a garden, a certain stone; *moana*, sea; *moa ta*, to be early; *moe*, sleep or dream; *moho*, a bird; *mou*, for thee; or *moua*, the back of the neck;* or that the natives used the expression to designate localities where moa bones were principally found. Another explanation might be given by pointing out that the word Moa is used in connection with other birds. Thus I may quote from the Rev. Richard Taylor's "A Leaf from the Natural History of New Zealand," Wellington, 1848, the following expressions:—*Moa kerua*—a black bird with red bill and feet; a fresh water bird; a water hen. *Moa koru*—very small rail. *Moeriki*—rail of the Chatham Islands. And may we not therefore conclude that if the Maoris had known anything of the *Dinornis*, the present representative of the genus, which, in appearance, form, and plumage, most probably closely resembles some of the extinct gigantic forms, would have in preference been named by them *Moa-iti*, or some similar appellation, instead of calling the *Apteryx*, *Owenii kiwi*, from its peculiar call; and the *Apteryx Australis*, *Tokoeka* and *Roa?* The fact that they added instead to the names of birds, resembling somewhat the domestic fowl, the prefix *moa*, might be taken as an additional confirmation of the probability that the theories advanced by me are correct. And how can we reconcile the difference in the statements concerning the plumage, which, according to one account, consisted of magnificent plumes on head and tail, whilst, according to the other, it resembled that of the *Apteryx*? Another point of importance must strike the observer, concerning Maori nomenclature. If the present race had known anything of the *Dinornis* should we not expect that several and very distinct names would have been preserved to us for the different species? We may safely presume that the moa-hunting races had different names for the huge *Dinornis giganteus*, *robustus*, and for *Palapteryx ingens*, for the smaller and more slender species of *Dinornis casuarinus* and *didiformis*, as well as for the stout-set *Dinornis elephantopus* and *crassus*; which, moreover, were doubtless distinguished by

*Williams' Maori Dictionary, London, 1852.

different habits and modes of life. Instead of that, we find them speaking of the Moa indiscriminately, a word extensively used all over the Polynesian Islands. I may also here state that the Rev. R. Taylor alludes already in the publication previously quoted to the native report about the Maero, or wild man of the wood. Another important fact, of which I have omitted to speak, is the discovery of a *Dinornis* skeleton in the Manuherikia plains, in which not only portions of integuments and feathers were still attached to the *sacrum*, and a portion of the sole of the foot was still intact, but also the joints of one leg had their ligaments and inarticular cartilages preserved. We owe to Dr. Hector many interesting details concerning the discovery and position of this unique specimen, which was found fourteen feet below the ground, partly imbedded in a stratum of dry sand. As some portion of the skeleton was already in the fossil condition in which moa bones are usually found, we must assume that the better preserved portion owes its present condition to a very exceptional case, such as being imbedded in a layer of very dry sand, by which it has been transformed into a natural mummy, and in which state human and animal remains are known to have existed in several parts of the world for a very considerable time. The discovery of a human skeleton, together with a moa egg-shell, in excavating for the foundations of a house on the Kaikoura peninsula, is another fact I should have alluded to. Unfortunately, the skeleton has not been preserved, or we might conclude from its examination to what race the owner of the egg had belonged. However, I have been informed that the Maoris had not the least tradition of a burial place of their own race having ever been in that locality, and disclaim the skeleton as belonging to them. And even if it had turned out that it had been of truly Maori origin, and that polished stone implements had been also found near it, we could not conclude therefrom that the *Dinornis* egg was of co-temporaneous origin with the individual with whom it was found buried. We might as well believe that the eocene or cretaceous fossils, artificially bored, which, together with human remains, have been found in caves on the continent of Europe, must be of the same age as the human bones with which they are associated. In addition to the facts that small heaps of so-called moa stones are found on the plains, which might indicate a spot where a bird had died, I wish also to state that I have met with moa stones in such localities where it would have been impossible for a body to lie, and which offered evidence that, like the Emu, the *Dinornis* had the power of disgorging the stones when they were so much polished that they could not longer be used for the comminution of the food. This is the more probable as the stones in such positions are always very smooth, while those I found with the skeletons, and of which one fine specimen, from the Aorere caves in the Nelson province, is in the Canterbury Museum, exhibit well their natural roughness. Finally, "Taylor's New Zealand," page 124, contains some instructive information concerning a Maori tradition, which, if reliable, at once points to the fact that when the present race arrived in New Zealand the Moas were already extinct. In giving the list of original canoes, Mr. Taylor relates, in speaking of No. 12, "Te Rangi na mutu. Tamatea Kokai was the chief; Nga ti rua nui. It came to Ranga tapu. On their arrival at that place they saw stones like English flints and moa bones," and he adds, "it was there that I discovered the largest quantity of the bones of the *Dinornis* which I have seen. The flints, I have no doubt, were the stones which that bird used to swallow, being chiefly quartz pebbles." However, as the reverend gentleman distinctly speaks of stones like English flints, might this not suggest that at least a portion of them were rude stone implements and chips made of flint, such as we still find in the kitchen-middens of the moa-hunting race?

Third Paper on Moas and Moa Hunters.

[*Read before the Philosophical Society of Canterbury, 20th December,* 1871.]

In my anniversary address delivered to you on 1st March of this year, I had the honour to lay before you some of the principal facts concerning the so-called native traditions about the existence of the *Dinornithes.* I also offered a description of the moa-hunter encampment situated between the junction of the Little Rakaia and the main river, and of some others of minor importance, discovered by me in other parts of this province, but of similar ethnological interest.

At our meeting of April 5th, I laid before you some additional information on some points of importance concerning the same subject previously overlooked, and to-night, with your permission, I wish to give a further account, based partly upon my own researches and partly upon communications received from different parts of the colony, all bearing upon questions intimately associated with the subject under review.

I am happy to say that my papers have had the effect of eliciting the publication of very important information; first, in two papers read before this society by the Rev. J. W. Stack and Mr. John D. Enys; and afterwards, in two other papers of Dr. J. Hector, F.R.S., and Mr. W. D. Murison, both read before the Otago Institute, which are full of valuable facts and suggestions, and to which I shall have to refer fully in these pages.

During the course of this winter I paid another visit to the Little Rakaia encampment, and as the ground had all been broken up, and the owner of the property, Mr. T. Cannon, allowed me to make excavations wherever I thought fit, I obtained a great deal more information than I formerly possessed. In fact, I was thus enabled to trace and examine the whole extent of the encampment from the banks of the Rakaia to the Little Rakaia, all across the fields.

During that visit the same gentleman handed over to me, as a presentation to the Canterbury Museum, a fine series of Maori and moa-hunters' stone implements collected by him.

In my first notes on the subject I explained that between the main river and the Little Rakaia a small terrace exists about eight feet high, by which a lower triangular flat is formed. The lines of the moa ovens and kitchen-middens run in the same direction as this terrace, so that their position must in some respects be in connection with that line. The ovens consist in the centre of five to six rows, sometimes close together, sometimes at some distance from each other, but near the banks of both rivers they diminish considerably in number.

Generally they are situated ten to twelve feet from each other, and are either empty, nothing except loam and vegetable soil lying upon the stones of which they are built, or they are filled with heaps of broken bones and chips of chert and knives of sandstone; this refuse sometimes also forming distinct heaps in close proximity to the ovens.

Besides this principal belt there are a few scattered ones on the open space towards the first terrace, as well as immediately below it, of which one refuse heap is of particular interest, to which I shall refer in the sequel.

I have previously described the moa-hunter remains near the small water-course bounding the triangular flat, and cannot add any new information, as I did not make any more excavations in that portion of the fields.

Before proceeding to an examination of the kitchen-middens of the moa-hunters, I wish to allude to the numerous polished stone implements found over the same property. In the small sketch map annexed to this paper I have marked the principal localities.

All over the fields numerous smaller polished stone implements are found indiscriminately in and near the moa-hunter encampment, as well as away from it. Many of them were picked up previously amongst the grass, but by far the greater portion became exposed when the land was broken up by the plough.

In my first paper on this subject I have shown that long after the moa-hunters had ceased to exist, this locality continued to be a favourite camping ground of succeeding generations, who, in the course of ages, became more civilized, as shown by their polished and more finished stone implements.

Near the north-eastern boundary of the moa ovens, but in close vicinity to them, Mr. Cannon, jun., found a *cache* containing four large stone adzes, made of a hard blackish chertose rock, of which two were finely finished, whilst the two others were only prepared for the polishing process by being cleverly chipped so as to assume the intended form.

These stone adzes are twelve inches long, and proportionately broad and thick. From the manner of their occurrence, as explained to me by the discoverer, it is evident that they had been placed in a *cache* dug for the purpose, just in the same manner as the chipped specimens of Palla described in my first paper, were hidden close by.

On the south-western side, just outside the line of moa ovens, a large square rubbing-stone, made of coarsely-grained sandstone, twelve inches long and four inches broad and deep, together with some other stone implements, were dug up, evidently forming also the contents of a *cache*. Some of the latter consisted of small chisels and gouges of distinct patterns, without doubt specially adapted for some peculiar kind of work.

Some of the smaller implements are made of a greyish chert, such as is found on the Nelson side of the Dun Mountain range. I am not aware whence the black chertose schist can have been obtained, but suspect that it has also been brought by the Maoris from a considerable distance.

A little away from this latter *cache* a piece of nephritic schist was obtained, ten inches long, four inches broad, and two to three inches thick. There had never been an attempt made to work it, without doubt owing to its inferior quality.

Amongst the other objects found is a sinker, made of white compact limestone, such as is of frequent occurrence north of the Kowhai, in the so-called Weka Pass formation. It is egg-shaped, with a depression for the insertion of a fastening string all round its longer axis.

Below the upper terrace, on the second flat, before the land was broken up, I observed on my first visit that a hut had been standing here, about fifteen feet long and seven feet broad, with an opening towards the north. The outlines were shown by the floor being raised above the surrounding flat. The plough, in effacing all traces of these contour lines, had exposed the spot where the former cooking place in this hut had been situated. Here the soil was baked to a hard cemented mass, containing small pieces of charcoal, bones, either broken or entire, of fishes and small birds, together with a few fragments of polished stone implements, but not the least sign of moa bones, flint implements, or chips amongst them. On the same terrace, in two localities, cemented masses of the same kind proved the former existence of similar cooking places.

In the neighbourhood of the hut four human bones were also exposed by the plough, consisting of two *tibia*, one *femur*, and one *humerus*, all belonging to the same individual, a full-grown man. Each of these bones had its extremities sharply broken off, as if for the extraction of the marrow, but only one of them appeared as if it had afterwards been gnawed by a dog.

It will thus be seen that polished Maori stone implements occur all over the extent of the land, and as I had occasion to convince myself, also in the neighbouring fields, in which no sign of moa-hunter encampments exist; but in no instance were polished stone implements found in the kitchen-middens of the moa-hunters, of which I examined carefully a great many, they invariably maintaining the same characteristic features.

A further examination of the kitchen-middens of the moa-hunters confirmed fully the statement made in my first report, concerning the relative proportion in the occurrence of the bones of the different *Dinornis* species, the remains of *Dinornis casuarinus* still continuing to be the most numerous, and next those of *Dinornis didiformis* and *crassus.* A few more specimens of *Dinornis elephantopus* were also obtained, but no more of *D. ingens*, and none of the largest species, *D. robustus* and *giganteus*, so that I cannot add any new information on this head.

The hollow space in one of the cooking places towards the central position of the encampment had been filled up with masses of broken moa bones, as this, as before observed, is not unusual; but this spot gained additional interest from finding that nearly two complete necks had been thrown on the heaps, so that, when we exposed the bones to view, we observed the *vertebræ*, and the rings of the *larynx* along them, still in their natural position. One of these necks, which were lying one across the other near the bottom of the old oven, belonged to *Dinornis casuarinus*, and the other to *D. didiformis*; the skulls belonging to them were also present, and had been scooped out in the usual manner. In examining and collecting carefully the contents of this oven, I found the broken leg-bones, portions of *pelvis*, *sternum*, also *phalanges*, ribs, intercostals, and even some of the tympanic bones belonging to these two specimens on one heap together, with a few chips of flint and a sandstone knife. Thus we had here the remnant of a meal before us for which two birds of different species had at the same time been cooked.

If we had had no other bones at our disposal, we could have constructed from this refuse heap alone, two species of the extinct *Dinornithes.* I also examined again fragment after fragment, to see if I could not trace by gnawed pieces the co-existence of a domesticated dog, but in vain; even the smallest bones being quite intact, and the bigger ones, which were broken, showing invariably the original fractures, sharply defined.

I may also allude here to the curious fact that I never obtained any *scapulo-coracoid* bone, which, judging from the existence of this bone in the skeletons of the larger species, the smaller ones ought also to have possessed. However, the Glenmark Swamp in this respect never yielded a single specimen except those of *Dinornis giganteus* and *robustus*, so that I almost despair of ever obtaining this bone from the smaller species.

Amongst other specimens of interest, I obtained a great quantity of bones of the New Zealand dog, of which one kitchen-midden below the terrace contained a considerable number, besides a great quantity of broken moa bones. We made at that spot quite a collection of lower jaws and fragments of skulls and of limb bones, having belonged to numerous specimens mostly of the same size.

The examination of the lower jaw shows that this dog had a very narrow muzzle, with powerful teeth for its size, resembling the dingo and jackal in that respect, although smaller than these animals. In one of these lower jaws I observed that one *præmolar* existed above the usual number. I also obtained a great quantity of the bones of the leg, but mostly broken in two or more fragments.

A considerable number of bones of seals were also dug up, including portions of the skull and lower jaw, but they invariably belonged to an *Otaria* (fur seal). Tympanic bones of whales, either entire or broken, were again found in considerable numbers, but without offering any clue as to their use.

Besides the numerous flakes of flint and obsidian, I obtained a few more well-worked flint implements, of which the principal ones are figured as illustrations to this paper.

With one exception they also exhibit the same peculiarity of being only chipped on one side; some of them were evidently used as knives. Amongst the larger pieces is a block of flint of a yellowish colour, about five inches long and four inches broad and thick, and another flat piece eight and a half inches long by five inches broad and two inches deep.

The former shows clearly, and this I think is very important, that it was used merely for the chipping of flakes whenever they were wanted, and not for the manufacture of larger knives or hatchets.

A fine block of obsidian, six inches long, four and a half inches broad, and three inches deep, shows the same marks of small chips and flakes having been broken off in a similar manner, and evidently for the same purpose.

Thus, from the appearance of these blocks, we may safely deduce that the moa-hunters were in the habit of breaking off small chips for their daily use, perhaps being compelled to do so by custom or superstition, not being allowed to use the same cutting edge to two animals; such an explanation, which I admit is very hazardous, might account for the enormous quantity of small chips and flakes found amongst the kitchen-middens.

Numerous sandstone knives were also obtained, turned up by the plough, some of them clearly showing that the cutting edge had been sharpened by additional blows all round. I was also fortunate enough to find during my last excavations a large flat sandstone boulder from which these knives had been broken off all round the edge. From the appearance of this stone it was evident that they had been obtained by one blow, as the stone was otherwise intact, but from the planes of fracture it could easily be seen that some of the knives had not been of the desired shape, and in searching closely I found some broken pieces which evidently had been thrown away as useless.

I also obtained during these last excavations a shell, *Fusus Zelandicus*, through which a hole was bored in a neat manner, a testimony that this prehistoric people was not devoid of the love of personal adornment.

Before I shall enter into a consideration of the arguments brought forward against portions of my deductions, based upon the facts given in these papers, I wish to lay before you some new information, some of it of considerable importance, bearing upon the subject under discussion.

Mr. Sherbrook Walker, who is well acquainted with the Friendly Islands, where he is a partner in a sheep run, writes to me as follows :—"There is a tradition of a gigantic bird which once resided in Eua (one of the Friendly Islands), and about half a mile from our house, on the top of the island, there is a small hill of about one and a half acres in extent, and about fifty feet high, covered with trees. This is called by the natives 'Te Moa,' which is, being interpreted, 'moa dung,' and the legend is that the bird one day, whilst passing over the island, evacuated at that spot, and raised the mount in question. Of course, all this is extremely absurd, but it is curious that the natives should have such a tradition ; and there is another thing I should like to point out to your notice, namely, that the native name for the common fowl is 'moa,' which would seem as though the traditions handed down amongt them anent the extinct bird showed that it had some external resemblance to the domestic fowl, which, I think, would certainly have been the case with the New Zealand Moa, only of course on vastly different scales. There is also a legend in this island of a gigantic lizard, which half the natives in the island made an attack upon, and, after a desperate battle, succeeded in slaying. I have often had the spot pointed out to me where the fight took place."

I consider this information highly important, because it proves beyond a doubt that the Polynesian inhabitants of the Pacific Ocean have the same legends about a gigantic bird and lizard, and that the Maoris, as proved by the Rev. W. Colenso, have in this respect no other knowledge which has a less fabulous character.

Speaking of this gentleman, I regret deeply that ill-health prevents him from writing more fully on the subject under discussion, of which no one in New Zealand is more thoroughly master, but I am glad to say that Mr. Colenso fully agrees with all the principal deductions concerning the extinction of the *Dinornis* in pre-historic times, and the utter ignorance of the Maoris on the subject.

In my first essay I tried to explain that the Maoris, by comparing the moa bones with those of other living species of birds, and finding that they resembled most closely those of the *Apteryx*, might have traced in such a way the near relationship of both *genera*; however, as Mr. Colenso states in a letter dated 13th July, even in this respect I went too far, because, alluding to this subject, the reverend gentleman says, "Believe me, no Maori of thirty or thirty-five years ago ever once supposed the moa bones to be those of a bird, they always obstinately denied it. That they since have done so is entirely owing to the pakehas."

Mr. Colenso informs me, also, that he would translate differently the Maori proverb, *Te moa kaihau*, to which I am indebted to the Rev. J. W. Stack, although he does not give me his translation.

My attention has been directed to a letter of Sir George Grey to the Zoological Society of London, in March, 1870, in reference to my first communication to the same society concerning the moa-hunter encampment at the Rakaia, in which that gentleman states, "The natives all know the word 'Moa,' as describing the extinct bird; and when I went to New Zealand twenty-five years ago the natives invariably spoke to me of the Moa as a bird well known to their ancestors. They spoke of the Moa in exactly the same manner as they did of the Kakapo, the Kiwi, the Weka, and an extinct kind of Rail, in districts where all these birds had disappeared. Allusions to the Moa are found in their poems, sometimes together with allusions to birds still in existence in some parts of the island. From these circumstances, and from former frequent conversations with old natives, I have never entertained the slightest doubt that the Moa was found by the ancestors of the present New Zealand race when they first occupied the islands, and that by degrees the Moa was destroyed and disappeared, as have several other wingless birds from different parts of New Zealand."

It will be seen from that extract that Sir George Grey speaks of allusions to the Moa being handed to us in the poems of the Maoris, and it is therefore very much to be regretted that none of these allusions are to be found in any of the published traditions or poems, of which the classical volume of Sir George Grey is considered the most reliable, because, as the Rev. James W. Stack informs me, in none of them is any allusion made to moa-hunting, though frequent references are made to kiwi and weka-hunting, and sports of other kinds.

In my first paper I alluded to two human skulls from the sandhills, sent by me to the late Professor Dr. C. G. Carus, and which by that illustrious anatomist were thought not to be of Maori origin. Since then Professor

Dr. Leuckart has examined them very carefully, compared them with a genuine Maori skull, and has informed me that they are not to be distinguished from the latter. This distinguished naturalist has thus set this matter at rest, and the question appears to me settled that if these skulls really belonged to the pre-historic moa-hunters, of which however there is no evidence, that race was not different from that at present inhabiting New Zealand.

There is another important point to which I wish to refer, namely, to the occurrence of a gigantic raptorial bird in New Zealand, the *Harpagornis Moorei*, of which the Canterbury Museum possesses portions, found in the turbary deposits of Glenmark, together with bones of the extinct *Dinornithes.*

There is no reason to suppose that the *Harpagornis* became extinct before the *Dinornis*, and thus if the present inhabitants of New Zealand had any reliable traditions about the Moa, would it not be evident that the existence of this more terrible bird of prey would have been recorded by them? This is certainly circumstantial evidence, which cannot easily be set aside.*

However, returning to Sir George Grey's letter, may I express a hope that the Maori traditions about the Moa, contained in songs, etc., to which that distinguished Maori scholar alludes, might be collected and published by him for our benefit, so that we can judge how far the present native inhabitants of these islands have any traditions concerning its existence; I wish this the more sincerely as the Rev. J. T. H. Woehlers, of Ruapuka, who has been nearly thirty years amongst the natives in the southern portion of this island, writes to me and states that he has never been able to obtain any information on the subject, thus in every respect testifying to the accuracy of the information received from the Revs. W. Colenso and Stack, and Mr. Alexander Mackay.

Two very important papers were read before the Otago Institute, to which I wish to refer at some length. Dr. J. Hector, F.R.S., gives in the first paper a great deal of valuable information which he possesses on the subject, for which every lover of science must feel grateful, and which was particularly welcome to me, although Dr. Hector arrives at somewhat different conclusions to my own.

One of the principal facts upon which Dr. Hector bases his conclusions as

* I found, however, that Professor Owen, when exhibiting in November 1839, at a meeting of the Zoological Society of London, the fragments of the shaft of a *femur* of *Dinornis*, the first bone brought to Europe, he observed that he had received this bone from Mr. Rule, with the statement that it was found in New Zealand, where the natives have a tradition that it belonged to a bird of the eagle kind, which has become extinct, and to which they gave the name of "Movie."

to the recent occurrence of the Moa is the neck of a *Dinornis* discovered in Otago, with portions of the skin partly covered with feathers still attached by shrivelled muscles and ligaments. Hitherto, however, we have not heard in what position this neck was found, but I may observe that the skeleton of *Dinornis robustus* excavated near Tiger Hill, on the Manuherikia plains, was found to possess also portions of skins, feathers, and ligaments, attached to the bones in exactly the same manner, although lying fourteen feet below the ground. Moreover, the important fact, which we must not overlook, that portions of that Tiger Hill skeleton were in the semi-fossil condition in which moa bones usually are preserved to us, is in itself sufficient evidence, that from the occurrence of another well preserved portion we cannot altogether judge correctly as to the recentness of these remains.

Dr. Hector himself, in a letter to Professor Owen, dated 15th February, 1864, as printed in the "Transactions of the Zoological Society," when giving him a description of the geological features of the ground where the Tiger Hill skeleton was found, expresses himself as follows :—"The dry climate and the fact that the bones were imbedded in dry sand, prevent our necessarily inferring from the well-preserved condition of this skeleton, that it is of more recent date than the bones that are usually found ; and, moreover, as some parts of the skeleton are quite as much decomposed as the generality of the moa remains, it is more natural to suppose that the preservation of the more perishable parts of the remainder of the skeleton has been due to an accidentally favourable position of the soil."

I fully agree with this conclusion, and I wish to point out that under favourable conditions, even in tertiary rocks, similar organic remains have been preserved. Thus in the paper coal of the brown coal beds of Rhenish Prussia, which are of miocene age, feathers of birds have been discovered, which shows that under exceptionally favourable circumstances organic substances can be preserved, which otherwise perish in a very short time.

That the neck of the Moa, now in the Colonial Museum, which is in a similar remarkable state of preservation as the Tiger Hill skeleton, was once imbedded in micaceous sand, is stated by Dr. Hector himself. We are, therefore, not too bold to assume that it has been excavated from a bed similar to that in which the last-mentioned skeleton was found.

However, to my mind, one of the main arguments in favour of the great antiquity of the moa ovens, from which we may conclude also of the long extinction of the *Dinornis* species, is given by Dr. Hector when relating the interesting discovery of the two steatite dishes carved in Maori fashion, of which one was found near an old Maori oven at the coast and the other far in the interior.

This fact proves beyond a doubt that the natives had reliable traditions for centuries back, even of such minor events as the existence and loss of two carved stone dishes, and this suggests that certainly they would have similar correct and reliable traditions as to the existence and the extinction of the huge wingless birds, had they been known to their forefathers. What better argument could I bring forward in proof of the long lapse of time since the *Dinornithes* must have become extinct?

The occurrence of moa bones on open plains, etc., as described by Dr. Hector, is quite in accordance with observations made in this province, but if their presence is explained in the way the Rev. J. W. Stack has so successfully attempted, all difficulties on this head are easily removed.

The south-eastern portion of this island was not only inhabited by large tribes of Maoris, but they were also constantly in the habit of travelling to the lakes in the interior for fishing purposes, and to the West Coast for obtaining the much coveted greenstone.

Every valley and peak, every creek and ford over a river had a name, and was perfectly well known to them for centuries. But besides these fishing and other excursions, they went to the interior for catching rats and woodhens, and they were therefore exceedingly anxious that no fires should run over the country, so as to destroy the means of their subsistence.

But when the Europeans came and settled upon the land, this fear was greatly removed; extensive fires passed repeatedly over the country, and the moa bones, which for ages had been preserved under the protecting cover of the peaty soil, were laid bare, but soon disappeared again, when subjected to the destructive atmospheric influences. How can we account otherwise for their sudden appearance and disappearance?

My first extensive exploration in this province dates back to the beginning of 1861, or ten years after the country was first occupied by European settlers; but even then I never found any moa bones lying in the grass, except when they could be traced to their having been washed out from the banks of creeks and deposited there by floods.

The extensive layer of bones which in many localities were seen by the first settlers had already entirely disappeared in the short space of ten years, and this has doubtless been the case in Otago.

Thus, for instance, there were great quantities of moa bones, no doubt uncovered a short time previously by great fires, at some locality on the banks of the southern Ashburton, when the first settlers went there, over which the track leads to the lakes near the head of that river, to which the Maoris resorted for centuries for purposes of eel-fishing. Now even supposing that the moa bones had been lying there for 100 years, which is utterly impossible, as the bones of horses and cattle disappear within twenty years on our plains, is it conceivable that the natives, of whom some were of very great age when the first Europeans arrived, should have had not the least idea of the existence of those birds, except perhaps a few fabulous legends common more or less to all the Polynesian Islands?

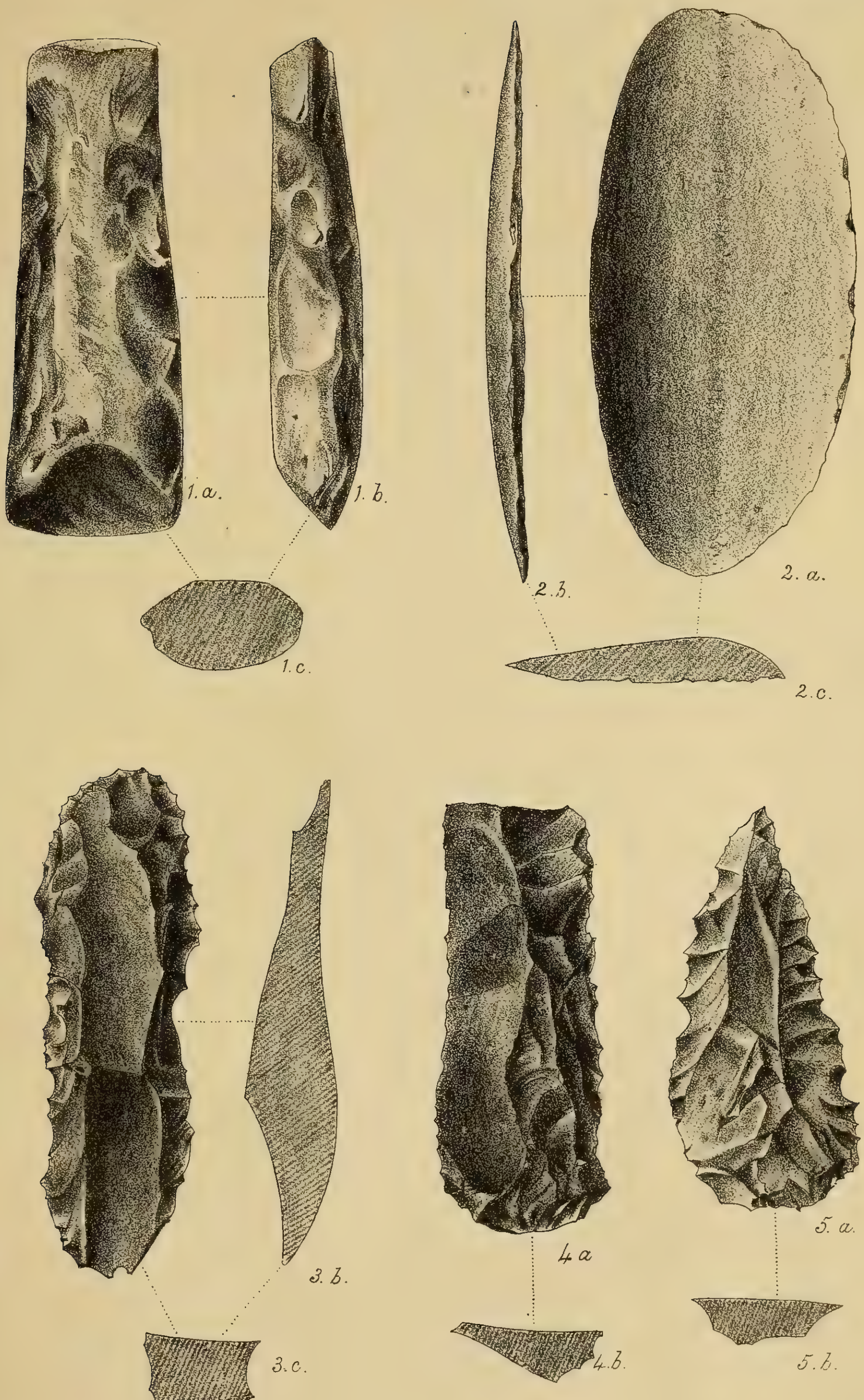
Dr. Hector, at the conclusion of his very interesting and instructive paper, cites, amongst others, the testimony of the Hon. W. Mantell in support of his view, namely, that the Moa survived to very recent times; but in my opinion the views of that gentleman do not altogether coincide with those of Dr. Hector.

In my second paper I quoted from a lecture of Mr. Mantell's, and showed that he had somewhat modified his former views. Since then, at a meeting of the Philosophical Society of Wellington, as I see from the "Wellington Independent," of 3rd July, 1871, when speaking of the occurrence of moa eggs in the Northern Island, Mr. Mantell is reported to have expressed himself as follows :—"Mr. Mantell explained that he had discovered these eggs in what were called Maori ovens, or, as he preferred to call them, pre-historic man ovens, etc., etc." Mr. Mantell thus offers additional confirmation to the correctness of my deductions, and I was truly glad to see that this gentleman was willing to modify his former views, in accordance with those advocated by me, as soon as he became convinced of their correctness.

The next paper to which I wish to refer is entitled "Notes on Moa Remains," by Mr. W. D. Murison, and was read before the Otago Institute. This contribution to the questions at issue is particularly valuable, as Mr. Murison offers principally the results of his own researches. His examination of the ovens in the Maniototo plains shows convincingly that in all their principal features they are identical with those of the Little Rakaia, with the exception that they contain numerous pieces of egg-shells, of which not a single specimen was obtained in the latter locality.

Mr. Murison lays great stress upon the fact that from the same place several fragments of polished stone implements were taken out, but as we have not that gentleman's testimony that they were found by himself in a kitchen-midden or oven of the moa-hunters, I cannot attach much weight to it. Although that gentleman thinks that it is unlikely the natives ever visited the Puke-toi-toi creek, on the banks of which the moa ovens are situated, with any other object than that of moa-hunting, I wish to point out that that small and insignificant creek has a Maori name, and that when the country was covered with vegetation, the volume of water was probably much larger than at present, when the whole district has been dried up by the systematic burning of the vegetable growth by the sheep farmer.

Unfortunately, I am not acquainted with the topography of that district, but I am certain that the occurrence of the numerous moa ovens on the banks of that creek proves it being a favourable locality for camping. I also wish to



To accompany Paper by Dr Haast.

J.F.McCardell del. J.B. lith.

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remind you that the Maoris went not only eel-fishing, but also rat and wood-hen catching.

If I am allowed to offer a simile, I would compare the finding of polished and unpolished stone implements together, with finding some coins of the middle ages near some stone implements and bones of the giant elk in a boggy deposit on the banks of a small gully in Ireland, and we should conclude therefrom that they must all have been co-temporaneous, because after the extinction of the giant elk no other means of sustenance could be procured near such a locality.

However, even supposing that really polished stone implements had been mixed up with the chipped flint Instruments, this would merely prove that of a people possessing a very low standard of civilization, the generality used only very rough and primitive stone implements, but numbered a few favoured persons amongst its members, who were already in possession of fine polished ones, indicating a much higher state of civilization for them than for the great mass of the tribes.

To believe in such an anomalous state of things would be, to my mind, taking a very strange view. However, this would not prove that the Moa had lived in more recent times, than from the absence of reliable traditions, and from the generally very primitive form of flint implements, we are compelled to assume.

Moreover, I wish to point out that even polished stone implements are of considerable antiquity in New Zealand, as they have been found in such positions that their great age cannot be doubted.

In volume II. of the "Journal of the Ethnological Society of London," page 110, etc., I have described two stone implements, a polished stone adze and a sharpening stone, found in Bruce Bay, fifteen feet below the ground, in an undisturbed deposit, over which a forest, consisting of large trees, was growing; since then I have received another adze made of sandstone, possessing a well polished cutting edge, found at Hunt's Beach, West Coast, eighteen feet below the ground, amongst the roots and stumps of an ancient forest, which last June, during the progress of gold mining operations, was laid bare.

Plate IV. fig. 1 gives a drawing of this stone implement, now in the Canterbury Museum, of the considerable age of which there can be no doubt.

The story of the whaler about the Moa, to which Mr. Murison alludes, is simply a sailor's yarn, with which we have been favoured repeatedly.

I am sorry I cannot agree with the conclusions of Mr. Murison, but sincerely hope that that gentleman will personally superintend some excavations in the valley in question, and if the discovery of polished and rudely chipped stone implements in co-temporaneous deposits should be confirmed by him, a great step towards solving the question at issue will have been made.

It is not my intention to enter into a discussion of the vexed question of Polynesian migrations, although in some respects this interesting subject has some bearing upon the so-called Moa traditions.

Several essays and books, in English, German, French, and Italian, lie on my table, all treating of that question from various points of view, and in which attempts are made to settle it one way or the other, but it would be beyond the scope of this paper to enter into a discussion of the different theories propounded therein. However, I wish to offer one suggestion, which might assist in removing some of the difficulties as far as New Zealand is concerned.

It appears that before the arrival of European vessels in the Pacific Ocean, frequent communications between the Ladrone Islands and Tahiti, and from both these points to Hawai, by canoes existed, which afterwards ceased, owing most probably to the circumstance that the Polynesian navigators were frightened by the European vessels. Consequently, if the Polynesians some hundred years ago had the courage to sail such long distances, it is very possible that some of the large canoes, taken from their usual track by currents and winds, landed in New Zealand, where a population of *Autocthones*, the direct descendants of the moa-hunters and of the same Polynesian race as the new comers existed.

Were this the case it could easily be accounted for, that when Tasman first visited our shores the Maoris possessed double canoes, manufactured by them in imitation of those which had brought the few new comers to their shores, but which, in course of time, were again discarded for their original canoe of a more simple construction.

Such an explanation might also account for the tradition about their arrival in New Zealand. The same explanation may also assist us to understand that some feathers of the Cassowary (Moa) were brought to New Zealand, and that the fable of the large Moa and huge reptile from the Friendly Islands, if not of much older origin, found also its way to our shores.

In summing up the points at issue, I think that the following propositions are proved by me :—

1st. The different species of the *Dinornis* or Moa began to appear and flourish in the post-pliocene period of New Zealand.

2nd. They have been extinct for such a long time that no reliable traditions as to their existence have been handed down to us.

3rd. A race of *Autocthones*, probably of Polynesian origin, was co-temporaneous with the Moa, by whom the huge wingless birds were hunted and exterminated.

4th. A species of wild dog was co-temporaneous with them, which was also killed and eaten by the moa-hunters.

5th. They did not possess a domesticated dog.

6th. This branch of the Polynesian race possessed a very low standard of civilization, using only rudely chipped stone implements, whilst the Maoris, their direct descendants, had, when the first Europeans arrived in New Zealand, already reached a high state of civilization in manufacturing fine polished stone implements and weapons.

7th. The moa-hunters, who cooked their food in the same manner as the Maoris of the present day do, were not cannibals.

8th. The moa-hunters had means to reach the Northern Island, whence they procured obsidian.

9th. They also travelled far into the interior of this island to obtain flint for the manufacture of their primitive stone implements.

10th. They did not possess implements of Nephrite (greenstone).

11th. The polishing process of stone implements is of considerable age in New Zealand, as more finished tools have been found in such positions that their great antiquity cannot be doubted, and which is an additional proof of the long extinction of the Moa.

ART. V.—*Some observations on the Annual Address of the President of the Philosophical Institute of Canterbury, delivered on the* 1*st March*, 1871. By the Rev. J. W. STACK.

[*Read before the Philosophical Institute of Canterbury, 5th April,* 1871.]

IN his very interesting paper on "Moas and Moa-hunters," our President spoke of the absence of any reliable traditions, amongst the Maoris generally, regarding the causes that led to the extinction of the Moa. He concludes from this, and other evidence, that the extinction of the Moa was long antecedent to the settlement of these islands by the Maori race. There is very strong presumptive evidence in support of his view, that the Maoris were not the moa-hunters. But that the *Dinornis* was hunted, and became extinct ages before the advent of the Maori, is a conclusion hardly deducible from the facts upon which the theory is based. The present Maori inhabitants—Ngai Tahu —have occupied this island for about ten generations. Allowing twenty-five years for a generation, their occupation dates back 250 years. In none of the traditions relating to this period, though numerous and detailed, are there any allusions to the Moa. We may safely conclude, then, that, for that period at least, the Moa has been extinct. The Ngai Tahu found this island in the possession of the Ngati-mamoe, another Maori tribe, whom they exterminated or absorbed. The Ngati-mamoe having previously succeeded Waitaha, a tribe descended from a chief of that name, who arrived from Hawaiki in the canoe 'Arawa,' twenty generations ago. Ngai Tahu having incorporated the remnants of the two preceding tribes, the traditions of these tribes would become the property of Ngai Tahu, and be handed down with the rest of their tribal lore to posterity. Now, while these traditions are full and distinct in everything else to which they relate, and extend as far back as to events that occurred before the migration from Hawaiki, they only contain very vague and meagre references to the Moa. It is inconceivable that an observant and intelligent people like the Maoris should be without traditions of such exciting sport as moa-hunting, had they ever engaged in it. And these traditions, did they exist, would not be confined to particular localities, but would be met with in every part of these islands in which the remains of the *Dinornis* are found. I have occasionally heard in the North Island stories of moa hunts, but they were regarded by all, but those perhaps who related them, as pure fabrications. In common with most people, I was long under the impression that the extinction of the Moa was an event of recent date, and hastened by the Maori. I took it for granted that the natives only required to be questioned to afford every information regarding its nature and habits, and the causes of its disappearance. Further inquiry, however, has led me to think that the Maoris were not moa-hunters, and that the bones that strewed the plains of Canterbury were lying there at a period anterior to the last migration from Hawaiki. I am strongly confirmed in this opinion by the fact that Mr. Colenso, after careful inquiry thirty-three years ago—when circumstances were more favourable for the collection of reliable traditions—came to the same conclusion. I may remark, in passing, that Sir George Grey published a collection of traditions gathered from all parts of New Zealand. In none of them is any allusion made to moa-hunting, though frequent references are made to kiwi and weka-hunting, and sport of other kinds. But how are we to account for any allusions to the Moa at all in Maori poetry and proverbs, unless the people were familiar with it? Dr. Thompson, as quoted by the President, says "That the Moa was alive when the first settlers came, is evident from the name of this bird being mixed up with their songs and stories." But Dr. Thompson was probably not aware that the Maoris were familiar with a large land-bird which they called a Moa before ever they came to New Zealand. The name by which the Cassowary is known in the islands is Moa; and as it somewhat resembles the *Dinornis* in form, an exaggerated description of it would be a sufficiently accurate description of that gigantic bird to mislead anyone not fully prepared to question the knowledge of the Maoris upon the subject, into supposing that they were perfecrly familiar with its form and habits. I remember hearing, when a child, of the beautiful plumes that were found at the top of the cliff which overhung a cavern somewhere on the East

Coast of the North Island, where the last of the Moas hid itself. But no one I ever met had seen them. Those who described them had only heard of them from others. It is quite possible that moa feathers may have been found and used as ornaments, but it is not necessary to believe they were so to account for the description the Maoris give of them. The feathers of the Cassowary are used as ornaments in the islands where they exist, and probably the ancestors of the Maori brought some away with them. These, from their rareness, would be highly prized and carefully preserved, and when all recollection of the Hawaikian Moa had faded away, would be thought to belong to that Moa of which remains were everywhere visible. In the same way, we may account for the saying regarding the toughness of the Moa's flesh, which could only be thoroughly cooked with the twigs of the koromiko, by supposing that it was the flesh of the Hawaikian Moa, and not of the *Dinornis* that was meant. But unless the Maoris saw the *Dinornis* alive, how did they know that the bones they found strewing the earth were the bones of a bird? The largest form of land-animal life with which they were familiar on their arrival here was that of a bird which they called a Moa. Probably they found many skeletons of the *Dinornis* lying in such positions as clearly to indicate its form when alive. Being careful observers of nature, they would note the resemblance between the skeletons they found here and the skeletons of the Moa with which they were acquainted in the islands, and would at once conclude that they were identical, and call them by the same name. Against the theory of the antiquity of moa remains, it is urged that the bones which were everywhere found in good preservation twenty years ago, have entirely disappeared since then. How, it is asked, could those bones have remained in exposed situations for hundreds of years before the advent of Europeans, when so short a period has sufficed, since their arrival, to destroy all traces of them in localities where they were so plentiful? I think the efforts of the Maoris to preserve, and the efforts of the Europeans to destroy, the rank vegetation of the country, account for the preservation in one case, and the subsequent destruction in the other, of the moa remains. Ever since the peopling of these islands by Maoris, the natural vegetation has been protected as far as possible from destruction. The grass of the Canterbury plains afforded cover for the *Kiore*, native rat, which was caught in immense numbers, being highly esteemed for food. If the Maoris have inhabited these islands for five hundred years, then during that period they preserved, as far as possible, the vegetation of the plains, the decaying leaves of which would each year add to the thick covering overlying the moa remains, and which, being impervious to wet, would preserve them from the destructive action of the atmosphere. On the occupation of the country by Europeans, the vegetation was burnt, the covering removed, and the bones exposed; and successive fires, coupled with atmospheric influences, have now destroyed all traces of them. So far, I think the evidence is against the theory of the recent destruction of the Moa, but the rejection of that theory does not involve the acceptance of the other, which refers the extinction of the Moa to a period immeasurably distant.

Art. VI.—*On Recent Moa Remains in New Zealand.*
By James Hector, M.D., F.R.S.

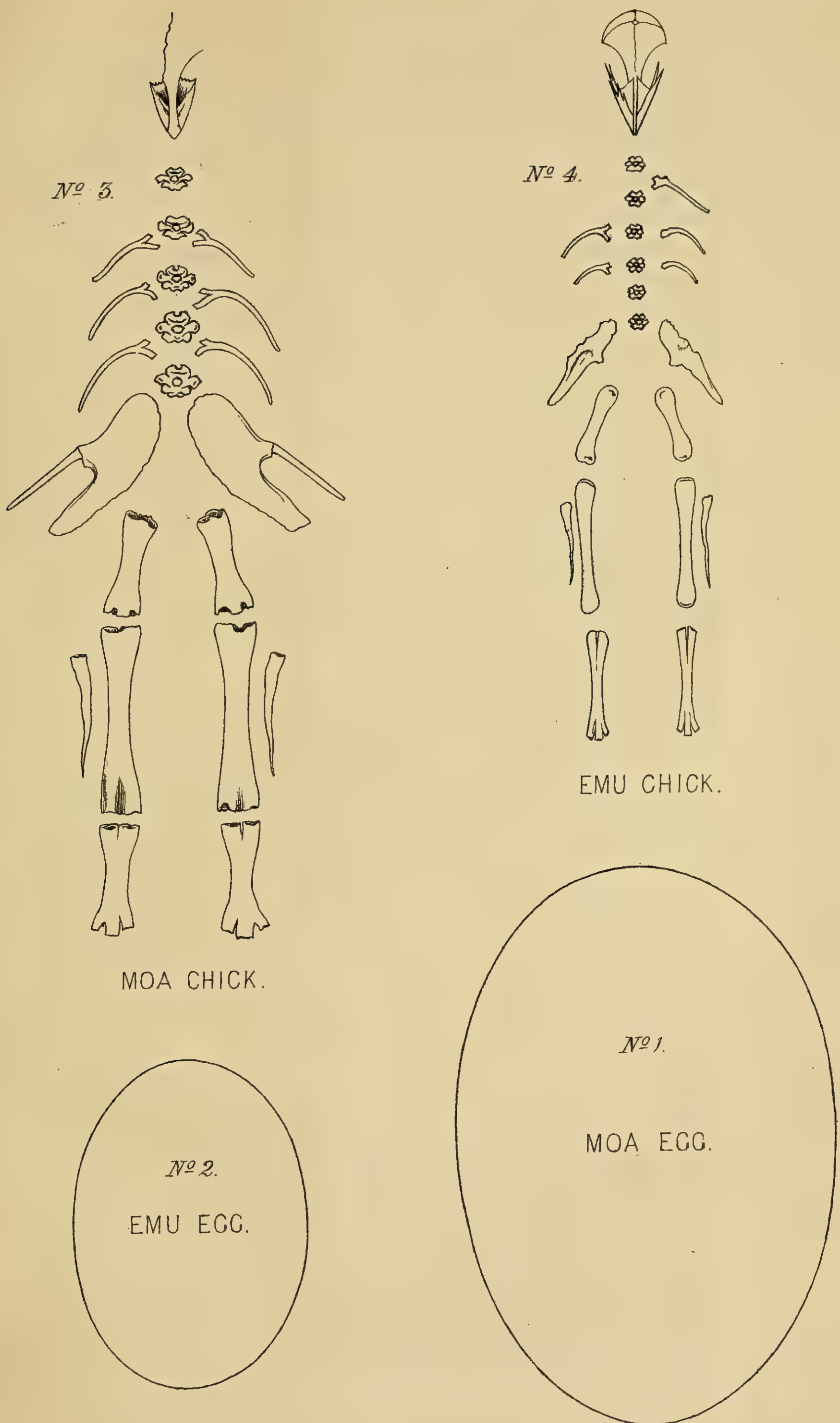
(With Illustrations.)

[*Read before the Otago Institute, 16th September,* 1871.]

It will be in the recollection of some members of this Society that in January, 1864, a remarkably perfect specimen of the Moa was found near Tiger Hill, on the Manuherikia Plains, in the interior of the province of Otago, and that it was transmitted to the Museum at York. Before the bones were packed for Europe, I was afforded an opportunity of examining and figuring them, and a photograph of the restored skeleton is in the Otago Museum. They afterwards formed the subject of a memoir by Professor Owen in the "Transactions of the Zoological Society" for 1869, who identified the species as *Dinornis robustus.*

These remains were chiefly remarkable on account of the well-preserved condition of some parts of the skeleton, portions of the ligaments, skin, and feathers, being still attached to some of the bones; whereas moa bones, in the condition in which they are usually found, are to some extent fossilized, or at least have undergone sufficient chemical change to deprive them not only of all ligamentous appendages, but to some extent of their original proportion of organic matter.

The discovery in the following year of a Moa's egg, containing the bones of an embryo chick, in a road cutting at Cromwell, was recorded by me in 1867. ("Zoological Transactions," London.) This egg was found imbedded in sand two feet below the surface, and was unfortunately broken by the workmen who extracted it, so that many fragments were lost. Those which remain have, however, been fitted together, and give the form of more than one half of the egg, which appears to have had the following dimensions:—Long diameter, 8·9 inches; short diameter, 6·1 inches. A model of this egg, which I have lately prepared, will be found in the Otago Museum, together with a model of the great egg which was obtained by Mr. Fife at the Kaikouras, and another that was found by Mr. Mantell near Oamaru in 1849. The texture of the shell of the Cromwell egg is soft and chalky, having, no doubt, been corroded by solvents contained in the soil. In order to ascertain



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J.B. del. et lith.

the probable extent of change to which the egg-shell has been subjected in this manner, a fragment was analysed and proved to contain only ·9 per cent. of organic matter, while the egg-shell of the Emu contains as much as 7·89 per cent., from which we may infer that the shell of the Moa egg had been almost wholly deprived of its animal matter.

I happen to have in the Museum an egg of the Emu, also containing the bones of a chick which had reached about the same stage of development, so that I was able to institute some very interesting comparisons. The principal difference in the outward appearance of the bones is, that while the Moa chick bones are of a light brown colour, spongy texture, and adhere to the tongue like baked clay, the Emu chick bones have a dense brittle structure, white colour, and smooth surface that is not porous. The most remarkable feature, however, is the enormous disproportion in the bones of the extremities, while there is very little difference in size between the *crania* and total relative height. Thus the length of the Moa chick may be estimated at 14·5 inches, and that of the Emu chick at 13 inches; and the weight of the bones of the limbs and *pelvis* in the Moa is 167 grains, while in the Emu chick it is only 40·5 grains, or in the proportion of four to one. I compared the specific gravity of the bones for the purpose of determining roughly the extent to which those of the Moa chick had been fossilized, and obtained the following results :—

Moa chick	sp. gr. of bone 1·538
Emu chick	1·577
Ordinary moa bone	1·700 to 1·979

We thus find that no marked change had taken place in the density of the bones of the chick, the shell having, no doubt, protected them from the action of the soil. Plate VI., figs. 1 to 4, shows the relative size of the Moa and Emu eggs and chicks reduced to one-third natural size.

I have now to describe another remarkable specimen from the same district, being the cervical *vertebræ* of a Moa, apparently of the largest size, upon the posterior aspect of which the skin, partly covered with feathers, is still attached by the shrivelled muscles and ligaments.

The specimen in question belongs to Dr. Thomson, of Clyde, who obtained it from a gold-miner, and kindly forwarded it to me for description. It was discovered in a cave, or under an overhanging mass of mica schist—the locality being thus described by Dr. Thomson, who has since visited it :—

"The cave in question lies at the foot of the Obelisk range of hills, and about four miles from its summit. I am unable to give you its proper geographical position, as we had no compass with us. It is situated at the back of a large rock, which stands about seventy feet high from the ground, and to me it appears to be more a rent and crumbling away of the sides of rocks round about. There are two openings, one of which is immediately opposite Alexandra, the other towards the Obelisk; the former is a steep incline, the other exactly like a funnel, and is in the centre of a flat about a quarter of an acre in extent, while the former is surrounded by rocks. The descent into the cave, which is accomplished by sliding down feet foremost, is by the former opening—by the other opening the descent is difficult; the two openings communicate with each other. On entering what may be termed as the first or upper floor, you have to be in a bent position. This floor is composed of loose dirt, pieces of wood, and other rubbish, and a few bones, and is bounded on all sides by rocks; and it is here that the separation of the rock is most apparent, and the fracture can be easily traced on all sides. Below this is another floor, to enter which you have to go on your face and slide under a piece of rock about ten feet long, there being just sufficient room to pass through, and the descent is also an incline. In this compartment, where you are altogether unable to stand, stooping, or rather kneeling and sitting, being the only positions that can be assumed, are found all the bones, lodged against the side of the rock (towards the south). The position may be described as that assumed by a ship when lying well over on her side. Below this floor are others, which become rocky as you descend, and in which are observed other rents. The entire depth of the cave from the surface is at least from forty to fifty feet. I have been so far minute in describing the place in order to give you some idea of how the bones found got there. I may mention that in the third floor the height is at least ten feet, so that there is plenty of room for standing erect.

"At our visit, and on entering the first floor, our attention was attracted to the remains of a fire. We found numerous charred bones, both moa bones and sheep bones, pieces of wood, and spear grass. No bones worthy of note were obtained here, but on entering the second floor, and by scraping away the loose dirt to a depth of two feet, we came upon numerous bones—*femora, tibiæ, fibulæ*, ribs, *vertebræ*, tracheal rings, and œsophageal rings, and pieces of skin and muscle, also bones of the toes and tarsal bones, and a portion of a *pelvis*. In the third storey we found pieces of egg-shell and the bones of some kind of flying bird (the keel on the breast-bone indicating the kind of bird).

"Our visit was paid rather late in the day, and as it began to rain and snow alternately we had to leave. Since then other people have been into the cave, and one man found a perfect head with lower jaw and tracheal rings attached; these were found lying whole. They also found a large lower jaw. The latter I have now in my possession, but the former the finder would not part with.

"On one of the thigh bones portions of muscular tissue are observed, in pretty good preservation, and found at the same spot where the portion of neck was found.

"I have been able to make out pretty distinctly the remains of eight birds, there having been found sixteen *tibiæ*, of course not all complete. I have referred to the remains of a fire in the cave; a great many pieces of charred bones were found in the first floor, chiefly of the *femur;* in the second floor a number of claws were found, and these were nearly all charred, and of all the leg bones only two were found slightly charred. Two *tibiæ* are evidently those of a young bird, as the ends are undeveloped, also a portion of *pelvis* evidently belonging to the same bird; these bones are thin and soft, much more so than any yet found either in that cave or elsewhere.

"My impression is that the flat ground round about the opening opposite the mountain was the camping ground of the birds, and, having been killed either on the flat or higher up the hill, their remains were washed down into the cave and deposited on the side of the cave above alluded to, for it is impossible to imagine how such gigantic birds could have found their way into the cave, unless, indeed, the openings were at some anterior period larger, and have since become closed by an earthquake or by the settling down of the huge rock. The idea of a landslip is negatived by the presence of the rocks and the entire flatness of the ground round about. They may, however, have been killed and then roasted in the cave, but it is difficult to say, especially as no implements have been found in or near the vicinity of the cave.

"Of the portions of egg-shells found, it may be stated that these were, along with the remains of the winged birds, found at the lowest and deepest part of the cave, in small crevices of the rock. In my opinion the only possible way of arriving at any positive conclusion as to how the bones got into the cave is a thorough examination of the country lying above the place, in order to see if any slip had ever occurred. I am inclined to think that they have been washed down, as a quantity of sheep manure and pieces of wood are scattered about the place, and such marks as are left after a place has been flooded are distinctly seen."

"I have again visited the cave, and still adhere to my former impressions. At this visit only a few claws were got, and a few tracheal rings and *vertebræ*.

"At another place (Butcher's Gully) bones have been found; a *tibia*, thirty-two inches long, has been got, which I have in my possession. Other bones have been found, and are to be sent in to me, and it is my intention to pay a visit to this place, about which I shall inform you if you think it necessary.

"Along with this I forward you a few feathers found half-way between Alexandra and Roxburgh.* They were found by a miner, eighteen feet below the surface of the ground, while sluicing. Perhaps you have already in your possession feathers, but these may not be unacceptable, and tend to show

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* Described by Captain Hutton, see *post*.

that the Moa was largely distributed over this part of the island, and has but recently become extinct."*

The total length of Dr. Thomson's specimen is 16·5 inches, and includes the first dorsal and last six cervical *vertebræ*, with the integument and shrivelled tissues enveloping them on the left side.

The surfaces of the bones on the right side, where not covered by the integument, are quite free from all membrane and other tissues, but are quite perfect, and in good preservation, without being in the least degree mineralized.

The margin of the fragment of skin is sharply defined along the dorsal edge, but elsewhere it is soft, easily pulverized, and passing into adipocere.

The circumference of the neck of the bird, at the upper part of the specimen, appears to have been about eighteen inches, and the thickness of the skin about three-sixteenths of an inch.

The only indication of the *matrix* in which it had been imbedded, was a fine micaceous sand that covered every part of the specimen like dust, there being no clay or other adherent *matrix*. On removing the sand with a soft brush from the skin, it was discovered to be of a dirty red-brown colour, and to form deep transverse folds, especially towards the upper part. The surface is roughened by elevated conical *papillæ*, from the apex of some of which springs a slender transparent feather-barrel, never longer than half an inch. On the dorsal surface a few of the quills still carry fragments of the webs, some being two inches in length. From this it appears that the colour of the barbs was chestnut red, like *Apteryx Australis*, but that they had two equal plumes to each barrel, as in the Emu and Cassowary; and in that respect differed from the *Apteryx*, the feathers of which have not any after-plume. On the other hand, the barbs of the webs of the feathers do not seem to have been soft and downy towards the base as in the Emu. From the direction of the stumps of the feathers it is evident that the portion of the neck which has been preserved is that contained within the trunk of the body, and which, in the natural position, has a downward slope, the cervical end of the spine being where the upward sweep of the neck of the bird commenced, which accounts for the absence of the *trachea* with its hard bony rings, no trace of which was

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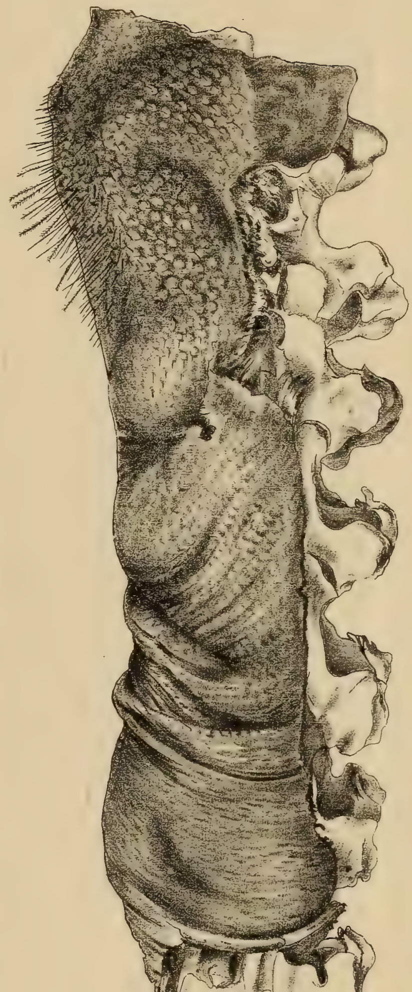
* Writing to me on 18th October, 1871, of some moa remains found in the same district, Mr. W. A. Low says:—"I have obtained a well-preserved piece of the bird's flesh, with portions of down and numerous feather-barrels observable on the outer surface. The flesh is not the least fossilized, simply well dried, and can be easily separated into fibres. You remember what quantities of rats used to infest this part of the country eight or nine years ago; they were legion, and I am astonished that this fragment should have escaped their ravages—perhaps on purpose that it might ultimately come into your hands, and enable you to settle the vexed question of the period of the existence of these gigantic birds, which once roamed in such immense numbers in this old lacustrine region."

c



b

Buchanan del. et lith.

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that the Moa was largely distributed over this part of the island, and has but recently become extinct."*

The total length of Dr. Thomson's specimen is 16·5 inches, and includes the first dorsal and last six cervical *vertebræ*, with the integument and shrivelled tissues enveloping them on the left side.

The surfaces of the bones on the right side, where not covered by the integument, are quite free from all membrane and other tissues, but are quite perfect, and in good preservation, without being in the least degree mineralized.

The margin of the fragment of skin is sharply defined along the dorsal edge, but elsewhere it is soft, easily pulverized, and passing into adipocere.

The circumference of the neck of the bird, at the upper part of the specimen, appears to have been about eighteen inches, and the thickness of the skin about three-sixteenths of an inch.

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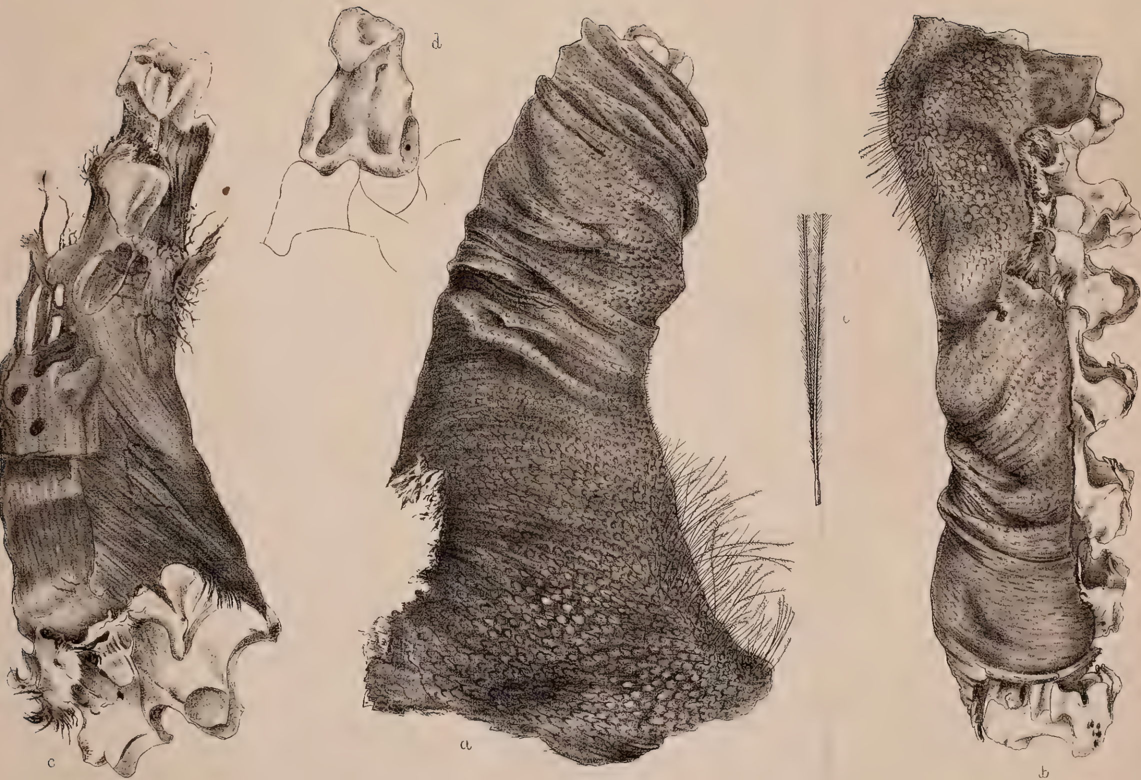


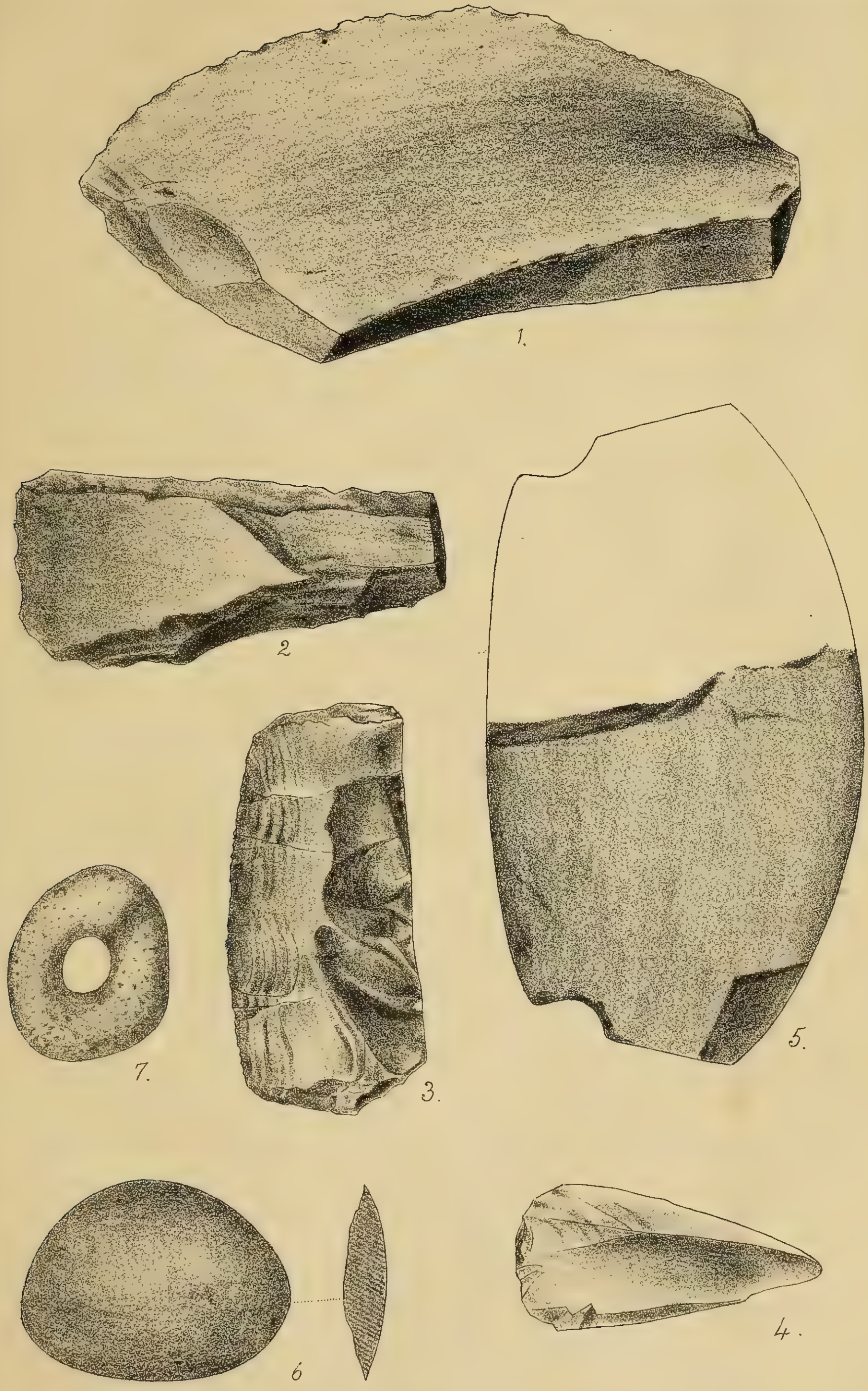
NECK OF MOA

J. Buchanan del et lith.

found among the soft parts which have been preserved. The integument was easily removed on dividing the few threads of dried tissue by which it was attached. The shrivelled up soft parts thus displayed could not be clearly distinguished, but may be guessed as follows: — 1st. A strong band of ligamentous tissue, connecting the spinous processes. 2nd. Intervertebral muscles and ligaments. 3rd. A sheath diverging from the lower part of the spine. The only bone present besides the *vertebræ* was attached to this sheath by its tip, the other extremity having been articulated to the first dorsal, as shown in the accompanying drawing, Pl. V. fig. *d*. Fig. *a* is the side view, showing the integument. Fig. *b* is the dorsal aspect, showing the portions of the *vertebræ*, which are covered and uncovered. Fig. *c* is a view of the soft parts after the removal of the skin.

The above interesting discoveries render it probable that the inland district of Otago, at a time when its grassy plains and rolling hills were covered with a dense scrubby vegetation or a light forest grôwth, was where the giant wingless birds of New Zealand lingered to latest times. It is impossible to convey an idea of the profusion of bones which, only a few years ago, were found in this district, scattered on the surface of the ground, or buried in the alluvial soil in the neighbourhood of streams and rivers. At the present time this area of country is particularly arid as compared with the prevalent character of New Zealand. It is perfectly treeless—nothing but the smallest-sized shrubs being found within a distance of sixty or seventy miles. The surface features comprise round-backed ranges of hills of schistoze rock with swamps on the top, deeply cut by ravines that open out on basin-shaped plains formed of alluvial deposits that have been everywhere moulded into beautifully regular terraces, to an altitude of 1,700 feet above the sea-level. That the mountain slopes were at one time covered with forest, the stumps and prostrate trunks of large trees, and the mounds and pits on the surface of the ground which mark old forest land, abundantly testify, although it is probable that the intervening plains have never supported more than a dense thicket of shrubs, or were partly occupied by swamps. The greatest number of moa bones were found where rivers debouch on the plains—and that at a comparatively late period these plains were the hunting-grounds of the aborigines, can be proved almost incontestably. Under some overhanging rocks in the neighbourhood of the Clutha river, at a place named by the first explorers "Moa Flat," from the abundance of bones which lay strewn on the surface, rude stone flakes of a kind of stone not occurring in that district, were found by me in 1862 associated with heaps of moa bones. Forty miles further in the interior, and at the same place where the Moa's neck was recently obtained, Captain Fraser, in 1864, discovered what he described to me as a manufactory for such flakes and knives of chert as could be used as rough cutting instruments, in a cave formed by overhanging rocks, sheltered only from south-west storms, as if an accumulation by a storm-stayed party of natives. With these were also associated moa bones, and other remains. Again, on the top of the Carrick mountains, which are in the same district, but at an altitude of 5,000 feet above the sea, the same gentleman discovered a gully, in which were numerous heaps of bones, and along with them native implements of stone, among which was a well-finished cleaver of blue slate, Pl. VII. fig. 5, and also a coarsely-made hornstone cleaver, the latter of a material that must have been brought from a very great distance.

Still clearer evidence that in very recent times the natives travelled through the interior, probably following the Moa as a means of subsistence, like natives in the countries where large game abounds, was obtained in 1865-6, by Messrs. J. and W. Murison. At the Maniototo plains bones of several species of *Dinornis*, *Aptornis*, *Apteryx*, large Rails, *Stringops*, and other birds are exceedingly abundant in the *alluvium* of a particular stream, so much so that they are turned up by the plough with facility. Attention was arrested by the occurrence on the high ground terrace which bounds the valley of this stream, of circular heaps composed of flakes and chips of chert of a description that occurs only in large blocks along the base of the mountains at about a mile distant. This chert is a very peculiar rock, being a "cemented water quartz," or sandy gravel converted into a hard quartzite, by infiltration of silicious matter. The resemblance of the flakes to those they had seen described as found in the ancient kitchen-middens, and a desire to account for the great profusion of moa bones on a lower terrace shelf nearer the margin of the stream, led the Messrs. Murison to explore the ground carefully, and by excavating in likely spots they found a series of circular pits partly lined with stones, and containing, intermixed with charcoal, abundance of moa bones and egg-shells, together with bones of the dog, the egg-shells being in such quantities that they consider that hundreds of eggs must have been cooked in each hole. Along with these were stone implements of various kinds (reduced to one-third natural size in Pl. VII., figs. 1 to 4), and of several other varieties of rock besides the chert which lies on the surface. The form and contents of these cooking ovens correspond exactly with those described by Mantell in 1847, as occurring on the sea coast; and among the stone implements which Mantell found in them, he remembers some to have been of the same chert which occurs *in situ* at this locality, fifty miles in the interior. The greater number of these chert specimens found on the coast are with the rest of the collection in the British Museum. There is another circumstance which incidentally supports the view that while the Moas still existed in great numbers, the country was open and regularly traversed by the natives engaged in hunting. Near the old Maori ovens on the coast, Mantell discovered a very curious dish made of steatite, a mineral occurring in New Zealand only on the



To accompany Paper by Dr. Hector.

J.B. del et lith

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West Coast, rudely carved on the back in the Maori fashion, and measuring twelve by eight inches and very shallow. The natives at the time recognised this dish by tradition, and said there were two of them. It is very remarkable that since then the fellow dish has been discovered by some gold-diggers in the Manuherikia plain, and was used on a hotel counter at the Dunstan township as a matchbox, till it was sent to England, and, as I am informed, placed in a public museum in Liverpool.

The manner in which the Maoris use their cooking ovens suggested to me an explanation of the mode in which these flakes of chert came to be found in such profusion, while only a few of them show any sign of having been trimmed in order to fit them for implements. The native method of cooking is to heat the hardest stones procurable in the fire, and then placing the food to be cooked on top, to cover the whole with green leaves and earth, and through an opening pour in water, which, coming in contact with the hot stones, causes the formation of steam by which the food is cooked. If masses of the white chert be heated and quenched with water in this manner, the result is the formation of flakes of every variety of shape with sharp-cutting edges. It is natural to suppose that when one of these flakes was found to be of a shape convenient for a particular purpose, such as a knife, cleaver, or spear-head, it was trimmed and dressed somewhat in the manner of a gun-flint when the edge became defective, rather than cast away, and favourite forms might be preserved and carried even as far as the coast.

This suggested explanation of how a race, advanced probably far beyond the so-called period of such rude implements, might yet find it convenient to manufacture and use them, is supported by the circumstance that along with the trimmed chert flakes the Messrs. Murison found polished adzes of aphanite, and even jade, which shows that the hunting natives had, in addition to the flake knives, the same implements as those which are so common among the natives at the present day, though their use is now superseded by iron.

In the ovens on the coast, besides flakes and rough knives of chert and flint, are found flake knives of obsidian, a rock which only occurs in the volcanic district of the North Island, and also adzes and stone axes of every degree of finish and variety of material. Although there is no positive evidence in the latter case that more highly finished implements were in use by a people co-temporaneous with the Moa, whose remains, collected by human agency, are so abundant in the same place, nevertheless the fact of a similar association occurring far in the interior, affords strong presumptive evidence on this point, as the finely finished implements must have been carried inland, and to the same spots where the moa remains occur, to be used at native feasts, of which these bones are the only other existing evidences.

So far I have been dealing with evidence gathered in the South Island of the recent co-existence of Man and the Moa, but in the North Island there is no lack of similar proofs. During the summer of 1866 His Excellency Sir George Grey made a fine collection at Waingongoro, on the West Coast of this island, being the same locality in which Mantell gathered the magnificent series of bones which he forwarded to Europe in 1847. At this place, along with the bones of the Moa and other extinct birds, were found those of dogs, seals, and many species of birds that are common at the present day, such as the Albatross, Penguin, *Nestor*, *Porphyrio*, and notably the *Notornis*, a gigantic Rail, which, till a comparatively recent date, was supposed to be, like the Moa, extinct, and of which as yet only two living examples have been obtained. Associated with these remains Sir George Grey obtained artificially-formed stone flakes of a very peculiar kind, being chips from rolled boulders of hard crystalline sandstone, produced by a single blow—probably when the stone was heated and quenched in water. (Pl. VII., fig. 6, also similar flakes found by Dr. Haast, Pl. IV.) The stones from which these chips were obtained had evidently been used in the first instance for cooking—as ancient umus or cooking ovens are chiefly formed of them; and, indeed, in many localities in sandy tracts on the West Coast where stones are rare, the identical stones that in former days were used for cooking Moas are still in use by the natives of the district for cooking pigs and shell-fish. Here, again, we find that the same necessity and circumstance that suggested the use of the chert flakes in the south, apparently gave origin to a similar adaptation of the chips from the sandstone boulders. It is of some interest to find that native tradition points to Waingongoro as the spot where the first Maori immigrants originally settled, and there appears to be nothing in the abundant traces which they have left of the great feasts which we must refer to this period that would indicate any difference in their domestic habits from those of the Maoris now existing, and who no doubt are their direct descendants. What has been advanced affords evidence that the Moas, although belonging probably to a race that was expiring from natural causes, were finally exterminated through human agency; and on this subject Mr. W. D. Murison has suggested how infallibly the wholesale consumption of the eggs, which were evidently highly prized as an article of food, must have led to their rapid extinction, without it being necessary that the birds themselves should be actually destroyed. That wide-spreading fires contributed in some instances to the destruction of these wingless birds, is rendered probable from the occurrence of little heaps of bones in spots where flocks of them would be overtaken when fleeing before the destroying element. At the south-west extremity of a triangular plain by the side of the Wakatipu Lake, in 1862, I counted thirty-seven of such distinct skeleton heaps, where the steep rocky slope of the mountains, covered with fallen blocks and tangled shrubs, meets the lake, and would therefore stop the progress of the fugitives in this direction. From what we know of the habits of birds akin to the Moa, we may fairly infer that they did not frequent heavily-timbered country, but roamed over the grass-covered plains and mountain slopes. This view is supported by the comparative rarity of moa remains in forests, the few exceptions being easily accounted for.

The whole of the eastern district of the South Island of New Zealand back to the Southern Alps, was completely surveyed and mapped as early as 1862, and had been thoroughly explored at least ten years before that date, without any of these gigantic birds being met with ; but there is a large area of rugged mountainous country, especially in the south-west district of Otago, that even to the present time is only imperfectly known. The mountain sides in this region are covered with open *fagus* forest, in which Kiwis, Kakapos, and other expiring forms of apterous birds, are still to be found in comparative abundance, but where we could scarcely expect to meet with the larger species. Nevertheless, owing to the peculiar configuration of this country, the mountains afford very extensive areas, above the forest limit, which are covered with alpine shrubs and grasses, where it is not impossible that a remnant of this giant race may have remained to very recent times. The exploration, however, to which the country has been subjected during the last few years, by parties of diggers prospecting for gold, forbids the hope that any still exist. I may here mention that on one of the flat-topped mountains, near Jackson's Bay, which I visited in January, 1863, I observed, at an altitude of 4,000 feet, numerous well-beaten tracks, about sixteen inches wide, intersecting the dense scrub in all directions, and which, owing to the height of the scrub, could only have been formed in the first instance by the frequent passage of a much larger bird than either the Kiwi or Kakapo, which, judging from the droppings, were the only birds that now resorted to them. On the sides of the tracks, especially near the upper confines of the forest, are shallow excavations, two or three feet in diameter, that have much the appearance of having been scraped for nests. No pigs or any other introduced animal having penetrated to this part of the country, it appears manifest that these are the tracks of some large indigenous animal, but, from the nature of the vegetation, it is probable that such tracks may have been for a very long period in disuse, except by the smaller ground birds, without becoming obliterated.

The above facts and arguments in support of the view that the Moa survived to very recent times are similar to those advanced, at a very early period after the settlement of the colony, by Walter Mantell, who had the advantage of direct information on the subject from a generation of natives that has passed away. As the first explorer of the artificial moa beds, his opinion is entitled to great weight. Similar conclusions were also drawn by Buller, who is personally familiar with the facts described in the North Island, in an article that appeared in the "Zoologist" for 1864. The fresh discovery, therefore, of well-preserved remains of the Moa only tends to confirm and establish this view, and it would have been unnecessary to enlarge on the subject by the publication of the foregoing notes, which were long since written, but for the dissimilar conclusions arrived at by Dr. Haast, in a recent address to the Canterbury Institute, which, from the large amount of interesting and novel matter it contains, will doubtless have a wide circulation. (See p. 66 *et seq.*)

Art. VII.—*Notes on Moa Remains.* By W. D. Murison.

[*Read before the Otago Institute, 16th September,* 1871.]

Dr. Hector, in his paper, refers to certain information which he obtained from me in 1866, relative to the discovery of moa remains in old cooking places on the Maniototo plains. I shall take the opportunity therefore of adding a few notes upon this interesting subject, in the hope that my observations will assist in solving some questions concerning the Moa, which have formed matter of controversy, and which still remain unsettled. Nearly every writer on New Zealand has had something to say about the wingless birds which formerly inhabited the country, but remarks concerning them have been confined chiefly to descriptions of the bones, to the conditions under which they have been found, and to inquiries about the Moa amongst the Maori tribes in the North. It was not until about six months ago, when Dr. Haast delivered his inaugural address to the Philosophical Institute of Canterbury, that any attempt, so far as I am aware, has been made to determine the approximate date of the disappearance of the Moa, or to show that the bird was known only to a race of people which is now extinct. (See Art. IV., p. 66.) Dr. Haast has met with great success in his search after moa remains, and mainly through his exertions the Christchurch Museum has acquired probably the finest collection of moa bones and skeletons that can be seen anywhere. In his able and exhaustive address he narrates fully the results of his investigations, and he indicates the conclusions which they have led him to arrive at. He contends that the large birds of New Zealand were the representatives of the gigantic quadrupeds of the northern hemisphere in the post-pliocene period; that New Zealand at the time of the arrival of the Europeans was in the neolithic period, or that of polished stone implements; but that there has been a palæolithic period, or age during which stone and flint implements, rudely fashioned, were used; that the Moa frequented the grassy plains of the interior during the latter period, and was hunted by a people who inhabited these islands before the arrival of the Maoris; and that hunters and hunted have both passed away. He remarks upon the absence of traditions among the Maoris concerning the Moa, and considers it inconceivable that natives who have traditions going back several hundred years, should have no account of the extinction of their principal means of existence ; and he is of opinion that overwhelming evidence can be brought to show that the forefathers of the Maoris not only neither hunted nor exterminated the Moa, but that they knew nothing about it. He addresses himself, in the first place, to the geological evidence which can be brought to bear to determine the age of the Moa. He confesses he has never observed the bones exposed on the surface of the ground, in the same way as he has been informed they frequently occur in Otago. He refers, also, to the small heaps of crop stones that are often met with in the latter province, and he admits that the occurrence of these, together with bones, on the surface of the ground is difficult to account for, when the absence of native traditions concerning the bird is borne in mind. He refers to the careful researches of Colenso and Stack, and he quotes the opinion of the former, who holds that the period of time in which most probably the Moa existed was certainly either antecedent or coetaneous to the peopling of these islands by the present race of New Zealanders. He alludes, also, to the discoveries of Mr. Mantell, and expresses a belief that he was the first to draw the attention of scientific men to the fact that man had been co-temporaneous with the *Dinornis.* What may be called the second part of his address is taken up chiefly with an account of his investigations of old kitchen-middens and cooking places on the banks of the Little Rakaia. He describes at great length the construction of the former, and the character of the implements and bones he dug up. It is not my intention, however, to follow Dr. Haast in the interesting investigations he made. I have indicated some of the leading points of his exhaustive address, and I must pass on to my own observations. At the foot of Roughbridge, where the Puke-toi-toi creek enters the Maniototo plain, I assisted in forming a station some ten years ago; and although I had had occasion to observe near the coast, and in other parts of the interior, the bones of the Moa, I was at once struck with the frequency of their occurrence at this place, as well as with the excellent state of preservation in which they were found. Scarcely a hole could be dug without some of those remains being exposed; and when the land came to be cultivated, bones and fragments of egg-shells in great number were laid bare by the plough. The bones most frequently picked up under these conditions were those of the feet belonging to the larger species of the *Dinornis*, and the *femur* and *tibia* of the *Aptornis*—a bird which stood some three feet high, whose remains are rarely met with in other localities. It was not till 1865, however, that any discovery of cooking places was made. These were first observed by my brother, when, in riding along the banks of the creek, he noticed a chain of hollows which he conjectured were Maori ovens filled up. Further investigation showed that they had been used for cooking the Moa, great quantities of bones being discovered in each oven that was examined. The ovens lay about ten or fifteen yards from the creek, and were covered with about six inches of silt. Mixed with the pieces of half-charred bones were innumerable fragments of moa egg-shells. In some of the cooking places these latter were found in layers, showing that a vast number of eggs must have been consumed as food. And scattered through the ovens were found rude chert implements, many of which bore signs of having been used. Most of these were fashioned like knives, and had been employed, no doubt, to cut the flesh and sinews of the bird. Some heavier implements were also found; one of these was shaped like a cleaver, and had probably been used to break the large bones. In one oven the jaw of a young dog was discovered, mixed up with the bones and knives; and from the same place were taken out several fragments of polished stone implements. A great deal of importance is to be attached to the discovery of the latter under such conditions, as, if it is conceded that the polished implements and the chert flakes were used by the same people, Dr. Haast's theory of a palæolithic period and a neolithic period for New Zealand will have to be abandoned. The two different kinds of implements have, according to Dr. Haast, been found at the same spot, but he thinks that careful research will prove that they have not been used at the same time nor by the same people. On the banks of the Little Rakaia greenstone adzes and other polished Maori implements have been turned up by the plough; but he explains that it is known that the Maoris frequented the locality on account of it being a favourable fishing ground. In the case of the Puke-toi-toi Creek, however, it is unlikely that the natives ever visited the spot with any other object than that of moa-hunting. There is a small volume of water in the creek, and there being no eels in it there was nothing to attract the natives to the locality. Even such a common article of food as the *Unio*, a fresh water mollusc, which is to be met with in great quantities in the Taieri River, some four miles distant, does not inhabit the creek. It appears tolerably certain, therefore, that the moa-hunters were the only people who ever visited this encampment, as no known means of sustenance is to be procured nearer than the Taieri River. I think it clearly established, from what I have stated, that the moa-hunters used both polished and rudely fashioned stone implements. The latter were easily made, and must have been of greater service in cutting the flesh of the Moa than any of the polished tools we know of. On the terrace above the ovens, and within about twenty yards of them, was found the place where those rude knives had evidently been manufactured. Traces of fires were to be seen, full of innumerable fragments of chert, and all round the fires broken stone knives could be picked up. A further examination of the *dêbris* of those fires which had been kindled on the flat surface of the terrace, showed that numerous fragments of egg-shell were mixed up with the chips. This looked as if those who were watching the stones, which were being heated to be broken up for knives, had passed away the time by cooking omelettes. There can be no doubt that the egg of the Moa formed a favourite article of food with those hunters, from the frequency of the occurrence of egg-shells in the ovens, and this circumstance very naturally suggested the idea that the extermination of the bird may have been brought about by this cause. The nests would be easily discovered, as the country generally was open and grassy, with patches of low scrub at the foot of the hills. The encampment I have referred to was in the midst of a clump of *korokio*, burnt patches of which were found on the low grounds in many parts of the interior when the first European settlers occupied the country. Chert knives, some of which bore signs of having been used, have been found scattered over a large area of ground in the vicinity of the encampment, and I should add that several polished stone axes have been found on or near the surface of the ground in the immediate neighbourhood. Upon the whole, my observations have led me to arrive at different conclusions from those of Dr. Haast, Mr. Colenso, and the Rev. Mr. Stack. The former admits, in referring to certain researches of Mr. Mantell in the North Island, that "if further investigations of these interesting localities would prove beyond a doubt that really the bones of man, moa, and dog, with flint chips and true Maori implements, occur together, and have not been mixed up accidentally, the present indigenous race having chosen the same favourable spots for their camping ground as the moa-hunters did before, the question, so far as the Northern Island is concerned, would soon be settled." I contend that, so far as the interior of this province is concerned, an analysis of the Puke-toi-toi cooking places has proved that the Moa has lived in comparatively recent times, and that the moa-hunters were, in all probability, the progenitors of the race now inhabiting the island. I do not attach much importance to the argument that if the Moa had been alive when Captain Cook visited New Zealand a hundred years ago, such a careful inquirer as the great navigator was must have heard of its existence, and would have alluded to it in his works. This argument can only hold good if it can be shown that Captain Cook visited a locality where moa remains have been found under conditions that would lead to the supposition that they were of comparatively recent date. I think, from the evidence we are in possession of, there is every reason to suppose that the *Dinornis* has existed within the last hundred years. In some work on New Zealand, I have seen it mentioned that the captain of a whaler who visited the mouth of the Molyneux River about the commencement of the present century, reported that he had seen the bones of the Moa, with the flesh adhering, in the possession of the Maoris, and I think that the frequent occurrence of bones on the surface throughout the lower Clutha valley, and the freshness of the remains in many other parts of the province, is quite compatible with a belief that the bird was alive at that time. In favour of the hypothesis that the Moa became extinct some five hundred years ago, Dr. Haast quotes the opinion of Colenso and others, who have been unable to find that the Moa has a place in Maori traditions, which go back for many centuries. The theory advanced by those authorities may be a perfectly correct one as regards the North Island, but it can in no way be advanced as an argument why the Moa did not exist in the interior of this province a century ago, or in any other part of the island concerning which the Maoris have no traditions. There can be no doubt that Otago presents a splendid field for palæontological research in this direction, and it is from a careful examination of the caves and cooking places of the interior that we may ultimately hope to have the approximate date of the extinction of the Moa determined. It is from these sources, also, that we may expect to learn something definite about the people who assisted to exterminate it. The recent discoveries of Dr. Thomson and Mr. Arthur in the caves near Clyde, if followed up, may tend to throw considerable light upon the question which has been raised; and it is to be hoped that an effort will be made to expedite investigations in that quarter. Whatever the results of future inquiries may be, I am strongly of opinion that each fresh discovery will tend to show that the theory of palæolithic and neolithic periods in New Zealand is unsustainable; that the *Dinornis* lived in comparatively recent times, and was hunted by the forefathers of the present aboriginals.

Art. VIII.—*On the Occurrence of Footprints of a Large Bird, found at Turanganui, Poverty Bay.* By Archdeacon W. L. Williams.

(With Illustrations).

[*Read before the Auckland Institute, 29th May,* 1871.]

The slabs, now in this Museum, showing the footprints of a very large bird, were procured just below high-water mark, on the right bank of the Taruheru River at Turanganui, Poverty Bay, about 100 yards from its mouth, just at the angle formed by it with the Waikanae creek. The exact position is denoted in the accompanying sketch map. (Pl. VIII.)

My attention was first called to these footprints nearly five years ago by David Millar, who at that time kept a ferry boat on the river, and lived within a short distance of the spot. The portion of rock on which the impressions were visible at that time was about fourteen feet in length and about five feet

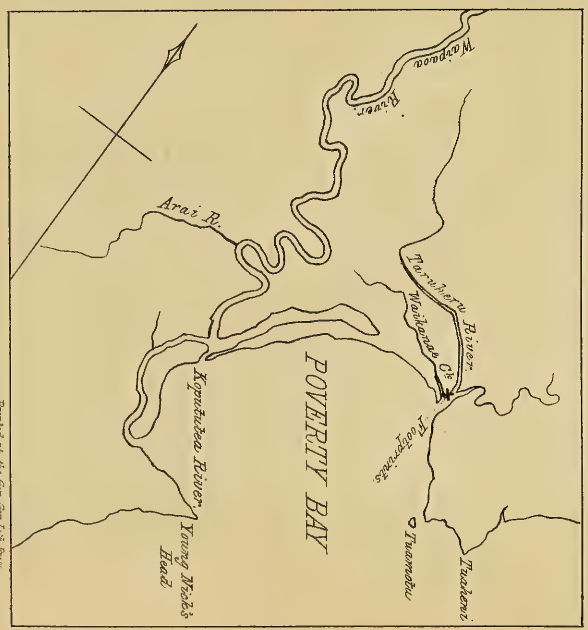
DIAGRAM

Shewing the relative position of FOOTPRINTS *of* BIRDS.

observed at POVERTY BAY.

reduced to 1/15 nat: size.

Locality marked thus + *on Plan.*



J.B. lith.

Printed at the Gen. Gov. Lith. Press

in width. The prints are such as one would imagine were made by one of the smaller species of moa. With a very few exceptions they were all of the same size, viz. :—

Extreme length from heel to tip of middle toe . .	$7\frac{7}{8}$ in.
From heel to tip of inner toe	6 in.
From heel to tip of outer toe	6 in.
Distance between tips of inner and outer toes . .	7 in.
Greatest depth of impressions	$1\frac{5}{8}$ in.

The only prints of a different size were those apparently of a young bird, all in one series and at regular intervals, every alternate impression being characterised by a peculiarity in one of the toes, which showed that they had all been made by the same bird. The removal of a portion of the overlying stratum of rock, about six inches thick, brought to view another of these smaller impressions, in the exact position which was indicated by the other members of the series. The greater number of the larger impressions were close together and pointed in various directions, as shown by the cast, which represents a few of them from a spot where they were very numerous. In the case of some of them, however, a connection could be distinctly traced, eight or more impressions following one another at regular intervals; but the stride is so short (barely twenty inches from heel to heel of two consecutive impressions) that the bird must have been walking at a very leisurely pace.

The rock in which these impressions are found is very soft, containing a large proportion of a fine pumiceous sand, and has all the appearance of being a river deposit, the birds having walked over it some little time after the fresh had subsided, when the mud was getting moderately dry. Soon after the impressions were made, a quantity of sand, much coarser than that which enters into the composition of the rock, must have been drifted over it by the wind, filling up all the foot-prints, and covering the whole surface to a moderate depth; the general thickness of the layer, after having been compressed by subsequent deposits, being about five-eighths of an inch. That this must have happened soon after the impressions were made, and before the mud had become quite dry, is indicated by the way in which this coarser sand is imbedded in the bottom of the impressions. It is owing to this layer of comparatively loose sand that the impressions have been so well preserved. Subsequent deposits of silt have taken place, covering that in which the impressions are found to the depth of about two feet. All these deposits are now being gradually worn away by the action of the water and of the weather. Overlying the whole, in the part which the water has not interfered with, is a layer of sand, gravel, shells, and soil, to the depth of four feet.

The question naturally suggests itself, what light do these footprints throw upon the age in which the Moa lived in this island? Moa bones have been found in great numbers in Poverty Bay, in years gone by, many of the earliest shipments to England having been sent from thence by the Rev. W. Williams, now Bishop of Waiapu, in 1842 and the following years. These bones were found by the natives generally in the river-beds, buried in the deep alluvial deposit which covers the bottom of the valley. None, as far as I know, have been found imbedded in the recent rocks, such as that in which the footprints occur. I have found them myself in the bank of the Kopututea River, about six feet below the surface, and I have also picked up a few on the beach at Turanganui, within a short distance of the spot where the footprints are found, but on the opposite side of the river. Whether these bones and the footprints belong to the same period is a question which it is not easy to determine. The alluvial deposit, in which the bones have been found, covers the whole of the lower portion of the valley, forming a plain of an irregular deltoid shape, the base of the triangle at the coast being about ten miles long, and the apex about eight miles inland. Running through this plain there are two rivers, viz., the Kopututea, which is formed by the confluence of the Waipaoa and the Arai, and occupies a middle position, rather towards the south-west side of the plain; and the Taruheru, which falls into the sea at Turanganui at the north-eastern corner of the bay. The alluvial deposit, averaging about twenty feet in depth, has been brought down mainly by the Waipaoa, the banks of which at the upper part of the plain are thirty or forty feet high. It is very seldom now that this river overflows its banks. The last instance of a flood, by which any noticeable addition was made to the depth of the soil on the plain, was in March, 1853, when the overflowing water found an outlet by running into the Taruheru River, leaving behind it a deposit of several inches of mud. But such an inundation had not been witnessed before by any of the natives then living, and as every year passes it becomes less likely that such a thing will occur again, in consequence of the gradual deepening of the bed of the river. Such inundations, however, must have been very frequent in early times, and as the surface of the plain grew higher and the bed of the river became deeper, they would come to be more and more rare, till, as now, they are almost entirely unknown. The growth of the deposit, therefore, under which the bones were buried, must have been very rapid at the beginning, gradually becoming slower, until at last it may be said to have ceased altogether.

The time that would be required for the depositing of twenty feet of loam by this river, and the circumstances under which the silt at Turanganui has hardened into stone, as well as the time that would be necessary for this process, are matters which I do not venture to decide.

Note.—The accompanying diagrams were made by drawing a straight line by the side of each series of impressions, and taking measurements from it to the heel and tips of the toes of each impression. The intervals between the consecutive impressions of the larger series, starting from one behind those which are represented in the diagram, were 19½, 20¼, 21¾, 19¼, 20½, 19½, and 19 inches respectively, measured from heel to heel. The intervals in the smaller series were 13½, 12½, 13, and 12¼ inches. (Pl. VIII.)

ART. IX.—*On the Occurrence of Footprints of the Moa at Poverty Bay.* By His Honour T. B. GILLIES.

[*Read before the Auckland Institute, 29th May,* 1871].

ON 2nd March last, being at Gisborne, Poverty Bay, I remembered having heard that Archdeacon Williams had discovered some moa footprints in the neighbourhood, and, on inquiry, I speedily found the spot whence he had taken out slabs containing the impressions. The spot is below high-water mark, on the Gisborne side of the Waikanae Creek, within 100 yards of its junction with the Turanganui River. On examination I found some other footprints on the surface of the same stratum, but so much effaced by the wash of the waves as to be scarcely worth removing. Judging, however, by the direction in which these semi-obliterated footsteps led, I determined to split off the overlying strata in hopes of finding some better impressions. In this I fully succeeded, as the blocks in the Museum, containing eight or ten footprints, will show you. A Mr. Worgan, of Napier, has, I see, further prosecuted my explorations. The footmarks are about eight inches in length from the extremity of the heel mark to the point of the projecting toe, and about an equal width between the extreme points of the two side toes. The extreme depth of the heel impression is about one inch to one inch and a quarter under the ordinary surface of the stone. The difference between the point of the toe and extreme of the heel in each step is between five and six inches, and this struck me as extraordinary in relation to so large a bird. Probably observations on the stride of other birds may throw light on the cause of the short distance between each footmark of the bird that left these tracks. The position in which they are found is worthy of special notice. The height of the land above the high-water mark is about five feet. This is composed of sandy alluvium, containing shelly layers of recent species. Below this occur successive strata of imperfectly solidified pumiceous sandy mud-stones, or muddy pumiceous sandstones, each of some four to six inches thick, but separated from each other by a thin layer of from a quarter to half an inch thick of pure coarse sand. These footmarks are found on about the fourth or fifth layer below the alluvial deposit above referred to, and are protected from the superincumbent layer by this thin layer of pure sand to which I have referred. These layers have a dip of about six degrees to the southward, and the footmarks were found about two feet six inches below the level of the alluvial deposit above, the rock, however, dipping eastward to about ten degrees.

My knowledge does not entitle me to build any theory on the facts observed, save this, that these footmarks are those of a bird proceeding southward over a sandy mud surface, soft enough to receive the impressions, and hard enough to retain them; a surface shortly after protected by a layer of pure sand, probably deposited dry; afterwards receiving successive depositions of similar sandy mud, having time to partially consolidate and receive a renewed drift of dry sand, and so on until an immense deposit of alluvium created the present soil of five feet deep, which was afterwards scooped out by the Waikanae Creek, till the rock surface was arrived at. This is all very recent, and deserves the attention of those having more time and knowledge at their disposal than I have.

Art. X.—*On the Geographical and other Features of some Little-known Portions of the Province of Wellington.* By H. C. Field.

[*Read before the Wellington Philosophical Society, 26th August,* 1871.]

The district to which this paper refers is that which lies between Taupo Lake, the Kaimanawa Range, and the source of the Wanganui River, and the settled districts on the north shore of Cook Straits; and is known to the natives as "Murimotu." Until lately, the whole, or nearly so, of the region in question was supposed, and actually appeared from the seaward side, to be a congeries of the most broken wooded country which it was possible to conceive. It was known that immediately under the skirts of Ruapehu and the Kaimanawa there was some open grassy country; but as some of those who had travelled from Rangitikei to Taupo and back asserted that they had not seen an acre of level ground the whole way, and others spoke of a stony desert lying to the eastward of Ruapehu, which it was dangerous to cross on account of the masses of rock which often come rolling down on to it from the mountain side, it was not generally supposed that even these so-called plains were of much value, owing to their uncertain extent and apparent inaccessibility. The absence of any known native tracks leading into the region in question, except from Rangitikei on the one side, and the upper waters of the Wanganui River on the other, in both cases over country of the most rugged description, tended to confirm the general idea of the worthlessness of the locality for purposes of settlement; and thus it was not until the reported discovery of gold at Kaimanawa turned the attention of the Wanganui settlers to the desirability of getting a road in that direction, that any attempt was made to penetrate it. The result of that supposed discovery, however, was not only that several parties of prospectors went to and from Kaimanawa by the known native routes, but that a party, under Messrs. James Hogg and G. F. Swainson, after going to Taupo *viâ* Rangitikei, succeeded in returning to the coast by way of the Turakina Valley, while Captain Pilmer and myself succeeded in reaching the portion of the plains lying to the south of Ruapehu, by following the valleys of the Mangawhero and Upper Wangaehu. Since then the survey of a large block of land, inland of the Turakina and Rangitikei districts, for the Native Lands Court, has added greatly to our knowledge of that locality, while the explorations of Mr. Booth and myself, in course of cutting the lines for pack-roads directly from the town of Wanganui, and from Ranana, on the Wanganui River, have given us a knowledge of the western portion of the region in question, sufficient to enable it now to be mapped and described with approximate accuracy. As I have spent the greatest amount of time in exploring the locality, and have been frequently in communication with the other explorers, and thus had an opportunity of learning what they had ascertained, either personally or from natives, and of comparing it with my own observations, or with the information I could get from Maoris, I am perhaps the best able to give a general description of the region, and therefore venture on the task.

The volcanic country, of which Ruapehu, Tongariro, Ngauruhoe, and Hauhangatahi, are the main summits, appears to form a sort of culminating point in the centre of the island, from which the drainage flows in all directions. The Wanganui, Mangawhero, Wangaehu, Turakina, Rangitikei, and Waikato, all have their sources here, as have also numerous streams which flow into them. Of the Waikato it is needless to say more than that it rises on the north-eastern slope of Ruapehu, and soon passes out of this province on its way northward to Taupo Lake. The Wanganui rises on the western side of Tongariro, and after flowing for more than thirty miles in a north-westerly direction (in which it passes to the north-east of Hauhangatahi), it bends and flows southwards to the sea. The country through which it passes to the bend seems to be excessively broken, but there appears to be strong reason to believe it auriferous. All who have visited the country lying south-east of Taupo Lake describe it as containing immense quantities of quartz; and as Mr. Crawford found slate cropping out in the bed of one of the upper tributaries of the Wanganui, it is probable that the gold which is found on the bars of this river, in increasing quantities as it is ascended, comes from somewhere in this locality. Just to the south of Hauhangatahi, the Manganui-a-te-ao rises, and flows thence south-westerly into the Wanganui River, after a course of about thirty miles. Around its source, and for some distance towards the Wanganui, there are open plains of pumice land covered with grass and flax, but lower down it passes through what the Rev. R. Taylor describes as a limestone formation, containing large caves. A person who resided near the mouth of this stream for several years, and who has since been for many years engaged on the goldfields in Victoria and in the Middle Island, expresses a very strong conviction that gold will be found in its neighbourhood, but hitherto there has been no means of testing the accuracy of his opinion, a party, who went up for the purpose, having been turned back by the natives.

South of the Manganui-a-te-ao, an extremely rich level bush country extends along the western skirts of Tongariro and Ruapehu, for a distance of about twenty-five miles in a southerly direction, and about ten or twelve miles from east to west. The timber is very fine, and the streams which run through the bush flow in channels only a few feet deep. These streams are mostly tributaries of the Manga-ai-turoa and Mangawhero, the former of which rises in or near the pumice plains I have mentioned, and flows southwards parallel to, and about seven or eight miles to the eastward of the Wanganui River, Its valley, which is of great depth, is, so far as I have seen, cut into the marine tertiary formations. It contains apparently no gravel, but for some distance, near where the new Ranana road crosses it, the stream, which is here more than a chain wide and about ankle deep, flows over a bed of what seems to be soft stratified limestone, over the ledges of which it forms falls varying from a few inches to more than twenty feet in height. There is some swampy level bush land in the valley, but behind this the hills rise abruptly to a height of nearly or quite 1,000 feet. The Mangawhero rises on the western slope of Ruapehu, and after passing in a south-west direction across the level bush country it turns southward along its western edge, and continues in this direction till it is joined by the Manga-ai-turoa, about thirty miles from its source. A little above the junction, at the Ranana road ford, it is about 100 feet wide, and rather more than knee deep; and here, and indeed throughout nearly its whole course, it flows over a bottom of coarse shingle intermixed with huge boulders. Its valley, which is as deep as that of the Manga-ai-turoa, is cut out of a similar formation, but I have seen no trace of anything resembling limestone. From the junction of the streams, however, the Mangawhero flows south-easterly for ten or twelve miles to Te Anu, and at about two miles below the junction it descends in two falls a height, according to the natives, of fully 150 feet. Such falls must be over some hard rock; and as the natives describe it as white stone it may be the same material as that over which the Manga-ai-turoa falls. I have not been able to visit these falls, and think it likely the Maoris have exaggerated their height, but from the fact that at a distance of five miles, through level heavy bush, the roar is as loud as that of the sea at the same distance on a rough day, they must be worth seeing. At Te Anu the Mangawhero again turns southwards, and continues generally in that direction to its junction with the

Wangaehu, about sixteen or eighteen miles farther south. Of course the directions above given are the general ones merely, the actual channel of this river, as well as those of the Wangaehu and Turakina, being wonderfully tortuous. For about a dozen miles above its junction with the Wangaehu, the Mangawhero flows through a beautiful valley, consisting of flats covered with fern, flax, and koromiko scrub. The next three or four miles, as you ascend, are more gorgy, and heavily wooded, though there are some fine bush flats covered with splendid timber. Above this the valley opens again, and for some miles consists of splendid flats of manuka and koromiko scrub. At the falls, and for several miles above and below them, it is all flats of heavy bush in the actual valley, but open fern and scrub towards the lower slopes of the hills. The lateral valleys, up to the Manga-ai-turoa junction, contain also fine open flats and terraces of rich fern and scrub land, and though behind and between these there are steep wooded ridges, rising in some places to a height of from 1,500 to 1,800 feet above the sea, even these contain a considerable quantity of available land, disposed in the form of tables and level basins about the heads of gullies. The lower spurs and bases of the hills all along the Mangawhero, Wangaehu, and Turakina valleys, consist of coarse gravel, but all the country above this level is of blue or yellowish white sandy clay, full of sea shells, and with scarcely a trace of a pebble about it. There seems to be an exception to this rule somewhere a little to the eastward of the Wanganui River, near to Karatia. Some years ago some beautiful specimens of copper ore were brought to town by a person, who asserted he had obtained them while out pig-hunting with some Maoris in that locality; and some natives have assured me that there is a quantity of it in a gully opposite Karatia. This would indicate the cropping out of primary rocks, underlying the high hill, Tauakira (commonly, but wrongly, shown as Taupiri on the maps) or its northern slopes. The Wangaehu River rises close to the Waikato on the north-east slope of Ruapehu, and at its source is so strongly impregnated with sulphur, and apparently alum, as to be quite nauseous. The colour of the water is a dirty bluish white. The river winds round the stony desert, and thence south-westerly along a tolerably level plain, mostly open, till it reaches a point about S.S.W. of the mountain, and about sixteen or seventeen miles distant from its summit. At this point it is joined by the Tokiahuru, a large stream which rises on the eastern slope of Ruapehu, and winds in a S.W. direction round its base. The Tokiahuru is joined by another large stream, the Mangahuihui, which comes down from the south-west slope of the mountain, and shortly afterwards by another, the Mangawarawara, which rises in the level bush country westward of the mountain, and flows through a lake in an extensive opening or plain in the bush, called the Rangataua, before it reaches the Wangaehu. Below the junction the united streams (still called Wangaehu) flow S.S.E. for about ten miles, skirting a succession of grassy plains, called respectively Rangiwhaea, Waitohi, Otumauma, Parakakariki, Papatatangi, and Matahitira. As the river flows on its channel gets deeper and deeper, till at Matahitira it actually runs in a chasm from 300 to 400 feet deep, with precipitous sides, the plains forming, as it were, terraces on the one or other bank. This chasm is generally ten chains or more in width, and the actual river bed, which is but a few feet deep, zigzags across it from side to side, between beds of shingle and volcanic sand overgrown with bush. The streams which flow into the river descend very rapidly as they approach the chasm, and in some cases have sheer falls of from 100 feet to 150 feet in height, or a succession of cascades. On the western side of the river the level bush country extends southwards to opposite Otumauma, and below this Parakakariki and Matahitira are also on this side. A very easy line of communication with the Mangawhero Valley crosses from Parakakariki. On the eastern side the whole country down to a point several miles south of Matahitira is broken into innumerable hummocks, the summits of which, however, rise to a tolerably uniform level, and which are covered with black birch bush. This description of country extends eastwards to the Turakina Valley, or nearly so. Southward of Matahitira the river enters a wooded gorge between high hills, and though the chasm soon afterwards disappears, and the banks of the river become less precipitous, the valley is of an extremely broken character, and for many miles is densely wooded. About five miles below Matahitira the valley curves to the south-west round the spurs of a high mass of hills called Puke Whakapu, opposite to which, on the eastern side of the river, is another high mass called Maunga-karetu. From this bend to the junction with the Mangawhero, fifteen miles distant, and just above the inland boundary of the Wanganui block, the river runs in a south-westerly direction, the valley gradually widening, and for the last three or four miles becoming open. Just where the bush terminates, a large stream, called the Mangamahu, flows into the Wangaehu from the eastward. This stream rises somewhere just to the eastward, or north-eastward of Maunga-karetu, and from twenty-five to thirty miles due south of the summit of Ruapehu. The valley of this stream is broad and well defined, and there is some fine country, partly wooded and partly open, along it, which the natives are proposing to pass through the Native Lands Court. Between the Wangaehu and Mangamahu is a gradually ascending table ridge covered with manuka scrub, along which an old war track to Taupo is said to have run. Mr. Booth is at present endeavouring to reach the plains by this route, in company with some natives; but besides its being many miles to the eastward of a direct line from Wanganui to Taupo, it appears to pass too high above the gravel level to be likely to be a desirable line of communication.* The Turakina River rises close to a hill called Tuhirangi, about fifteen miles south-east of Ruapehu, and flows a little to the eastward of south for about twenty miles, and then towards the south-west for about twenty miles farther till it reaches the boundary of the settlement. For the greater part of this distance it runs in a chasm similar to that of the Wangaehu, but of less depth; and, like the latter river, has a very rapid course, much encumbered with boulders. There is, however, this distinction between the two, viz., that while the boulders of the Wangaehu consist largely, or chiefly, of volcanic rocks, those of the Turakina are of primary rock and sandstone. There are two falls on the Turakina, each about six or eight feet in height. The first of these is about ten miles inland of the Turakina upper boundary, and the other considerably higher up. There are, so far I can learn, no actual falls on the Wangaehu; but in one of the rapids near Matahitira there is a large rock, with a hollow in its upper side, and the recoil of the water within this hollow produces a humming sound which can be heard for several miles. In the Turakina Valley there is a large extent of rich level scrub and bush land, as well as a great deal disposed in terraces on the hill sides. On the eastern side there is also an immense extent of level table land, extending nearly to the Rangitikei River. This is covered with scrubby bush, interspersed with large grassy openings, and the whole is so intersected and opened up by the tracks of the wild cattle, (which exist here in thousands), that the natives ride all over it in hunting them. A belt of broken ground separates this level district from the Rangitikei and Turakina settlements; but as these wild cattle are strays from the settlements, or their progeny, there seems good reason to believe that practicable road lines exist through the hills, though as yet their whereabouts are not ascertained. I believe the natives who own the recently surveyed block would be willing to sell it for about 7s. or 8s. per acre, and that it would be well worth the while of a capitalist or company to buy it, and cut it up into moderate sized farms for sale to settlers. The block consists of nearly 50,000 acres, and there is a large extent of similar country inland of it. Half, or nearly so, of the water in the Turakina River comes out of a large stream called the Mangapapa, which rises somewhere a little south of the Turangarere Falls, and, after passing for some fifteen miles through

* Since the above was written, Mr. Booth has returned to Wanganui, and reports this line quite impracticable. For some distance it promised well, but as it is ascended the Mangamahu forks into five or six tremendous gullies, descending from the sides of Maunga-karetu and Puketoui, which break up the ground so that no road could cross it without enormous earthwork. He found, however, a route about four or five miles to the northward, which he considers practicable, though it evidently rises over hills at least 1,200 feet high.

this level country in a south-westerly direction, empties itself into the Turakina over a fall, which the natives describe as being from 100 to 150 feet high. Above the fall the current of the stream is said to be sluggish, and navigable for canoes for many miles. The Moawhango, a main, if not the main source of the Rangitikei River, rises among the spurs of the Kaimanawa, about ten or twelve miles east of Ruapehu, and winds along in an easterly direction under the southern spurs of the range. It is navigable for canoes, but flows for a considerable distance through a chasm of great depth, and so narrow that the shrubs growing out of its sides often meet overhead. Another important feeder of the Rangitikei, the Hautapu, rises a little to the eastward of Tuhirangi, and also flows generally towards the east and south-east. The Turangarere Falls are situated on this stream, which, like the Moawhango, flows mostly through an open grassy country. The ground between the two streams and the lower spurs of the Kaimanawa are also open and grassy, but so fearfully broken, and so intersected by boggy bottoms, as to make it difficult to find one's way across them. A party from Wanganui and Rangitikei tried in vain to cross the former this summer, but had to give up the attempt and return, after penetrating about sixteen miles beyond Captain Birch's station. This is the locality known to the natives as the Patea country, and seems only to be available as cattle or sheep runs, though there are level flats in the valleys of the streams, which may make small farms. The level bush and grass country between the Turakina and Rangitikei is the source of the Pourewa stream, which flows southwards along a wooded valley of mixed gravel beds and swamps, till it enters the Rangitikei settlement. The land between it and the Rangitikei is mostly wooded, and extremely high and broken. A sort of main ridge, called, at different parts, Rangatira, Otairi, and Te Wahakauwae, extends along it from north to south, and it is on this that the native track from Rangitikei to Taupo runs. It rises to a great elevation; in fact, though Dr. Hochstetter speaks of Tauakira (he calls it Taupiri) as the highest point between Ruapehu and Cook Straits, it is very doubtful if the top of Te Wahakauwae is not actually higher. At all events it rises to between 1,800 and 1,900 feet above the sea.

I think the above description will show that this hitherto unknown region is likely to prove one of the most valuable portions of the province; that, in fact, it only needs to be opened up to add enormously to our resources. Even the opening by the Colonial Government of a pack-horse track into the Mangawhero Valley to a distance of about thirty miles from Wanganui, has caused the whole of the land along it, which there was time to get surveyed before the last session of the Native Lands Court, to be sold to settlers, and all the remainder, or nearly so, will be adjudicated at the next sitting of the Court, preparatory to its sale to persons who are even now in treaty for it.

The whole of this country, in fact, belongs to friendly tribes, who have made no use of it for the last twenty or thirty years, and who are desirous of selling or leasing it through the Court, as soon as purchasers or tenants can be found. From the great amount of rain which falls in it, as compared with the lower country near the coast, it is doubtful how far it is adapted to the growth of grain crops; but as a grazing district, and for dairy farms. it is certainly second to none, and the richness of the soil and the immense amount of water power available throughout it, seem to point it out as likely to be an important centre of the flax cultivation and manufacture. The absence of high winds, the warmth of the valleys, and the fact that the salt gales which occasionally do so much damage near the coast, do not extend so far inland, also indicate that fruits, and other productions, which do not thrive in the coast settlements may be grown here without difficulty. In fact, near Pipiriki, a place which enjoys a similar climate, there is an orange tree which has borne fruit in the open air for some years; and grapes have been grown abundantly, and even wine made from them, for a long time past near Ranana. Tobacco is also cultivated to a considerable extent by the natives at most of the pahs on the Wanganui river, and grows luxuriantly, and there can be no doubt that it can be grown at least equally well throughout the country I have been describing. If the country about the head of the Wanganui should prove to be auriferous, as I have already stated there is reason to suppose it, or if the Kaimanawa or Kaweka should ultimately prove so, as those who have visited them seem still to think they will do, the importance of the Murimotu region can scarcely be estimated, for, as far as I can learn, there is no other locality equally near and rich, from which goldfields situate as above could draw their supplies. All these things seem to combine to show the desirability of calling public attention to this portion of the province, and as I have reason to believe that your society would not object to the means of doing so, I have ventured to trouble you with these remarks respecting it.

ART. XI.—*A Description of the Foundation of the Lighthouse in the Ponui Passage.* By J. STEWART, Assoc. Inst. C.E.

[*Read before the Auckland Institute,* 31*st July,* 1871].

THE sandbank known to those engaged in the Thames traffic, and to all who have journeyed there during the last four years as the "Sandspit," is a well defined feature in the route, narrowing as it does the navigable channel at Ponui, to a passage one-tenth of a mile wide.

At extreme low water it dries to within about forty fathoms of its extremity; the water thence abruptly deepens from six feet to fifteen feet in the channel. In the greater part of its length it is a narrow ridge stretching three-quarters of a mile in a direction E.N.E. from Pahiki; thence it curves backwards W. by N. for about three-eighths of a mile, assuming a hook-shape. On a flattish table bank in the bend of this hook, the lighthouse has been erected, the depth of water at low springs being five feet, and at high water sixteen feet.

At the request of the late Colonial Marine Engineer, the structure of the sandspit was ascertained—about two years ago—by Captain Burgess, Chief Harbour-master, Auckland, from borings made on the site of the proposed works. It was found to consist of loose sand and shells, with shingle, overlying at a depth of seven to fourteen feet a hard crust, the exact thickness of which was undetermined.

Below this was a homogeneous sub-stratum of soft muddy and sandy clay; a very hard, but not rocky bottom was reached at a depth of thirty-one feet from the surface of the sand.

At the time of Mr. Balfour's death, he was understood to have made some progress with a design for this lighthouse; however, no sketch or trace of such was found, and the writer was intrusted by his Honour the Superintendent with the design and erection of the work.

In determining the *nature* of the foundations, the question was a narrow one. Screw piles offer by far the most advantageous method of supporting heavy weights on sub-marine sandbanks. But the *details* of form of screw, area, and pitch of thread, etc., have to be adapted, as well as can be, to the nature of the material in each case; not only with a view to the efficient support of the structure, but also to the screwing, and the amount of torsion necessary to be borne by a long pile (in this case forty feet) working down through stiff material. It is unnecessary to describe in full the calculations leading to the form and elements of the screw pile adopted; it may be sufficient to remark, that for the sake of permanency, cast iron was used for the complete pile (excepting the joint bolts); the stem is ten inches outside and eight inches inside diameter; diameter of screw flange, three feet three inches; pitch, six inches. The form of screw is conical, the thread commencing at nothing, near the pointed end of the pile, and attaining its full width of fourteen and a half inches in one and a half turns, it then made one turn more at the full diameter. The conical shape was found of great service in penetrating the hard crust existing a little way below the surface. Imbedded timber was the only contingency to be feared, and its actual existence at the bottom was proved by one of the borings made by Captain Burgess. Several tests were made before screwing down, to guard against this contingency, and the nature of the ground may in a measure be judged from the fact that little more than the weight of the rods was necessary to send them from the surface to the hard. This required the best efforts of four men about ten minutes to penetrate, which being effected, a further depth of twenty feet was easily done in about two minutes more. The crust was, in these trials, estimated at a thickness of four inches.

A temporary platform having been built on the site, the screwing down was effected by fitting a strong capstan embracing the body of the pile, which was moved upwards a few feet at a time as the pile descended. This capstan was nineteen feet in diameter over the ends of the bars, which were fitted so that a rope could encircle them, as round a drum. An ordinary single and double power winch was placed in a convenient position, and the power transmitted to the capstan by an endless rope coiled three times round the winch barrel, and twice round the capstan bars ; the slack was usually taken up by hand. The pile could be, and usually was, screwed down about five feet, before fleeting the capstan up another lift. The winch was usually placed in single gear, and with this four men could work easily, making twenty-eight revolutions of the handles per minute. The ratios of the winch handles and radius of the barrel, and of the single gearing compounded, show that a force on the handles is increased a little over twenty-five times at the circumference of the barrel. Hence four men at the handles were equal to 100 exerting the same force at the ends of the capstan bars. The circumference of the capstan was sixty feet, and it revolved at the rate of ten feet per minute, or one turn in six minutes. As the average descent of the screw was three inches per revolution, its rate was thus one half inch per minute, requiring for actually screwing the full depth of twenty feet, a period of eight hours. A man's power, working at a winch eight hours per day, is usually taken at 2,600 foot pounds per minute, but as the men in this case never worked more than from one to two hours without stopping, and adjusting the capstan, or other parts, and rests often occurred, we may take the power exerted at 3,000 foot pounds. The circumference of the path of the handles being 8·6 feet, twenty-eight revolutions per minute give 240·8 feet, by which dividing 3,000, we have nearly thirteen pounds as continuous pressure exerted by the hands. This again is equal to (with four men) 1,300lbs. at the capstan rope, moving ten feet per minute, and as each foot required twenty-four minutes to screw down, it follows that it was also attained after an expenditure of 312,000 minute foot pounds, or a force equal to raising 139 tons one foot high had to be exerted to screw the piles down one foot. The slip is stated at an average of three inches per revolution, being 50 per cent. of the pitch. The actual descent was about two and a half inches at the beginning, one and three-quarter inches in passing through the crust, and from three inches to five in the mud, for each revolution.

The total weight of the structure is about sixty tons ; this is mainly supported on the six outer piles, the centre one being relieved of nearly all direct weight, and serving to take the thrust of the other through the bracing, when the building is subjected to high winds. The area of each screw is 8·38 feet, and 1·2 tons thus fall to be borne by each square foot of surface, an amount shown by the screwing force to be far within the limits of safety. The interiors of the piles are filled with good cement mortar, to preserve the iron from rust, and the heads and nuts of the joint bolts are imbedded in the same. Tubular cast iron braces, and the lower timber frame, three feet above high water, complete the foundation which has answered all expectations in the recent exceptionally stormy season.

Art. XII.—*Work for Field Naturalists.* By P. Thomson.

[*Read before the Otago Institute, 16th September,* 1871.]

It must be evident to all the members of our Institute, that in a district like this, with such a diversified surface, where mountain and valley, hill and dale, land and water, forest, scrub, flax, and grass, are to be found in almost every possible condition, there is a very extensive field for the study of nearly all the natural sciences, and more particularly those which require work in the field. In the vicinity of the town, and within the reach of an easy hour or two's walk, lie many scenes of considerable beauty and grandeur, while the views to be had from the various hill-tops are not to be surpassed anywhere. In laying the following remarks before you, it is my object to specify a few of the more interesting localities in our neighbourhood which present facilities for out-door study. Without making any pretence to exhaust the subject, I will merely mention a few of the things to be seen in the different places.

And first, as to the geology of the district. Some very fine sections have been opened along the line of the Port Chalmers railway, and the line of the Southern Trunk promises some very interesting cuttings through the Caversham and Lookout Point hills, as well as that more distant range the Chain hills. Some very curious sand deposits have been lately cut into at Anderson's Bay; and along the beach at Vauxhall, the igneous rocks have overlain the clay and turned it brick-red in the process. (This phenomenon may be seen in a small cutting in the Town Belt, nearly opposite the foot of Howe-street.) In the valley of the Leith there are many curious places. About two miles from town there is a long steep-sided mound, probably a terminal moraine, and about two miles further up, opposite the foot of Nichol's Creek, there is another very large accumulation of rolled stones, evidently the result of a similar cause. In the Town Belt, at the back of Royal Terrace, there are some very large peculiarly worn rocks, which look as if they had long been exposed to the wash of water. About an hour's walk from Anderson's Bay, there is, right on the top of the hill at the righthand side of the road, an immense block of stone, the "Big Stone," from the flat top of which a magnificent view is had, worth all the labour of getting there. Then there are the various quarries in the neighbourhood of Caversham, in which fossil shells and sharks' teeth are occasionally found. Farther off is the grand section of the sandstone rock exhibited in the line of cliffs which bound the coast near Green Island, the cliffs themselves bounded in turn by the noble promontory of Green Island Peninsula, which shows, in a most beautiful way, the varied phenomena of basaltic pillars. In the same neighbourhood are the coal pits, and a little further out is the quartz reef at Christie's. Beyond Anderson's Bay is Lawyer's Head, with a fine cave under its northern face, and at Tomahawk Bluff there are several others, all of which can be visited at low water. The Green Island cliffs also boast of a cave; and on the estate of Lauriston, near Saddle Hill, there is a singular cave, in which a large number of moa bones were found some year or two ago. Underneath the trap rock of Bell Hill there is a bed of sand, which also underlies that bold rock face at the southern end of Princes-street, passing through to the Glen road. At the head of Pelichet Bay there is an extensive bed of pipe-clay, and another which contains singular concretions of ironstone, as well as small masses of a bright white substance which turns blue on exposure to the air. At Kempshell's quarry, up the North-east Valley, beautiful specimens of dendritic iron and manganese are plentiful. There are places farther off, such as Whare Flat, the Heads, Portobello, Blue-skin, etc., which are well worthy of a visit. But, to be brief, I have surely said enough to show that a wide field exists in our neighbourhood for the study of geology; although, at the same time, it is to be regretted that there are few fossiliferous localities near town.

Turning, now, to botany. Perhaps there is not in all New Zealand a town so favourably situated for the study of this science as Dunedin. The immense tracts of forest which extend to the east and north are now intersected in every direction with tolerably good roads, so that the student has little difficulty in penetrating with his field book to almost any given point. Most of the members of the Institute are aware, through our late vice-president, Mr. Webb, that the collection of flowering plants in the museum is deficient in a good many species, so that here is a capital chance for the Field Naturalists to supply those *desiderata.* At the same time, I must, as a caution not to be over sanguine, say that it is no easy matter going into the bush with a list of wants in one's hands and expect to come out of it again with more than one, or, may be, half-a-dozen. It is possible to traverse the bush for hours and not find a single example of the plant wanted, and yet it may be almost stumbled over in the first few yards. In addition to the flowering plants wanted, there are extensive families of plants which are totally unrepresented in the museum—I mean the mosses, lichens, etc. Some of these are very interesting, and nearly all are very beautiful, and will well repay the trouble of collection. There is one thing in connection with our bush which not only the botanist but every lover of nature must regret, and that is the rapid rate at which it is disappearing. A few short years and the only forest left will be patches here and there in inaccessible places, where it would not pay to remove the trees. It is an interesting subject for speculation, too, as to what influence this clearing away of the forest may have on the climate of the country.

It is rather singular that here we have no native mammals to look for. In various places, rabbits, rats, and mice, and their natural enemy the cat, are not unfrequent; but for the aboriginal rodent, the Kiore, we may now look in vain. In the early day of the gold rush, they were not uncommon in the interior, and used to be caught and eaten by the diggers under the name of Maori rabbits; and if any yet exist, it can only be in the far away mountainous country of the south-west. The only mammals now to be found are marine—seals, porpoises, etc. Two species of seal are represented in the museum, specimens having been beautifully mounted by Mr. Purdie; but a couple of porpoises would be a decided acquisition, and now that whale fishing is revived on the coast, the skeleton of one of the smaller sorts would be valuable as a type of the rest. While I am on this head I may here allude to one of the most patent wants of the museum—neither the *Crustacea*, nor the *Mollusca* have a place there. There are a few shells—a *Pinna*, a *Turbo*, and *Haliotis*, and there is a small collection made by Dr. Buchanan, I think at Lyell's Bay, Wellington. *Crustaceans* abound on our coast. From the active and predatory crayfish down to a minute shrimp, there are many that sport a long tail; while the short-tailed ones, from a large solitary-living spider crab down to a little mite of a thing, no bigger than a pea, are abundant everywhere. The edible crab—the partan—so large and plentiful in the old country, is represented here by a little tasteless thing about three inches by two, but of precisely the same colour and habits. With regard to the *Mollusca*, the shells are neither so remarkable in colour or form as those found on the islands to the north; but nevertheless there are many beautiful species, and a collection for the museum should form one of our earliest attempts. It is a pity that there is always so much surf breaking on our shores, as by this means many of the finest shells are seldom got whole, being pounded to pieces in coming ashore. Still, after a storm, and the heavier the better, when there is a lot of kelp thrown up, there are always a few of the deep water shells to be got among the roots. There are also a few in the fresh waters of the district, and a rather fine lobster inhabits most of the streams. The museum contains only two specimens of *Radiata*—a sun-star and an *echinus*; there are many others to be got; while of the hundred and odd fishes that inhabit the sea on our coast, there are only about a dozen specimens on the shelves.

I am afraid these details are rather dry and wearisome, but the importance of the subject must be pleaded as an excuse. Enough has been said to show the breadth of the field of study which lies before us; but one other thing I would like to enjoin, more particularly on those of our members who happen to live near the coast, and that is to keep a careful look out for those shoals of fish which every now and then come in on the beaches in such numbers. An effort should be made to get as perfect a specimen, or two if possible, as can be got, for preservation in spirits or otherwise. Every now and then, too, one hears of "odd fish" turning up, all of which should be secured for preservation or comparison. In short, all the members of the Institute ought to be Field Naturalists, and never lose an opportunity of securing specimens, whether for the museum or their own collections.

I have hitherto said nothing about the personal effect of such work on a man, both mentally and bodily; that is, I think, too obvious to need remark. I will bring these notes to a close by formally moving the establishment of a society, having for its objects work such as I have attempted to describe above, to be called The Dunedin Field Naturalist Club, to consist of all the members of the Institute who are willing to join. Their first meeting to take place—weather permitting—at the north end of George-street, at one o'clock on the afternoon of Saturday; the field for exploration to be the Leith Valley.

ART. XIII.—*Description of a Simple Contrivance for Economising the Current of Large Rivers, for Gold-sluicing, Town Supplies, and Mill-power.* By J. T. THOMSON, F.R.G.S.

[*Read before the Otago Institute, 21st February,* 1871.]

I CLAIM for my present little contrivance some indulgence from the members of this Society while I endeavour to explain its properties and probable uses. By way of preface, I may say that in my report to Government, dated 12th August, 1867, I find I wrote as follows :—

"Large sluicing operations would appear to be the ultimate great industry of the interior (of Otago), and that the mining portion of the population have been fully alive to this will be proved by the enumeration in those reports of their great and numerous water races.

"The principal sources of water are in the Snowy Ranges, and others, the Dunstan, Umbrella, Nevis, Richardson, Pisa, Hawkdun, Kakanui, Rock and Pillar, Lammermoor, etc., etc. But it appears to me that in the Golden

Stream—that is, in the Clutha itself—is to be found a power that will serve to wash away all its auriferous banks, and clear the same to the profit of the miner. The fall of this river, from the lakes to the sea, is about 1,000 feet in 100 to 120 miles, and the area from which it collects its waters above the gorge of the Dunstan is equal to 3,325,000 acres. From these data, we can have a rude or comparative estimate of the power contained in it. Allowing twenty-four inches of fall over the area by averaging the greater fall in the mountains with the lighter fall in the plains, we have 289,674,000,000 cubic feet per annum as the discharge of the Clutha at the above point. This is equal to a discharge of 551,130 cubic feet per minute, but allowing, again, half the rainfall to be absorbed by evaporation, the actual result will be 275,565 cubic feet per minute.

"How to arrive at the object of the inquiry? We have the fall from the lakes to the sea, as above stated, at 1,000 feet, which gives 422,500 nominal horse-power. This may truly be said to be a very valuable property of the province, which always remains to it, and which, if only partially made use of, may be fraught with great importance to the prosperity of our interior population.

"It would not be consistent with the object of this report for me to suggest modes for the economical use of this power; but I may shortly state that I am aware that the mining population have applied it to a limited extent to social purposes. Of all contrivances, however, the simplest, I have no doubt, will prove the most successful, and the merits of the paddle wheel and the marine screw as motive powers will no doubt eventually be much canvassed. I would presumably advocate the latter, on account of its greater hold on the body of the flowing stream, its ready management and applicability in swift or slow currents, and its easy connection with the apparatus for raising water."

Since the above report was written, of which this is a short extract, though fully alive to the importance of the subject, I have, owing to constant engagements in other works and services, been able only to give an occasional thought in its direction. Since then I have heard of various attempts by miners and others to apply the force of the current of the Clutha to machinery employed in these enterprises, but how far successful they have been I have had no opportunity of learning. Some years ago I inspected two machines, one of which was for the purpose of raising water, and the other for working the gearing of a dredge, and in both cases the principle adopted was that of the paddle wheel, though one was of unusual construction, being set obliquely to the stream. Neither machine had great power, and, having become disused, appear not to have met the expectations of their designers. The paddle wheel, of proper and peculiar form, is no doubt well adapted for driving the machinery of floating mills (flour, bone, saw, etc.) in shallow rivers, where the shallowness of the stream would prevent the screw being applicable, and where there was large floatage capacity, at any rate, required to support the mill and its contents; but the great size, cost, and weight of the paddle form of wheel create a most important objection to its general use in the Clutha, where only the temporary works of gold mining for the most part are engaged in. On the contrary, the great depth of the stream is particularly applicable to the screw, working as it does so much below the surface, and when its smallness and lightness make it so easily handled, and its cheapness and simplicity render it of easy construction and repair.

The floating paddle wheel in a seven mile current requires forty square feet of floatboard to give a power of twelve horses, and of floatboards there require to be eleven in number; while one screw of eight feet diameter would give the same power, and this, instead of requiring to be floated like the paddle wheel high out of the water by sufficiently strong barges or punts, can be immersed and attached not only to barges and punts, but to a buoy, wire rope, boom, bridge pier, piles, or other fixtures suitable to the various situations.

The Otago sluice head, by the Goldfields Regulations, being equal to ninety-five cubic feet of water delivered per minute, machines of the above dimensions will raise one sluice head to an elevation of seventy feet, or seven heads ten feet, and this without intermission day and night.

The advantage of the screw, when made of timber (as I would support) is in its easy construction and repair—this fact should be particularly noted; besides, the screw is the only portion of the apparatus, whether for mills or pumping gear, that need be subject to accidents from floods. Accidents from floods can also be avoided by drawing the screw into the banks till the danger from drifts is over. On the Clutha, with its great body of water, the construction of the screw need not now be scientifically correct, but may be of the rudest description, the fault in form being amply compensated for by the superabundance of power. Thus, the screw may be easily made by a common carpenter and blacksmith—in fact, out of an old gin case and a piece of scantling I would engage to make a very effective two horse-power machine. The contrivance then, I am sanguine in stating, supplies that which is wanted by the sluicing, dredging, pumping, and other enterprises on the banks of the Clutha, viz.,—an inexpensive and simple machine for economising the power of the current. The nature of the contrivance is simple. A model is now on the table for inspection. I will be happy to show it at work in the stream of the Water of Leith, at any time the members of this Society may appoint, when they could judge of its effectiveness themselves.

The model will be seen to be made of wood, in the make-shift fashion much had recourse to on the diggings, the only portion of it executed by skilled labour being the brass force-pump and india-rubber tubing. The screw (or more properly speaking fan wheel, as the blades in this little example are plain, and not to the helical curve) is fifteen inches in diameter. The blades are set to an angle of twenty degrees to the disc, and in a two-mile current the revolutions are once per second nearly. The pistons of the pump are worked by a crank, and, being single-acting, propel its contents once per second. The diameter of the cylinder is three-quarters of an inch, and stroke of piston 2·7 inches. The quantity of water per stroke is therefore 1·1925 cubic inches. At the above rate of speed, the quantity delivered is therefore 71·55 cubic inches per minute, or 59·5 cubic feet, equal to 368·9 gallons per diem of twenty-four hours. This little model would, therefore, liberally supply the wants of a house of the largest class, and the first cost (not including piping) would not be over four or five pounds sterling.

For town supply, the screw, pump, and gearing would require to be designed for the population; but taking for example one of the largest force-pumps in the works of Messrs. Burt, of this city, I find it to be four inches in diameter, eight inch stroke, single action once per second. This pump, in constant operation, would deliver 3·5 cubic feet per minute, or 5,025 cubic feet, equal to 31,155 gallons for twenty-four hours, which would amply suffice for the supply of a town of 1,000 inhabitants. Had the water supply to be raised 100 feet above the level of the river, such as would be necessary for Balclutha, Alexandra, Clyde, or Cromwell, as one horse-power raises 5·28 cubic feet to that elevation per minute, this power, allowing amply for friction, would suffice for the above service. So, were a screw applied to the pump revolving in a current of seven miles per hour, one of three feet six inches in diameter would do the duty.

The cost of the apparatus complete, delivering water at the top of the bank (not including street pipes, etc.) will of course vary with the nature of the position and relative facilities afforded. Where the river is narrow, the screw and pump would best be held by a wire cable stretched across the current or arm of the river. Where the banks are steep and rocky, a boom secured by stays and guys would be the best mode. Where the river is wide, a small punt, or even a barrel or buoy, might be used, and so forth. In either case the cost would not vary very much, so taking the first by way of example, the following is an approximate estimate :—

	£	s.	d.
50 fathoms of 3 inch galvanised iron wire rope . .	8	15	0
Pump	10	0	0
Screw	10	0	0
150 feet of 2 inch india-rubber tubing at 2s 6d per foot .	18	15	0
150 do. do. iron piping, at 1s. 3d. per foot . . .	9	7	6
Carriage and labour of erecting	50	0	0
	£106	17	6

In this case, for the avoidance of damage by heavy floods, arrangements would be made to elevate the wire cable and draw the screw and pump in-shore till they had abated.

I have already given the dimensions of a screw required to raise one sluice head (ninety-five cubic feet per minute) seventy feet above the level of the river, and an approximate estimate of the cost of the same would be as follows. The duty required would take a single acting pump fourteen inches diameter and eighteen inches stroke per second, or double acting, eleven inches diameter and 14·5 inches stroke of same velocity :—

	£	s.	d.
Pump	65	0	0
Screw	20	0	0
50 fathoms of $4\frac{1}{2}$ inch galvanised iron wire . . .	45	0	0
150 feet of leather 6 inch hose, at 5s. per foot . .	37	10	0
150 feet of cast iron 6 inch pipes, at 4s. per foot . .	30	0	0
Carriage and labour (say)	100	0	0
	£297	10	0

Of course the cost would be much modified by position and the relative facilities given by the state of the river, its banks, rocks, and currents. In applying the large machinery, it would be advisable to choose such sites as would afford rock foundations for the pump and gearings, so as to avoid the necessity of supporting the same by cable or punt, and in such cases the permanent material (cast iron) might be used solely for the piping.

As the altitude of water to be raised in many parts, especially below the Teviot, does not require to be so great, of course much reduction in cost could also be effected. This remark is also particularly applicable to the service of pumping water from river bank claims carried on below the level of the stream surface, where the height to be raised is generally small.

In many parts of the goldfields of Otago large capital has been expended in bringing water to claims on the banks of the Clutha now worked out. The cost of bringing in water when not available for other claims thus remains a loss. Thus a great advantage is gained, under such circumstances, by the introduction of the contrivance and machinery proposed, inasmuch as the plant can be removed to other localities, and re-erected for new operations.

Art. XIV.—*On some Experiments showing the Relative Value of New South Wales and New Zealand Coals as Gas-producing Materials.*

By J. Rees George.

[*Read before the Wellington Philosophical Society, 30th September,* 1871.]

The table giving the result of tests of coal from various mines will be of interest at the present time to those desirous of developing the various mineral resources of New Zealand. I propose to add a few remarks showing the manner in which the experiments were conducted, and such explanation as may be necessary to show the relative value of the different samples tested.

In testing coal for the purpose of ascertaining its value as a gas-producing material, the result depends so much on the heat at which the retorts are worked, that it is only by numerous trials, under variable conditions, that its true value for practical purposes can be ascertained. Some coal will give a good result when worked at a great heat, which, if worked at a low heat, would prove the reverse of economical. The Old Lambton coal is an instance; this, at a high heat, gives a large quantity of gas, but with a small illuminating power and at a moderate heat gives less gas, but of better quality. The results given in the table were ascertained by comparing the illuminating power of the gas burning in a standard Argand burner of fifteen holes, consuming nearly six cubic feet per hour, against a standard sperm candle, burning 120 to 125 grains per hour, the power being measured on the graduated scale of a photometer as in use by the government examiners in London. The pressure of gas, in cases where samples of 112 pounds weight were tested, was 2·5 inches, or about the same pressure at which the gas is delivered to consumers from the mains; in cases where samples of only seven pounds or ten pounds were tried, the pressure was 1·4 inches, and this difference of pressure accounts largely for the decreased power of illumination shown in the smaller samples. In the case of the larger samples the illuminating power was ascertained immediately after the gas had passed through the purifiers, before being stored, or subjected to the friction of a long length of pipe; while in the case of the smaller samples it could not be tried until some two or three hours after storage, and passing through a length of, perhaps, 100 feet or more of a small tube. These circumstances combine to make the small samples show a worse result than the larger quantities, as storage and friction rapidly reduce the illuminating power of coal gas.

The mode usually adopted for ascertaining the exact standard illuminating power of gas is by reducing the amount consumed by the gas burner and candle respectively to a standard quantity of five cubic feet of gas, and 120 grains of sperm per hour. In the results given this calculation has not been made, in consequence of the want of convenient apparatus for ascertaining the different quantities consumed during the tests. The comparisons given will be slightly in favour of the gas, but not to a sufficient extent to affect the value of the experiments.

The specific gravity of the various gases I have been unable to ascertain, but I am not sure that the specific gravity of gas is a reliable testimony of its value as an illuminating agent, as a large specific gravity may arise from the presence of carbonic acid, one of the many impurities of coal gas.

In some instances the illuminating power is given as from twenty-one to twenty-five, and an average; in these cases the photometer was read at different periods during the baking of the coal; on the Grey coal for instance, half an hour after starting the photometer gave twenty-two and a half candles; one and a half hours after starting, twenty-four candles; two and a half hours after starting, twenty candles, which was the lowest reading.

A fact worthy of observation, and one I am unable to explain, in reference to the Grey coal, is that the slack or coal dust gives a better illuminating power than the large coal.

In classifying the coals in accordance with their relative values, at the head of the list I must place the New Zealand coal, from the Brunner mine on the Grey River. It will be difficult, indeed, to discover any coal more suited to *general* purposes, and for this reason I think it entitled to the first place. It is not only a very good steam and house coal, but also gives a large quantity of gas of very fair illuminating power. It is more free from impurities than any coal I have tried, and the coke remaining after the gas is worked off is large in quantity, of first-class quality, and, in burning, clinkers less than the coke from any of the other coals.

The Collingwood coal is next best on the list, and for purely gas purposes is superior to the Grey coal. The quantity and quality of the gas obtained is equal to that from good English Cannel, but it possesses one great advantage over English Cannel, viz., that it leaves a large quantity of coke of fair quality. Coke obtained from Cannel is of very little value; the Collingwood coke, however, appears to be superior to some of the coke obtained from the Australian coals for heating purposes, but it makes a larger amount of clinker. The gas obtained from this coal possesses a great advantage over most, as it appears to be less affected by storage, and does not lose its illuminating power so quickly. This coal contains very little sulphur, or other impurity, and is a very good house coal. For steam purposes it has been tried by Mr. Kebbell, of Wellington, who informs me that he finds it superior to New South Wales coal, but has not yet reduced the result to figures.

Third on the list I should place the Newcastle coal, of New South Wales. Of the samples tried there is not a very marked difference, but the coal from the Australian Agricultural Company's mine is, for general purposes, the best of these, the Old Lambton being second, and Co-operative Company's third.

Bay of Islands coal gives a large quantity of gas, of average illuminating power; the coke obtained is smaller in quantity, and not of such good quality as that obtained from the Collingwood coal; the large quantity of sulphur contained in this coal makes it difficult to work and expensive to purify; this defect reduces very considerably its value for general purposes.

A specimen of coal sent from Mount Somers, on the Ashburton River, in Canterbury, is entirely useless for gas purposes, in fact, appears to be a sort of lignite. The gas obtained from this sample burns with a small blue flame, giving no light whatever.

It is necessary to mention that the weight of coke is ascertained after being extinguished with water, on being removed from the retort, and it shows the weight available for sale. This accounts for the great difference observable in the weight of coke, as, if rapidly extinguished, it takes up more water than if extinguished gradually.

I may, in conclusion, state that the trials or experiments have been made with only a practical purpose in view, and that every endeavour has been made to obtain a large number of samples for comparison, but without success. I hope that at some future time I may be enabled to carry further these tests, and to report a more exact result. There can be no doubt, however, that New Zealand coal is superior for all purposes to that at present imported. The only cause of its not being more freely used is the difficulty of obtaining it, and the great price charged for it as compared with New South Wales coal; it appears only to be necessary te invest sufficient money in plant to work the mines economically, to make coal become an article of export instead of the colony depending on other places for its supply. The following will, I think, be found a correct statement of some of the circumstances that combine to shut out the New Zealand coal from the market.

At the Grey River the price of coal is twelve shillings per ton, delivered alongside the vessel; twelve shillings towage per ton is charged for vessels entering and leaving the river; making the price twenty-four shillings per ton before paying freight and dealer's profit. The report of Dr. Hector and Mr. Blackett* will furnish information as to the necessary means of developing the mine.

The Collingwood mine is situated on a small river, allowing vessels of only seven feet draft to enter, and the price charged for coal alongside is sixteen shillings and six-pence per ton. One disadvantage this mine labours under is, that the coal is only a thin seam of about three feet, and is always delivered wet.

At the Bay of Islands, a short time since, sixteen shillings and six-pence

*Parliamentary Papers, 1871.

was charged for the coal per ton, but I believe the price has lately been reduced. A more melancholy example of the result of incompetent management and want of means it was never my fortune to witness, than was exhibited at this mine in 1868. A seam of coal, twenty-four feet thick, only covered by an earth crust of a few feet in thickness, was being tunnelled, and in some cases the roof or covering had fallen in, leaving the coal exposed to daylight. After the coal had been obtained from the mine it was carried on a tramway worked by horses, a distance of about three miles, to the side of a tidal creek; the coal was then transferred to flat-bottomed punts, and at high water these proceeded about four miles down the creek, and delivered the coal at the vessel's side—a staff of about fifteen or twenty men, thirty horses, and six or eight punts, being employed on the transport after the coal had left the mine. By extending the tramway little more than a mile, and erecting a small bridge about 150 feet in length over the creek, the anchorage of the colliers would have been reached, and the coal could have been delivered from the trucks to the vessel. Three men and one locomotive would have done the work, and about six shillings per ton expenses would have been saved; the expenditure required being about three thousand pounds to remove all this great expense, risk, and delay.

In New South Wales none of these disadvantages exist. A convenient harbour allows large vessels to enter, which are loaded at a very short notice, the coal on board costing only seven shillings and six-pence or eight shillings per ton.

I trust means will be adopted to develope the New Zealand mines, and so enable New Zealand coal to compete on more equal terms with the imported, with advantage both to the colony and to consumers.

Table showing Gas-producing Qualities of various Coals.

NEW SOUTH WALES COAL.

Date of Test.	Name of Mine.	Weight of Sample tested.	Quantity of Gas produced from sample, in cubic feet.	Quantity of Gas per Ton of Coal, in cubic feet.	Illuminating Power of Gas in standard candles.	Weight of Coke per Ton of Coal, in lbs.	Remarks.
1871. Jan. 30	Australian Agricultural Co.	7 lbs	27	8,640	13	1,600	
Mar. 17	" " "	14 lbs. mixed with ½ oz. Kauri Gum Dust.	—	—	17	—	
July 26	" " "	112 lbs.	505	10,100	17	1,580	Obtained at high temperature, 1,700° or 1,800° Fahr.
Feb. 23	Co-operative Co.	10 lbs.	40·85	9,150	11½	1,680	
July 28	" "	112 lbs.	500	10,000	16½	1,600	Obtained at high temperature, 1,700° or 1,800° Fahr.
Feb. 23	Old Lambton Co.	7 lbs.	33·4	10,700	6 to 7	1,760	This gas had been stored several days before testing, and in consequence lost largely in illuminating power.

NEW ZEALAND COAL.

Date of Test.	Name of Mine.	Weight of Sample tested.	Quantity of Gas produced from sample, in cubic feet.	Quantity of Gas per Ton of Coal, in cubic feet.	Illuminating Power of Gas in standard candles.	Weight of Coke per Ton of Coal, in lbs.	Remarks.
1871. April 30	Grey Coal, Test No. 1 ..	7 lbs.	35·5	11,360	14½	1,590	This is not a guaranteed sample, it was obtained from the s.s. 'Luna,' and may possibly have other coal mixed.
"	" " Test No. 2 ..	7 lbs.	31·3	10,016			
July 10	Grey Coal .. (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	550	11,000	20 to 24	1,820	
July 17	Grey Coal, Slack..	112 lbs.	430	—	21 to 25	—	The quantity registered is doubtful.
July 18	" " " ..	112 lbs.	510	10,200	Avrge. 22½	2,020	
July 20	" " " ..	112 lbs.	550	11,000	Avrge. 22½	1,880	Retorts were at a much greater heat than in the preceding and following examples.
July 24	" " " ..	112 lbs.	530	10,600	Avrge. 20	1,800	
Mar. 23	Collingwood Coal (Nelson)	7 lbs.	—	About 5,000	18½to19	—	Retort at only a dull red, about 1,000°.
Mar. 31	" " " (3 tests, about equal)	7 lbs. ea.	28·27	9,811	18 to 19	1,280	Illuminating power ascertained after gas had been stored some time, perhaps two or three days.
June 30	Collingwood Coal (Nelson)..	tns. cwt. 8 4	76,960	9,300 nearly	19	1,780	This gives illuminating power after storage, and as was supplied to consumers.
July 25	" " "	112 lbs.	500	10,000	25 and above	1,500	
July 8	Bay of Islands Coal (Kawa Kawa)	112 lbs.	530	10,600	18 to 19	1,328	
July 17	Mount Somers, Ashburton River, Canterbury	84 lbs.	200	5,300	None	A small quantity of light breeze only left after working off the gas.	

Approximate Analysis made in the Colonial Laboratory of Coals and Cokes referred to above.

Locality.	COALS.					COKES.
	Water.	Per Centage.				Per Centage of Pure Carbon.
		Volatile Hydro-carbon, etc.	Fixed Carbon.	Sulphur.	Ash.	
Grey River . .	1·60	33·50	59·80	·90	4·2	88·81
Collingwood . .	1·26	35·51	58·12	With hydro-carbon.	5.11	No sample
Newcastle, N.S.W.	1·42	27·25	61·21	1·02	8·80	84·09
Bay of Islands .	4·28	29·66	54·54	4·91	6·61	83·36
Mount Somers .	8.80	35·10	39·60	4·10	12·40	67·40

Art. XV.—*On Experiments made to determine the Value of Different Coals for Steam Purposes.* By J. Rees George.

[Read before the Wellington Philosophical Society, 14th October, 1871.]

The value of different New Zealand coals for steam purposes will be best illustrated by comparing the work performed with coal from longer established and more deeply worked mines. Mr. John Kebbell, of Wellington, having kindly furnished me with the result of several trials made at his mill, together with his notes on the subject, I now lay the same before the Society as a continuation of the paper read a short time back on the New Zealand coal for gas purposes.

Mr. Kebbell's trials were made by burning half a ton of coal, and ascertaining the time the engine was kept at work with the consumption of this weight of coal; care was taken in each case that the height of water in the boiler, the pressure of steam, the work being performed by the engine, and all other circumstances, should in each case present exactly the same conditions when the trials were commenced and completed.

The result of three experiments in 1869 was as follows:—

		h.	m.
No. 1.—English steam coal . .	worked engine	3	35
No. 2.—Newcastle, N.S.W., . .	,, ,, .	3	50
No. 3.—Bay of Islands (Kawa Kawa) coal	,, .	4	20

No. 1, English coal, would generate steam very rapidly if required.

No. 2, New South Wales coal, made 114 pounds waste from the half ton.

No. 3, Bay of Islands; this coal made twenty-eight pounds pure clinker. The clinker is as injurious to the fire bars as the South Wales coal of England; it adheres very strongly, and can only be removed by allowing the bars to cool down. If it were not for this fault it would be a good steam coal. With narrow spaces between bars, say five-eighths of an inch or less, it might give a better result; the ashes should be returned quickly to the furnace or they waste away.

Experiments made with the same weight of coal, during the present year, gave the following results; the improvement will be due to alterations in the engine and boiler:—

		h.	m.
No. 1.—English steam coal . .	worked engine	4	25
No. 2.—Collingwood coal, No. 1 trial ,,	,,	4	55
No. 3.—Collingwood coal, No. 2 ,, ,,	,,	5	0
No. 4.—Grey coal ,,	,,	5	5

No 1 gave about the same quantity and description of coal as the New South Wales coal.

Nos. 2 and 3. This coal cokes sufficiently to prevent it running through the bars. If the fires are fed regularly they require no stoking, and the least attention of any coal ever used by Mr. Kebbell. The clinker is similar in quantity and quality to the New South Wales coal.

No. 4, Grey coal, is a good coking material, and cakes very much in furnaces with a moderate draught, requiring a good deal of attention. The quantity of clinker and waste was so small as not to be worth mentioning.

In these trials all the New Zealand coals give a better result than either English or New South Wales coal, in work performed with an equal weight.

New Zealand coal, as a rule, appears to be of a less specific gravity than imported coal; this, however, may in time be altered as the mines become more deeply worked, and this renders them at the present time less valuable for steamers, and furnaces with a strong draught.

From inquiries made of the engineers of steamers, who have made use of the Grey and other kinds of coal, it appears to be the fact that the Grey coal is not so economical as the New South Wales for the use of steamers, for the reason that it is more bulky, and with the strong draught of the steamer's furnace burns away more quickly. The engineer of the steamer 'Luna' states, in his opinion, first-class New South Wales coal would be worth, for steamers, three shillings per ton more than the Grey, that is to say, if the price of the New South Wales is twenty-six shillings per ton, the Grey coal would only be worth twenty-three; but at the same time he prefers the Grey coal to much of the New South Wales coal that is sold in New Zealand.

For household purposes, all who have tried the Grey and Collingwood coal prefer them to any coal imported into the colony, as being cleaner and burning more freely and pleasantly.

All the experiments made, and information that I have been able to obtain, tend to show that New Zealand possesses superior coal for steam purposes, when worked with stationary engines, at a moderate draught, and for household and gas purposes, to that of New South Wales; but that for steamers' boilers, working at a strong draught, the heavier coals of England and New South Wales have the advantage. It is to be hoped that the further development of the mines will ultimately remove the last-named disadvantage.

ART. XVI.—*On the Destruction of Land by Shingle-bearing Rivers, and Suggestions for Protection and Prevention.*

By A. D. DOBSON, Provincial Engineer, Nelson.

[*Read before the Nelson Association for the Promotion of Science and Industry, 6th December,* 1871.]

THE great loss of land and damage occasioned to property yearly in New Zealand, is a matter which is rapidly assuming a more and more serious aspect; and although at present, as a general rule, the greater portion of the land destroyed is of no great value, nevertheless in many places on the banks of the smaller rivers considerable quantities of valuable land have been lost, in some instances entailing great expense and heavy loss to the owners and occupiers. For instances we need not go far in the Nelson province. Both the Motueka and Waimea rivers have widened their beds considerably; the former was, twenty years ago, only a few chains, but is now in many places nearly half a mile wide, and is rapidly filling up its bed with shingle brought down by the floods, and cutting new channels in the alluvial flats adjoining. Between the lowest ferry and the upper part of Pangatotara, several hundreds of acres have been destroyed during the last few years, and the river is now rapidly destroying some of the best land in Riwaka. The Waimea, although of considerably less volume than the Motueka, is continually encroaching upon the adjoining alluvial lands, every flood doing more or less damage. This has been particularly the case above Appleby, and again near Wakefield and Fox-hill. To take larger examples, we have the Wairau, which has always been a source of great anxiety, danger, and loss, to the inhabitants of the plains near Blenheim. The Waimakariri, in Canterbury, has encroached enormously on the alluvial land lying to the northward, and caused a great amount of damage to the farmers by the loss of crops, homesteads, and land. In fact, all the shingle-bearing rivers of the country are continually altering their beds and destroying adjoining land.

In order to correctly appreciate the causes which make this the rule, it will be necessary to consider the general characteristics of shingle-bearing rivers and the country which they drain. The greater number of the rivers in the Middle Island of New Zealand are, more correctly speaking, mountain torrents, which rise in lofty mountains and run but a short distance before reaching the sea; they are subject to very high and sudden floods, which occur in the spring and early summer, from the melting of the snow by the warm rains. The greatest floods occur generally in the streams which are fed by the glaciers in the Southern Alps, the warm northerly rains which fall on the glaciers and extensive snow-fields occasioning enormous floods. From the rapid fall in the river beds, many of them having a greater inclination than thirty-three feet to a mile in their upper parts, vast quantities of drift shingle and silt are brought from the higher levels and deposited in the lower, where the velocity of the stream is diminished by the lessening inclination of the bed; the fine gravels and sand are borne onward to the sea, and form the bars and shoals which exist at the mouths of all our rivers.

The larger gravels are thrown down as the velocity of the stream diminishes, and rapidly fill up the lower portions of the river bed until it is raised above the level of the adjoining land, when the stream, during some flood, overflows its banks, inundating all the low ground adjoining, and makes a new channel in the lower ground, which in its turn will be rapidly filled up, and the stream overflows again into the lowest ground in the neighbourhood. To this action is due the formation of most of the alluvial flats bordering the lower portions of the river courses. This subject has been very carefully investigated in connection with the formation of the Canterbury plains, by Dr. Haast and Mr. Doyne, C.E., whose reports and maps are most instructive. The process of successive elevations of the river bed is much more rapid in an open country such as Canterbury, where there is nothing to prevent the destruction of the river banks, than it is in a wooded country, such as the Nelson province, but the process is exactly the same in both cases. In a forest-covered country, such as the greater portion of the Nelson province is, the elevation of the river beds is necessarily a slow process. The forest clothing the mountain sides checks the sudden rush of water down hill during rain, besides preventing it from cutting water-channels in the surface, thus preventing a supply of *detritus* to the river in the first instance; and also the banks of all streams and rivers in a state of nature, before disturbance by the hand of man are, thickly covered with scrub and ferns, which, hanging down into the water, constitute a most effective protection against the destructive action of the rivers. The natural vegetation which covers the surface of a wooded country may be truly said to form the best protection to its surface, and the difference in the manner in which the water of precipitation drains off forest and open land is very striking, and well worthy of attention. When heavy rain falls on forest land, before it begins to flow on the surface it has to saturate all the humid and decaying vegetable matter which lies at the foot of the trees; the surface of the ground is also so covered with a network of roots that the water can only form a series of pools, which overflow from one to another as the rain continues, and a large body of water is thus retained upon the ground, which drains off slowly through the moss and roots. The small water-courses also get filled with trees, masses of twigs and moss, which materially assist in checking the velocity of the streams, and prevent abrasion of the surface—but the case is very different in open country, where there is nothing but grass to check the flow of water on the surface. After saturating the soil the water rushes without hindrance into the nearest hollow, and, rapidly accumulating volume and velocity, soon forms a dangerous and foaming torrent, which, cutting into the surface of the ground, carries down large quantities of gravel and *detritus* into the nearest river.

Whenever a river, for the greater part of its course, runs through a wooded country, the changes are effected so slowly in the river bed that the vegetation has ample time to take possession of any ground the river may abandon and convert it into forest land; the scrub and undergrowth also retain the silt borne amongst them by the floods, so that the banks and lowlands are raised and fertilised by every inundation. All this, however, is totally changed as soon as settlement commences and man begins to clear the timber and cultivate the soil. The timber is frequently taken from the river banks first, from the facility of transport by water—cattle feed on and destroy the scrub which clothes the banks, which, denuded of the natural covering, become an easy prey to the action of floods—every ditch that is dug increases the rapidity with which the rainfall is carried into the river, and the floods necessarily rise higher than before from having to carry off a greater body of water in the same time; as the clearing is carried further inland and the hill sides are bared, the water, during rains, can collect rapidly in all the small gullies, which will be converted into foaming torrents, and, no longer prevented by roots and moss from abrading the surface, they carve deep gullies in the mountain sides, bearing down enormous quantities of broken stone and gravel into the main stream below, which, in its turn, will carry on the *detritus* as far as the strength of the current permits, and then throw it down to fill up the river bed, and add to the destruction already in progress by the cutting away of the river banks. The enormous devastation occasioned by the indiscriminate destruction of forests in the Old World is so clearly shown by Mr. G. P. Marsh, in "Man and Nature," that I must refer to his work, as it gives a far better idea of the evils to be apprehended from the destruction of forests than any description of the devastations at present in progress in this province.

His descriptions show that most disastrous results may be expected from the felling of timber in the valleys and on the mountain sides in this province, unless steps are taken to prevent the evils thus occasioned by renewed planting, and the conservation of the forests in the upper course of the streams.

The town of Nelson, standing as it does on the banks of a mountain torrent, is particularly liable to damage from inundations. Floods which have already occurred show the amount of damage even a small stream can do in a few hours, when flooded and heavily charged with *detritus*. Owing to the inaccessibility of the valleys of the Maitai and the Brook, but little clearing has been done, but, as the means of communication are improved, there is no doubt that a great deal more timber will be obtained from these districts; the extension of the dray road up the Maitai will enable fire-wood cutters to work where they have been unable to do so hitherto, and, if the road was but a good one, there is no doubt that a great deal of wood would be brought in from there. The destruction of the forest in the basin of the Maitai I conceive to be prejudicial to the safety of the town in the highest degree, so much so, that I feel no hesitation in stating it as my opinion that before two-thirds of the water-shed of the Maitai are bared of timber, the destructiveness of the floods will have so increased that all the lower parts of the town will be converted into shingle bed. As the upper parts of the rivers in the province run for the most part through wooded country, composed to a great extent of drift shingle, very great destruction may hereafter be confidently expected if steps are not taken, on some general scheme, to preserve the woods which clothe the mountain drainage basins, and to protect the river banks from damage.

For the protection of the river banks, I would suggest the planting of willows, in great quantities, all along the banks and on the shelving gravel beds. Cattle should be kept from destroying the trees, which should be planted on every available part of the river bed; all low flats should also be planted with useful trees, and every little streamlet and water-course that carries shingle should be well planted. The great object to be attained is to prevent shingle from travelling in the first instance as much as possible, and this can be achieved to a great extent in all open ground by planting along the water-courses. An excellent example of the efficacy of this system can be observed at Stoke, near Nelson, on the property of Mr. Marsden, where a dangerous and troublesome stream has been carefully and judiciously planted in this manner, with willows in the bed and European trees on the bank, and thus changed from a destructive torrent into a pleasant brook, which greatly adds to the beauty of the grounds. In the large streams, where the banks are perpendicular and are at present being undermined, planting could not be executed without other measures were taken in connection with it. The banks would require to be well sloped, or, if the land was sufficiently valuable, it might be worth while to undertake the erection of engineering works to divert the current from the bank until the planting could be properly effected. But it must be borne in mind that so long as the higher parts of the rivers are neglected, whatever may be done on the lower levels will be of very little use, for, if the action of the river is to raise its bed, any protective works that may have been erected on the banks will require to be raised as the bed rises, thus entailing a constant outlay. The streams should be encouraged to meander at first as much as possible over the existing shingle beds, for, by encouraging the length, the fall and velocity are naturally diminished.

If the banks and gravel beds of the Waimea, for instance, were well planted with willows, and the neighbouring low grounds planted with rows of trees and shrubs at right angles to the flow of the water, but little damage could be done by floods, and the trees on the banks would materially assist the deposit of silt during floods, thus raising and fertilising the low ground. In the open country, where timber is very scarce, such as in Canterbury and Otago, the planting could be made to serve a double purpose, for, if properly managed, twenty years after planting a great deal of wood might be cut without in the least endangering the efficacy of the trees as a protection from floods. There are many difficulties in the way of preserving the timber and instituting a general system of planting such as I have suggested; there would also be a difficulty about keeping cattle from destroying the trees,* but these matters are questions which could be readily settled by the inhabitants of the districts likely to be damaged, as soon as the magnitude of the evils, which are certain to follow the clearing of the mountain sides and destruction of river banks, was clearly appreciated. No one who travels much in the Middle Island of New Zealand can fail to be struck by the amount of ground occupied by the river beds, nor fail to observe the rapid increase in size of most of the streams on the banks of which clearing is going on, and it is with the view of directing attention to this important subject that I have ventured to write this paper.

It may be urged that but little loss has been suffered yet, and that it will be time enough to go into the question when it assumes a more serious aspect; but, in answer to this, it must be remembered that preventive measures can hardly be taken too soon; and further, when the destruction has once commenced on a large scale, nothing but time and a very great expenditure can possibly remedy the evil.

Art. XVII.—*Notes on the Remains of a Stone Epoch at the Cape of Good Hope.* By B. H. Darnell.

[*Read before the Wellington Philosophical Society, 25th November,* 1871.]

Having seen the sand-worn stones in the museums of Nelson and Wellington, so strongly resembling those which are undoubtedly the work of human hands, and which Mr. Mantell, half jestingly, half seriously, has assumed to have been placed where they were found by the prudent foresight of ancient Maoris, in order that the abrading action of drift-sand might utilize them for posterity;

* The *Acacia dealbata* is recommended by Mr. Ludlam, of Wellington, as a good tree for such purposes, and not so liable to be destroyed by cattle as the willow.

and, having lately read Dr. Hector's paper on "Recent Moa Remains in New Zealand," I venture to believe that my slight experience in the remains of a stone epoch, gathered in another colony (the Cape of Good Hope) may not prove uninteresting to you.

I may premise that, unlike New Zealand, no native tribe in South Africa has been known to have used stone implements within historical times. In the early days of the colony, Hottentots, or Bushmen, are represented to have used the perforated stones or stone-rings, (of hard sandstone, greenstone, etc.), which are frequently turned up from under the soil, in weighting the ends of sticks with which they dug up roots, but they probably found them to their hand and thus utilized them, many of them being so small as to be useless for such a purpose. As they are found quite independently of the so-called "arrow-fields," they probably belong to another and later period. Arrow and spear-heads, celts, hammers, saws, chisels, etc., were first found a few years ago by Mr. T. H. Bowker, a well-known colonist at the Cape, and since then have been discovered at various localities, both on the coast and inland. It is remarkable that they are generally found on the surface of the same red clay or gravel, a circumstance which may assist in determining their age. As to that I will hazard no opinion, but at East London the coast line has been submerged and raised again since the implements found there were fashioned. The following extract from a paper by Mr. Mackay, Clerk of Works, in the employment of the Government, (which accompanied a collection of implements that I have seen), may throw some light on this part of the subject. The calcareous tufa referred to is a recent deposit. On one part of the West Coast, near the mouth of the Orange River, I observed numerous shells of ostrich eggs imbedded in it. He says, "The red soil in the interior affords no indication of the age of the implements; but on the coast the red clay can be shown to be overlaid by the calcareous tufa, followed by a wind-stratified sand-limestone, on which rests a yellow plastic clay that is from a rock decomposing at the higher levels, and the resultant clays transported to and filling in the depressions at the lower levels; then follow gravels, and over them alluvial and sedimentary mud; then the modern sand-drift." "In 1851 the whole of the ground between East London and Fort Glamorgan was covered by drift-sand, with a thick carpet of grass grown over it. Waggon traffic cut up the sand in all directions, and in a short time all was blown away except a few hillocks from four to eight feet high. The exposed *black clay*, formerly protected by the sand, was gradually cut through, and the implements exposed to view. In this condition they were discovered by Mr. T. H. Bowker, in 1867, who had previously discovered them elsewhere. No doubt the implements were made on the spot, for with them were cores and flakes, also their being found in the small islets of black clay that still remain undenuded in the 'arrow field,' and their occurrence in the cutting at the road, where they are overlaid by four feet of black clay, place this matter beyond dispute. No bone or any other material has been found."

The imperfect specimens which I now send for the Wellington Museum, are only the remnants of a larger collection which was sent to Vienna. They were found by me on the "Cape Flats," a low tract of land mainly covered with drift-sand, averaging ten feet in depth, and lying between Table Bay and False Bay, at the south-west angle of the Cape. The "arrow-field" is of considerable area, many acres in extent. In fact, the chips and flakes are found wherever the dark red clay or gravel is exposed by denudation of the drift-sand. The material of which they are made was, and still is, found on the surface in the form of boulders, which accounts for the extent of the "field," and the cores from which they were struck are to be met with everywhere. Mr. Bowker, who is an ingenious person, has succeeded in manufacturing flakes readily by striking the stones in a peculiar way. The finds on the Cape Flats consisted principally of broken arrow and spear-heads, broken in the manufacture, and of numerous "rubbers" and flakes, and an occasional saw. The field had been pretty well gleaned by another before my introduction to it. I was, however, fortunate in finding the remains of an earthenware pot (only the second or third found of the kind) of which I also send you one handle and some of the sherds. These remains lay at the base of a high sand-drift, and had apparently been recently uncovered. It is difficult to believe that these pots were contemporaneous with the stone flakes, but at the same time they might be preserved for an indefinite period when covered up with dry sand. They resemble in form the utensils figured in the old books of travels as used by the Hottentots. A thong of hide was passed through the holes in the handles wherewith to carry them. Some years before I had seen an extensive bed of potsherds exactly similar on the coast, about three hundred miles to the eastward, underneath many feet of drift-sand, and concluded that it was the site of an ancient Kaffir pot manufactory, that part of the country having been formerly occupied by Kaffirs, but the composition of these pots is of coarser material than that of the modern Kaffir pots.

Happening to show some of these implements to a friend, who had been many years before in Greece, "why," said he, "these are the very same things they pick up on the field of Marathon, and call Persian arrow-heads, but I never believed they could be that!" Shortly afterwards I read what follows in Mr. Gladstone's "Juventus Mundi," "There is no reason to believe that there were any earlier occupants of the Greek or of the Italian Peninsula than the group of tribes called Pelasgian. Neither of these countries presents us with remains belonging to what is called the stone period of the human race, when implements and utensils were made of that material, and the use of metals was unknown."

Art. XVIII.—*Notes on the Practice of Out-door Photography.* By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 28th October,* 1871.]

The following notes and suggestions on the practice of out-door photography may possibly be useful to those who propose to follow this art, premising that they are offered as the result of my own experience during the last three or four years.

In the first place it is essential that the operator should use the very best instruments and chemicals, and above all things, as the most important condition of success not only in this, but in all other branches of the art, that he should observe the strictest cleanliness in all the operations. After trying several instruments, I ultimately selected, and confined myself to, a Ross doublet, constructed for whole plates, but which covers, without the least distortion and with perfect definition, as may be observed from my pictures, ten by eight glass plates. I have always used Mawson's collodion, with the accompanying directions for development, and I have found this important advantage from adherence to one formula, that the operator ascertains by experience the best length of time for exposure of the plates under the most varying conditions of light and temperature. I may add, also, that I always use the wet process, and for this purpose I have succeeded in constructing portable apparatus of different, but in each case of simple kinds, which I have found no difficulty in carrying safely over country in which a pack-horse alone can travel, and over which, in many cases, it required very well trained pack-horses to make their way at all. Indeed, to those who are compelled to use pack-horses in the more rugged and difficult parts of the Middle Island, for the purpose, for example, of supplying gold-diggers and others with provisions, the sagacity and surefootedness of these animals, under kind treatment, recall the anecdotes of the mule in travelling through the mineral districts of Peru, or in crossing the snow-capped passes of the Pyrenees.

The advantage of using the wet process over every form of dry plate is, that the operator knows at once whether he has obtained a satisfactory picture or not, so that he can, by the use of a second or third plate if necessary, correct errors or imperfections appearing on the first trial. It is, in effect, for the purpose of describing the apparatus I use in connection with the wet process that these notes are written, as I venture to think them superior, in point of simplicity and general utility, to any which are to be found described in treatises on photography.

My camera is so constructed as, when completely closed, to occupy a space only four and three-fourths inches deep by eleven inches square, and the dark slide permits of the pictures being taken either the wide or the long way of the glass; but although, as I have before observed, the lens face covers admirably a ten by eight plate, I have reduced the size of the glass to nine by seven, and I never take a picture of less size, for the simple reason that to do so would involve carrying separate glass boxes, whilst, of course, the larger size includes all that could be got by using a smaller plate. The nitrate bath is carried in a porcelain trough fixed in a strong wooden frame, with a small space between the ware and the wood, from which it is kept generally free by a few india-rubber buffers. This precaution diminishes the risk of damage from any accidental blow or crush. I use a glass dipper, which also fits into a wooden case, after being wrapped round with a soft rag. My developing and cleansing solutions are kept in six-ounce bottles, which fit into a box made of thin board, divided into cells, padded with cotton wool and lined with cloth. I usually carry in these cells two bottles of cyanide solution, and one each of iron, pyrogallic, and silver solutions. The collodion bottle is also fitted with a small wooden box, into which I stuff a few of the cloths which are necessarily used for wiping the developing glasses, etc., when I am at work. A galvanized iron dish, with a pipe about an inch long in one corner for carrying off the waste water, plateholder, developing glasses, a spare silver dipper, and a few other odds and ends which every one accustomed to landscape photography ordinarily requires, complete the materials for the work. When I travel in mountainous or other districts, in which there are no carriage roads, I usually carry all these articles packed in a developing box, which I propose to describe, and which I have found admirably suited for the purpose.

The bath in its case, the camera when folded up, the boxes containing the collodion and developing solutions, etc., are all of nearly uniform thickness, which is about five inches. The developing box, answering to the dark room of the stationary photographer, is made of three-quarter inch well seasoned deal, and is thirty inches long by sixteen inches broad, and five and a half inches deep in the inside. The inside is fitted with straps which are screwed close to the edges, and which are so fixed as, when buckled, to secure in their respective places the various articles laid in the box. On the left hand side I place the bath, lying across the width of the box, next to it, in the middle, the iron washing dish, in which the box containing the developing solutions, the dipper, and any odds and ends, lie, and on the right side the camera and lens, whilst the remaining available space affords room for the collodion bottle, the focussing screw, cloths, etc. When the lid is down, and a pair of straps are fastened round the box, the whole is secure, and it can easily be slung on one side of an ordinary pack-saddle. Besides the articles contained in this box, there are of course, the tripod for the camera, and boxes containing glass for the pictures. The glass boxes are also made of stout deal, with grooves for the glass, and are padded with several thicknesses of old, well-washed calico. Cross legs, similar to those used for supporting a butler's tray, complete the equipment. When I intend taking any large number of pictures, I always carry the necessary raw chemicals (if I may use such a term) with me, as I prefer having the solutions fresh and fresh.

The above photographic outfit, with a tent, provisions, clothes, etc., makes a reasonable load for a pack-horse for an expedition into the mountains to last ten days or a fortnight. I now proceed further to describe the dark box when in use. Assuming it to be resting on the cross legs, it is kept firm by four strings attached to the lower corners, and pegged to the ground in the manner of tent ropes. The lid is then raised, and forms the back of the dark box. In the centre of this lid is a small window, fitted with orange-coloured glass, which opens inwards, and is protected on the outside by a shutter which slides over it. Two arms, two inches broad by three-quarters thick, are fixed by hinges to the inside of the box, on the side opposite to the fastening of the lid, and these, when raised, are kept upright by a cross piece of the same dimensions, the whole forming an open frame opposite to and of the same dimensions as the lid. The latter is then attached to this framing by pieces of stout iron wire, which slide into loops in the lid and open frame. The box, when open in this manner, resembles a butler's tray, to which a back (the lid) has been fixed, with a slight frame-work in front, which, if solid, would make it a box thirty inches long, sixteen inches wide, and eighteen inches high. To the edges of the lid and the bottom of the box a tent, which stretches over the framing above referred to, and falls behind the operator, is fixed. This tent, in my case, is formed of three thicknesses of stuff, the inside one of close black holland, the outside of close black cotton twill, and between these a close yellow twill. Over these I throw a light white calico covering, in order to prevent too great heat when working in the sun. I usually select, if possible, some spot near a tree for fixing the apparatus, in which case a string run through the top of the tent-covering enables me to draw it well up, and thus increase the inside height. When engaged in developing, I wrap the hanging end of the tent-covering round me, thus excluding all light. I have found this apparatus perfectly sufficient, even when the actinic condition of the light is most active. For washing the pictures during development, I use a strong tin kettle, ten inches high by six in diameter, which also serves the purpose of a tea kettle for the camp. With an apparatus such as I have described, I have taken nearly two hundred negatives, many of them in very rugged and difficult localities.

In places accessible to a wheeled vehicle I use a dark box, the sides of which are solid throughout, but of very much the same general construction as the other, and which I usually carry at the back of an ordinary spring cart. It opens in front by a lid divided into two parts, one folding on the other, to the inside of which a dark cloth is attached, which falls behind me, and which I wrap round me, precisely as in the other case, when engaged in developing a picture.

In conclusion, it may be useful to those who contemplate engaging in landscape photography in the country, if I add a few words on my own practice, which has been more than ordinarily successful. I chiefly use Chance's patent plate for my negatives. The perfect flatness, smooth surface, and general freedom from flaws, of this glass more than compensate for the extra cost, though I have taken good pictures on the same maker's flatted crown glass. I invariably clean both sides of the glass equally, and never use a plate which I cannot feel sure of being chemically clean. I always prepare overnight the number of plates I expect to use on the following day, and never use glass which has been kept more than a few days in the boxes, without recleaning it, for I have found that even in the driest weather it is liable to become spotted. For taking three or four dozen of negatives, when they are likely to be taken within ten days, I find it convenient to prepare a sufficient quantity of the various developing and cleansing solutions, of double strength, which I reduce with river-water; but, in order to guard against accidents, I always carry the necessary quantity of raw chemicals, carefully packed in a strong wooden box, and requiring only the addition of water to fit them for use. The best times for working are from nine in the morning until about half-past three in the afternoon. I have taken fair pictures before nine o'clock, but as a rule the half tones are rarely obtainable, or very imperfect, in pictures taken very early in the morning, and the light loses a good deal of its actinic power after three o'clock, owing, I believe, to the air being much charged with moisture. The actinic power of the light is most active in clear cool weather, as, for example, during north-east weather in Wellington and Canterbury, north-west weather being unfavourable even for printing. After the operation of developing a picture I invariably wash out the developing glasses, and I never use the cleansing solution over again, which I feel sure is a bad practice, though sanctioned by many writers on the art. The water used for washing the pictures should pass through fine muslin tied over the mouth of the vessel, as I have observed that "pin-holes" are often caused by small particles of matter in the water coming in contact with the film. In fact, no precaution ought to be neglected to insure a perfectly clear and uniform film, without which all kinds of shifts, destructive to anything like perfection in the prints, must be resorted to in order to produce a passable picture. It may be observed that my pictures are entirely free from blemishes of this kind, and this is attributable solely to close attention to cleanliness, and to care in the mechanical operations. Of course there are cases in which the most careful operator must be content to put up with imperfections; but I am assuming the case of one who has it in his power to control circumstances. As a last suggestion I would add that perfect calmness and deliberation in all stages of the work are in the highest degree necessary, anxiety and hurry being fruitful sources of failure.

II.—ZOOLOGY.

Art. XIX.—*On Megapodius Pritchardi*, Gray. *Megapodius Huttoni*, Buller.
By Captain F. W. Hutton, F.G.S.

[*Read before the Auckland Institute*, 31*st July*, 1871].

In the third volume of the *Transactions* of the New Zealand Institute, p. 14, Mr. Buller has described a bird in the Auckland Museum as *Megapodius Huttoni*. This bird was presented to the Museum by Captain Rough, of Nelson, who brought it from the island of Nuifo (not Nuipo), and gave me the following information concerning it.

Nuifo is one of the Friendly Island group, and is under the Government of Tonga; it lies 100 miles west of Keppel's Island, and about 300 miles south-west of the Navigator Islands. It consists of a ring of high land which is the summit of a volcano, the interior crater of which is occupied by a lake of brackish water, studded with two or three islands. It is on these islands that the *Megapode*, called Malau (not Malan) by the natives, lives.

At the breeding season the bird scratches a hole in the ground, in which it lays several (about six) eggs, and then covers them up with earth. The young bird comes out of the egg fully fledged and able to fly.

The specimen now under notice was brought to the Museum in spirits, but was afterwards skinned and set up by order of the Council of the Auckland Institute; the body, however, is still preserved in spirits in the Museum.

There can, I think, be little doubt but that Nuifo of Captain Rough is identical with Niafu, or Niufu of Dr. Finsch; and Mr. Buller, in his description of *M. Huttoni*, has omitted to mention that the tail feathers are whitish at the base, and that a ring round the neck is almost bare of feathers. With the exception of the tail, the general plumage of the bird corresponds exactly with the description of *M. Pritchardi*, as quoted by Mr. Buller, but no mention is there made of the quill feathers. The bill and feet certainly do not quite correspond, which may be owing to the Auckland Museum specimen having been kept for some time in spirits, but I can see no difference between the two sufficiently great to warrant the establishment of a new species, and think, therefore, that this bird must be referred to *M. Pritchardi*, Gray.

Art. XX.—*On the Microscopical Structure of the Egg-shell of the Moa.* By Captain F. W. Hutton, F.G.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 26th August,* 1871.]

Having been kindly supplied by Dr. Hector with some broken fragments of the Moa's egg, I have now the honour to lay before the Society the results of a microscopical examination which I have made of them; I must, however, first observe that I have been informed that the structure of the Moa's egg was described many years ago, but, as I cannot find any trace of that description, I hope I shall escape the accusation of making you listen to a repetition of well known facts.

About four years ago Dr. Blasius published an extensive and detailed account of the structure of the shell of birds' eggs. This account I have not seen, but I am aware that he arrived at the conclusion that the microscopic differences are neither constant nor reliable, and cannot be used for purposes of classification. There is, however, one constant feature that distinguishes the eggs of the Struthious birds from the rest of the class, or the Carinate birds. This is, that in the eggs of the Struthious birds the carbonate of lime shows a prismatic structure, while in the eggs of the Carinate birds the prismatic structure is absent.

I believe that I have examined the egg-shell of more than one species of Moa, but I find the structure to be fundamentally the same in all, and that the differences in different portions of the same specimen are quite as great as in any two different specimens. The shell, when not abraded, is of a pale yellow colour, smooth, and irregularly pitted on the outside with dots and linear markings, sometimes 0·08 of an inch in length. (Pl. IX., Fig. 1). On some fragments the markings were all straight, in others they were nearly all curved, while in others again both straight and curved markings occurred together. Round dots were on all the specimens. In appearance they are more like the egg of the South American *Rhea* than any other that I know. The specific gravity I found to be 2·714. On dissolving in dilute hydrochloric acid no residue was left. The shell is about 0·07 of an inch in thickness, and is divided into two layers, each presenting a different structure (Fig. 2).

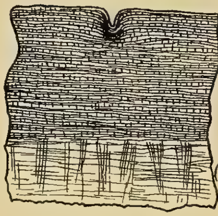
The outer layer (Fig. 2 a) forms about two thirds of the whole thickness, and is composed of a large number of thin laminæ, arranged parallel to the surface of the egg. Each of these laminæ appears to be void of structure when viewed under a power of 400 diameters, being made up of numerous points variously aggregated together into clouds (Fig. 3), very similar in appearance to mucilage.

nat. size.

Fig. 1

portion of shell.

× 15. Fig. 2.



transverse section.

× 25 Fig. 3.

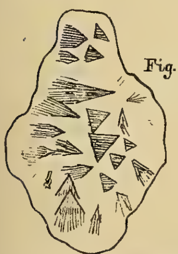
outside (a.)

× 25. Fig. 4

inside. (b).

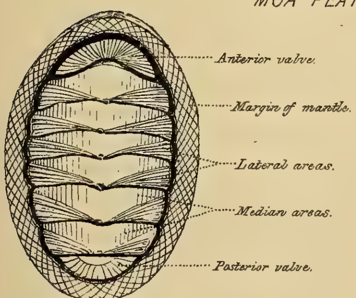
× 100.

Fig. 5.

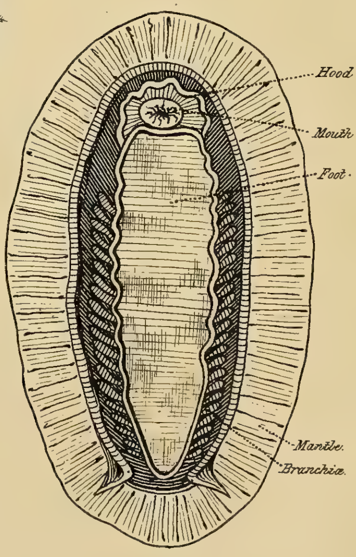


a single column from the inside more magnified.

MOA FEATHER



CHITON QUOYI.
Dorsal view



CHITON.
Ventral view. (after R. Jones.)

F. W. Hutton del. J. B. lith.

Printed at the Gen. Gov. Lith. Press.

The inside layer is totally different, showing an irregular columnar structure, which very easily breaks up (Fig. 2 b). Sections made parallel to the surface of the egg, or at right angles to the columns, show that each column contains many, more or less complete, triangular prisms of carbonate of lime. Under a low power these prisms appear to have a radiating arrangement from a nucleus, and often there are two, three, or four nuclei in each column (Fig. 4), but under a higher power this disappears. This appearance is owing to the prisms being collected more thickly in the centre of the column, and to many of the imperfectly formed ones having a well formed apex pointing inwards, while the base of the triangle is undefined, and shades off outwards into a brush of very fine spiculæ (Fig. 5).

The prisms appear to be always triangular, and to vary in section from an equilateral to an isosceles triangle, in which the base is about half the length of one of the sides. These, however, might all be produced by variously inclined sections of an equilateral triangular prism. The length of the sides vary from very small up to 0·003 of an inch, which is the longest that I have measured.

The egg of the Kiwi *(Apteryx)* shows none of this prismatic structure, but is in every way similar to that of the common fowl, and we have, therefore, here further evidence that the Moa belongs to the Struthious type, where it has always been placed, while the Kiwi, in the structure of its egg-shell belongs to the Carinate type of birds.

Note, Aug. 29th, 1871.—Since reading this paper I have found the following notice in the "Zoological Record" for 1869, part I., page 103:—"*Dinornis.*—The structure of its egg-shell is essentially similar to that of other *Struthiones*, and agrees most nearly with *Rhea.*—W. von Nathusius, Zeitschr. wissensch. Zool. XX., p. 118." Also on p. 104, "*Apteryx*, in the structure of its egg-shell, does not much agree with other *Struthiones.*"

Art. XXI.—*Notes on the Lizards of New Zealand, with Descriptions of Two New Species.* By Captain F. W. Hutton, F.G.S.

[*Read before the Wellington Philosophical Society, 16th September*, 1871.]

The following notes embody the results of an examination of the collection of New Zealand lizards in the Colonial Museum, which contains the types of Mr. Buller's three new species described in the *Transactions* of the New Zealand Institute, Vol. III., p. 4, etc.

Family *Scincidæ.*

Hinulia ornata.

Tiliqua ornata, Gray, "Dieff. N.Z.," Vol. II., p. 202. *Eulampus ornatus*, Fitz.

This species varies from pale to golden brown; it is more or less spotted on the back with blackish brown, and generally has an interrupted band of the same colour on the sides; the scales of the back are streaked with black; below it is greenish, or yellowish white with black spots. The tail is thick and short, and is slightly serrated by the projecting tips of the scales. The length of the head and body is about 3 inches; of the tail 2·25 inches. It is found under stones and logs, both in the bush and in the open country.

Mocoa Zelandica.

Tiliqua Zelandica, Gray, "Dieff. N.Z.," Vol. II., p. 202. *Lampropholis moco*, Fitz. *Hinulia variegata*, Buller, *Trans.* N.Z. Inst., Vol. III., p. 5.

The fronto-parietal shield is divided into two, and the ears are denticulated in front in this and all the other New Zealand species of *Mocoa*, except, perhaps, *Smithii*, which I have not seen. The colours in this species are very variable. Generally the back is pale, or dark reddish-brown, sometimes greenish, generally with an irregular whitish stripe, edged below with black, from the nostrils, over the eye, down the side, and often with a darker stripe down the centre of the back. Sometimes it is pale golden brown on the back and darker on the sides, with a narrow black line dividing the colours. Down the middle of the back there is generally a shallow groove, which is deepest over the fore and hind legs.

I have examined both the specimens on which Mr. Buller founded his *H. variegata*; they both have the lower eyelid of *Mocoa*, and cannot be distinguished from *Mocoa Zelandica*. The specimen answering to Mr. Buller's description is a rather remarkable variety as regards its colours, but the other is a very common one, and differs but slightly from the typical *Zelandica*. In neither of them is the ear round, as described by Mr. Buller, but oval. This species is more common than the last, and frequents the same localities. There is a specimen in the Colonial Museum from the island of Rangitoto, near Auckland.

Mocoa Smithii.

Mocoa Smithii, Gray, "Voy. Erebus and Terror." *Lampropholis Smithii*, Fitz.

I have seen no specimens that I can refer to this species.

MOCOA GRANDIS.

Mocoa grandis, Gray, "Catalogue of Lizards in the British Museum," p. 272.
Lampropholis grandis, Fitz.

This species appears to vary little in colour. The length of the head and body is about 2·5 inches, that of the tail the same. The tail is short, and thick at the root. The specimens in the Colonial Museum were obtained in the neighbourhood of Wellington. It was, I believe, this species that was seen by Mr. Kirk and myself on Flat Island, near the Great Barrier Island, and also on the Little Barrier Island, and referred to by Mr. Buller (*Trans.* N.Z. Inst., Vol. III., p 4.)

MOCOA STRIATA.

Mocoa striata, Buller, *Trans.* N.Z. Inst., Vol. III., p. 6.

This species differs from *Zelandica* in its colours, and in having the ear circular; the palbebral disk is moderate, and the pre-anal scales are rather larger than the others.

No locality is attached to the type specimen.

MOCOA ? LAXA. sp. nov.

General characteristics as in *Mocoa*. Fronto-parietal plates 2, separate; ears ovate, open, denticulated in front with 6 rounded scales; rostral erect, triangular, rounded in front; nasal shields moderate, rather distant, inter-nasal semicircular in front, bi-lobed behind, a semi-oval inter-frontonasal shield separates the inter-nasal from the frontal; fore part of the head, including the frontal shield, depressed; eyebrow shields 5-5 elevated, rounded; palpebral disk rather large. Scales small, rather thick, smooth, loosely imbricating on the back; central pre-anal scales rather larger than the others. Length from muzzle to tail 2·5 inches; of tail 3.75 inches.

Colours.—Top of head pale brown, marbled with black; back and limbs pale brown, with irregular undulating transverse bands of black; tail pale brown, with three longitudinal rows of black spots, below greenish white; soles of the feet black.

The specimen from which this description is taken is in the Colonial Museum, but no locality is attached, there can, however, be little doubt but that it comes from New Zealand.

The loose thick imbricating scales on the back, and the extra inter-fronto-nasal shield, perhaps entitle it to rank as a new genus, but I have placed it in *Mocoa* until some naturalist, with greater experience than myself, thinks that it ought to be removed.

NORBEA ISOLATA. sp. nov.

Head depressed, with a large saucer-shaped hollow on the crown; shields even, minutely granular; rostral squarish; nasal lateral, squarish; inter-nasal large, squarish, slightly emarginate on the posterior edge; fronto-nasal distinct; frontal elongated, tapering behind; eye-brow shields large 4–4, orbits granular, upper eyelid with a row of six scales; temples covered with scales; scales of the body rounded posteriorly, those of the back slightly rugose; those of the throat and belly smooth and polished. Pre-anal shield single, large, four-sided. Tail elongated, tapering, anterior half flattened above and below, with a row of keeled scales on each of the upper edges; posterior half much compressed. Limbs rather short, strong, and compressed. Front feet with the second and third toes equal, first longer than the fourth. Hind feet with the third toe rather longer than the second, first longer than the fourth. Claws 5–5.

Length from muzzle to tail, 1 inch; of tail, 1·35 inch.

Colours.—Above blackish brown, below blackish grey; minutely dotted all over with black; scales of the inner surface of the thighs margined with yellowish white.

This specimen is in the Colonial Museum, and is said to have been brought from White Island in the Bay of Plenty, but I have not yet been able to find out who obtained it. It differs from the genus *Norbea*, as described by Dr. Gray in the "Catalogue of Lizards in the British Museum," p. 101, London, 1845, in the remarkable depression on the top of the head, in the upper eyelid being furnished with a row of scales, and in the scales of the back being slightly rugose posteriorly. The only other known species of this genus is *N. Brookei*, from Borneo.

Family *Geckotidæ.*

NAULTINUS ELEGANS.

Naultinus elegans, Gray, "Dieff. N.Z.," Vol. II., p. 203. *Hoplodactylus elegans*, Fitz.

In this species the toes are very slender, and the scales on the front of the head are convex in the adult, although flat in the young. In the female the enlarged scales at the root of the tail, on either side of the vent, are much less developed than in *punctatus.* Both sexes have a small transverse patch of pre-anal pores, but no femoral pores. In colour this species varies from bright green to yellow; in spirits they are often purple, but, according to Mr. Buller, this colour is caused by the spirits. They are generally more or less spotted on the back and head, the spots being sometimes surrounded with black and sometimes not. The average length is about 4·5 inches, of which the tail occupies rather more than half.

Sub-species *stellatus.*—Stouter in its proportions, two inter-nasal shields, no pre-anal pores in the female ; (male unknown).

Colours.—Above reddish-purple, getting yellowish towards the muzzle. From the base of the upper lip to the ear, and again behind the ear, a white streak ; another on each side of the crown. Down each side of the back a row of six four-rayed star-shaped white spots, and on each side of the upper part of the tail a row of about ten irregular, angular, white spots. On each side a row of four rounded, or stellate white spots, and below them an interrupted band of white. Lower surface yellowish white, tinted with purple on the belly. Limbs yellowish purple, spotted with yellowish white ; feet and toes yellow.

Length, from muzzle to tail, 1·35 inch ; of tail, 1·33 inch.

This specimen is a female. It was obtained by Mr. Brough, under stones among the snow, near the top of Mount Arthur, in the province of Nelson. It is now in the Nelson Museum. This specimen differs very much from the typical *elegans*, not only in its colours, but in its stouter form, and in the absence of pre-anal pores ; but, until more are obtained, I hesitate to call it a distinct species.

The figure of *N. elegans* given in the *Transactions* of the New Zealand Institute, Vol. III., p. 4, is not that species, but *N. punctatus.*

NAULTINUS PUNCTATUS.

N. punctatus, Gray, "Dieff. N.Z.," Vol. II., p. 203. *N. Grayi*, Bell, "Voy. Beagle," Vol. III., p. 27. *Hoplodactylus punctatus* et *Grayi*, Fitz.

This species is distinguished from the last by its larger size, more robust toes, and the scales on the fore part of the head being flatter. The male, which is the *N. Grayi* of Bell, has the head concave, and a single inter-nasal shield ; a large square patch of pre-anal pores, and a triangular patch extending for some distance up each thigh. The conical scales at the root of the tail are much developed, forming short spines, and there is a large rounded swelling just behind the vent. In the female the inter-nasal shield is divided into two, the head is much more flat, only one or two of the pre-anal scales are punctured, and there are no pores on the thighs. The average length is about 6·5 inches, of which the tail occupies about one half.

In colour this species is variable, being sometimes a uniform green above and yellowish below, but usually the top of the head and the back are marked with oblong yellow or white spots ; it appears occasionally to turn purple in spirits, but generally retains its green colour.

This species is much more common than the last ; both are found in the open fern land.

Naultinus sulphureus.

N. sulphureus, Buller, *Trans.* N.Z. Inst., Vol. III., p. 8.

This species differs from *punctatus* only in its rather larger and flatter scales, and in the slightly more elongated tail, as pointed out by Mr. Buller. The type specimen is a female.

Mr. Buller was mistaken in supposing that this specimen was obtained near Rotorua, for Dr. Hector informs me that he got it at Maketu, on the sea coast, thirty-five miles from the nearest hot spring.

Naultinus pacificus.

N. pacificus, Gray, "Dieff. N.Z.," Vol. II., p. 203. *N. granulatus*, Gray, "Catalogue of Lizards in British Museum," p. 273. *Hoplodactylus pacificus* et *granulatus*, Fitz.

The lower labial shields vary very much in this species, so that, although the difference is great between a typical *pacificus* and a typical *granulatus*, all kinds of intermediate grades can be found. The colours are very variable, and are not characteristic, as the white fronted dark bands are just as common in one variety as in the other.

This species is found in both the islands, generally under the bark of trees, but Mr. W. T. L. Travers informs me that at Lake Guyon, in the province of Nelson, it is found under stones. From the same gentleman I also learn that it is occasionally infested with a small red parasite on the inner parts of the thighs. It is exceedingly sluggish in its movements.

Art. XXII.—*On Some Moa Feathers.* By Captain F. W. Hutton, F.G.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 28th October*, 1871].

When at Dunedin last July, I was shown by Mr. Purdie some feathers of the Moa which had been found by Mr. Samuel Thompson with moa bones, buried in sand, about fifty feet from the surface, at the junction of the Manuherikia with the Molyneux River, and quite recently some more moa feathers have been received at the Colonial Museum from Dr. Thomson, of Clyde, which were found between Alexandra and Roxburgh, eighteen feet below the ground.

The feathers from both these places are so much alike that there can be little doubt but that they belong to the same species of bird, their differences being simply due to their coming from different portions of the body. They are all quite fresh in appearance, and the colouring is as bright as if just plucked from the bird, but unfortunately all are more or less broken, and only one (in the Otago Museum) shows the tube that enters the skin. In this feather the length of the tube is 0·25 of an inch, and it contains two plumes or feathers. The main plume is unbroken, and is 4·75 inches in length, and 0·5 of an inch broad at the tip; the other, or accessory plume, is 2·75 inches long and broken off, but in size it almost equals the main plume. The greater number of the feathers have a very peculiar shape, gradually enlarging from the tube to the apex, where they are rather bluntly rounded off; some, however, especially the more downy ones, have the sides more parallel. The largest I have measured was 7 inches long, and 0·75 of an inch broad at the apex. The barbs are unconnected and rather distant, but not so much so as in most Struthious birds. They are furnished with barbules up to the very tips of the feathers, except in a few cases where for a short distance the barbs are simple. No barbicels exist on any part of the feathers, the downy portion being simply formed by the barbules being more elongated and set closer together. The shafts are slender and flexible, and do not project beyond the barbs.

In colour the feathers are brown for about the basal two-thirds, the more downy ones being of a redder brown than the others. This brown gradually shades off into black, which colour is kept as far as the rounded portion of the tip, which is pure white. The shaft is of the same colour as the feather.

The structure of the feathers, therefore, is decidedly of the Struthious type, but owing to the nearness of the barbs, and the presence of barbules to the tips, it is not so typical of that order as some living species. The long after shaft and the numerous barbs in the feathers of the Moa show an affinity to the Emu, while the egg, as I have previously remarked, shows an affinity to the *Rhea*, thus connecting the Moa more nearly with the *Struthiones* of South America and Australia than with the Ostrich of Africa. (Pl. IX).

ART. XXIII.—*On the New Zealand* Chitonidæ.

By Capt. F. W. HUTTON, F.G.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 25th November*, 1871].

THE Chitons form a very distinct family of the Mollusca, easily recognised by their oval or oblong form, covered by several shelly plates or valves, which give them something the appearance of those Isopod crustaceans commonly known as Wood-lice *(Oniscus)*. The shell is composed of eight transverse moveable valves, the anterior edge of each being covered by the posterior edge of the one next in front; these valves are inserted into a tough ligament called the mantle, which holds them all together, and which expands into a broad margin round the animal. (Pl. IX.) The margin of the mantle presents many differences, whichare used to divide the family into various genera. Sometimes it is covered with small imbricated scales, sometimes with spines, while in many species it is nearly smooth, or tomentose with short hairs. The anterior and posterior valves are smaller than the others, and generally rounded on the outside margins; the intermediate ones are broader than long, and elevated in the centre, either by being uniformly arched, or by each side being more or less flattened so as to form two sides of a triangle. These intermediate valves are usually divided into a dorsal, or median, area, and a triangular lateral area on each side, which are called respectively the median and lateral areas. The sculpturing on the lateral areas is generally different from that on the median areas, while it is almost always the same as that on the anterior and posterior valves, or terminal areas.

The animal is of an oval or oblong shape, with a long and broad foot rounded at each end. The head is not furnished with eyes nor with tentacles, but has a waved membranous hood surrounding the mouth. The tongue is long, spirally rolled, and armed with hooked horny teeth. The branchiæ, or breathing organs, are in the form of a series of small triangular leaves, and are situated in a row on each side of the body, between the mantle and the foot. The sexes are distinct. They adhere to rocks, or shells, sometimes even to fish, and when detached roll themselves up; a few are found creeping on sand. They generally live between high and low water marks, but some small species inhabit the sea to a depth of twenty-five fathoms. Some fix themselves on the upper surfaces of rocks, and, when the tide is out, bear the full heat of a tropical sun on their backs, while others are only to be found during very low tides, and are seldom exposed to the air. The greater number, however, inhabit the bottoms of rock-pools, or the under surfaces of stones, and so always keep moist even when the tide is out.

Very little is known about their habits further than that when covered with water they move slowly from place to place in quest of food, which is supposed to be entirely vegetable.

They adhere to the rocks with great tenacity, and in order to collect them without breaking the shell they must be taken by surprise, the blade of a knife being slipped suddenly under them and one side lifted up. If the animal is at once removed from the shell the mantle contracts, and cannot be straightened out again without great risk of breaking or displacing the valves. The best method of proceeding is to place the animals, immediately after they have been collected, on small flat stones, or pieces of slate, under the water, when they will soon attach themselves, and may then be removed, and the stones, with the Chitons on them, wrapped up in separate pieces of paper. On arrival at home they should be placed in a basin of fresh water for a short time, then removed, and either tied down to the stones with string, or a light weight put on each, and put into a dry place. After two or three days, when the margin has got quite hard, they can be easily removed from the stones, and the animal taken out, and after another day or two for the interior to dry, they will be ready for gumming down on to cards, on which the name, locality, date of collecting, and the position in which they were found, should be written.

The genera are founded upon the shape and covering of the mantle; the species chiefly on the shape and sculpturing of the valves, which latter is easily made out with the aid of a pocket lens. The colour varies very much, and can never be taken as a specific distinction, although in many cases it may assist the beginner in naming his collection; those of the margin of the mantle, and of the spines upon it, are, however, much more constant than those of the valves. The shape, or the proportion of breadth to length, is generally pretty constant, but the size of individuals, especially the larger kinds, varies considerably, and too much weight must not, therefore, be attached to it. The shape of the posterior margin of the valves will also be often found very useful when the specimen is rubbed or eroded. The teeth on the tongue, and the branchial laminæ are also of great importance in determining the species, but as these parts are not easily examined and preserved, they will not be found to be so useful as the other characters.

Chitons are found in all countries, but they are not so abundant in the northern hemisphere as in the southern, nor on the shores of the Atlantic as on those of the Pacific, neither are they so common nor so large in cold latitudes as in warm, the sub-tropical portion of the South Pacific appearing to be their head-quarters. In England only about a dozen species have been found, while twenty-one are here described as already known to inhabit New Zealand, and undoubtedly many more have yet to be discovered, for, with the exception of M. Quoy in the 'Astrolabe,' and the late Dr. Sinclair, few people have collected them. Altogether nearly 300 species are now known to science.

In a fossil state about twenty-four species have been found, some of them dating so far back as the Upper Silurian period.

I have not thought it necessary to give figures of the different species, for, with a moderate amount of attention, they will be readily made out from the descriptions, and I quite agree with Messrs. Kirby and Spence that they who begin their zoological studies by turning over figures usually end them there, and never attain to that nameless tact in making out species that can only be the result of patient study.*

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* "Introduction to Entomology," Vol. IV., p. 569.

Genus *Chiton.* Lin.

Mantle covered with scales; exposed portion of the valves broader than long. All parts of the world.

A. Scales distinct (*Lophyrus*).

Chiton concentricus.

Chiton concentricus, Reeve, "Conch. Icon.," pl. 16, f. 95. *Lophyrus concentricus*, Angas, "Pro. Zool. Soc.," 1867, p. 221.

Oval; mantle with rather large scales; valves compressed on each side, keeled; posterior margins pointed; terminal and lateral areas closely concentrically ribbed; median areas distinctly longitudinally ribbed; dorsal line smooth.

Length, 1 inch; breadth, ·5 inch.

Colour.—Mantle white or pinkish, irregularly banded with yellowish brown; terminal and lateral areas yellowish brown, median areas white with yellowish brown ribs.

This species is also found in Australia.

There are several specimens in the Colonial Museum, locality not stated, probably dredged.

Under stones at very low tide (Angas).

Chiton canaliculatus.

Chiton canaliculatus, Quoy and Gaim., "Voy. Astrol.," Vol. III., p. 394. *Chiton canaliculatus*, Desh., "Anim. sans Vert," Vol. VII., p. 502.

Oblong; mantle with moderate sized scales; valves compressed on each side and keeled; posterior margins straight, crenulated on their sides; terminal and lateral areas with radiating moniliform ridges; median areas with longitudinal ridges; dorsal line smooth.

Length, 1 inch; breadth, ·5 inch.

Colour.—Mantle pink, with about twenty transverse yellowish pink bands; terminal and lateral areas deep pink; median areas yellowish pink, sometimes longitudinally varied with black.

Several specimens are in the Colonial Museum, which were dredged off the island of Kapiti, in Cook Straits.

Chiton pellis-serpentis.

Chiton pellis-serpentis, Quoy and Gaim, "Voy. Astrol," Vol. III., p. 381. *Chiton pellis-serpentis*, Desh., "Anim. sans Vert.," Vol. VII., p. 508.

Oval; mantle with moderate sized scales; valves elevated, rounded, solid, opaque; posterior margins curved, meeting in an obtuse point on the back;

terminal areas with radiating moniliform lines; lateral areas of intermediate valves with curved radiating ribs, concave behind, and crossed by curved longitudinal furrows, which are concave upwards; median areas slightly longitudinally striated; dorsal line smooth and polished on the anterior parts of the valves, but striated on the posterior parts.

Length, 1·5 inch; breadth, ·75 inch.

Colour.—Mantle yellowish or greenish white, with about twenty transverse black bands; valves generally greenish black, passing into yellowish on the back, and with a triangular black spot, with its apex pointing backwards, along the dorsal line of all the intermediate valves. It is generally much eroded, but the size and colour of the scales on the mantle are always sufficient to distinguish it from other New Zealand species.

Abundant on rocks between high and low water marks.

Chiton Sinclairi.

Chiton Sinclairi, Gray. "Dieff. New Zealand," Vol. II., p. 263.

Oval; mantle with moderate sized scales; valves elevated and flattened on the sides; posterior margins straight, with a slight central point, and crenulated on the sides; terminal areas with radiating moniliform ribs; lateral areas with flat, sub-moniliform, radiating ribs, crossed by a few irregular transverse furrows; median areas finely longitudinally striated on the sides, but smooth and polished on the back.

Length, 1·35 inch; breadth, ·7 inch.

Colour.—Mantle brown, transversely banded with black; valves pale brown, longitudinally varied with paler brown and black. The scales on the mantle are smaller and flatter than those of *pellis-serpentis.*

I have only seen one specimen which was in the collection of the late Mr. W. Swainson; locality not stated.

Chiton Quoyi.

Ch. viridis, Quoy (*nec* Chemn.), "Voy. Astrol.," Vol. III., p. 383. *Ch. Quoyi*, Desh., "Anim. sans Vert.," Vol. VII., p. 509. *Ch. glaucus.*, Gray. *nec* Quoy. et Gaim. *Lophyrus glaucus*, Angas, "Pro. Zool. Soc." 1867, p. 222.

Oval; mantle with moderate sized scales; valves elevated, flattened on each side; posterior margins slightly concave, with a small central point; the anterior valve, the greater part of the posterior valve, and the lateral areas of the intermediate valves with fine radiating striæ; median areas very finely longitudinally striated.

Length, 1·5 inch; breadth, ·75 inch.

Colour.—Generally dark olive green, or blackish green when dry, but sometimes brown, or green rayed with brown, and the mantle is sometimes varied with white.

Common under stones in pools left by the retreating tide.

Found also in Australia.

B. Scales minute *(Lepidopleurus).*

Chiton sulcatus.

Ch. sulcatus, Quoy and Gaim., "Voy. Astrol." *Ch. sulcatus*, Desh., "Anim. sans Vert.," Vol. VII., p. 512.

Oval; mantle with small scales; valves depressed, slightly flattened on each side; posterior margins straight, crenulated on the sides; terminal and lateral areas finely granulate; median areas with fine distant longitudinal ribs.

Length, ·4 inch; breadth, ·25 inch.

Colour.—Mantle reddish brown; valves whitish brown, dull.

Specimens from Kapiti are in the Colonial Museum; it is also found in Australia. I do not feel quite sure as to the identification of this species, for I have no Australian specimens for comparison, and the description in Lamark is not very definite, but I think that the difference between the two, if any, must be very slight.

Chiton longicymbus.

Ch. longicymba, De Blain., "Sow. Conch. Mus," f. 67. *Lepidopleurus longicymba*, Angas, "Pro. Zool. Soc.," 1867, p. 222.

Oblong; mantle with very minute scales; valves rounded; posterior margins straight, or slightly concave; terminal areas with fine radiating moniliform lines; lateral areas with radiating ribs crossed by rather deep, curved transverse furrows; median areas of both terminal and intermediate valves finely punctate.

Length, 1·4 inch; breadth, ·65 inch.

Colour.—Brown, variously tinted with green, yellow, or whitish, sometimes pink on the back when rubbed; often entirely greenish brown, minutely freckled with yellow; often brown with a broad white stripe down the back.

Very variable both in shape and colour.

Common under stones.

Found also in Australia.

Chiton empleurus. sp. nov.

Oblong; margin with very minute scales; valves rather elevated and flattened on each side, sub-carinate; posterior margins slightly concave, with a small central point; terminal and lateral areas raised above the rest minutely punctate; median areas minutely punctate, sometimes with a row of deep longitudinal pits along the anterior edges of the raised lateral areas.

Length, ·75 inch; breadth, ·3 inch.

Colour.—Uniform yellowish pink.

Founded on two specimens in the Colonial Museum, locality not stated.

CHITON RUDIS. sp. nov.

Oblong; margin with minute scales; valves elevated, flattened on the sides, not keeled; apex of anterior valve recurved, with its posterior margin slightly convex at the sides, and deeply concave in the centre; posterior margins of intermediate valves straight; posterior valve rather small; apex posterior pointing and emarginate; anterior valve, and lateral areas, with radiating moniliform ribs; posterior and median areas widely, but rather irregularly, deeply longitudinally furrowed, with narrow ridges between.

Length, 1·75 inch; breadth, ·75 inch.

Colour.—Margin grey, with broad irregular reddish brown transverse bands; valves greyish brown; interior greyish white.

Founded on a specimen in the Colonial Museum, locality not stated.

Genus *Tonicia.* Gray.

Margin of the mantle simple, naked, nearly smooth, or velvety; last valve entire.

South America, Australia, Greenland.

TONICIA UNDULATA.

Ch. undulatus, Quoy and Gaim., "Voy. Astrol." *Acanthopleura undulata*, Gray, "Dieff." Vol. II., p. 245.

Oval; valves rounded, polished, sub-carinate; posterior margins straight, produced into a rather acute central point; terminal area of anterior valve, and lateral areas of intermediate valves, with indistinct radiating moniliform ridges; posterior valve, and median areas of anterior and intermediate valves with waved transverse striæ.

Length, 1·15 inch; breadth, ·55 inch.

Colour.—Mantle reddish brown; valves generally green, inclining, more or less, to yellowish on the back, with the waved striæ brown; sometimes the valves are greyish green, with many of the undulating striæ white.

Not uncommon under stones at low water.

Tonicia rubiginosa.

Chiton rubiginosus. Swains. *Ms.*

Oblong; margin slightly tomentose; valves rather elevated, sub-carinate, flattened on each side; posterior margins straight, produced into an acute central point; lateral areas indistinct, the whole surface rather coarsely granular, the granules smaller on the back.

Length, ·45 inch; breadth, ·2 inch.

Colour.—Pink, getting yellowish on the back.

This species is named from a specimen from the late Mr. W. Swainson's cabinet, and now in the Colonial Museum, which is labelled as coming from the island of Kapiti. I do not know whether Mr. Swainson ever published a description of it, but have retained the name written on it to prevent confusion, if such should have been the case. It is also in the Colonial Museum collection from Kapiti.

Tonicia zig-zag. sp. nov.

Oblong; mantle slightly tomentose; valves slightly flattened on each side, but not keeled; posterior margins sloping backwards into a point, crenulated on the sides; anterior valve with 9 radiating ridges, crossed by fine concentric zig-zag striæ; lateral areas with two, on each side, radiating ridges crossed by fine zig-zag striæ; posterior and median areas with very fine oblique striæ diverging from the dorsal line outwards and forwards, crossed by others diverging outwards and backwards, forming an "engine-turned" pattern.

Length, ·88 inch; breadth, ·31 inch.

Colour.—Mantle white; valves greyish black, with a white stripe on each side of the dorsal line; interior greenish blue.

A single specimen is in the Colonial Museum, locality not stated.

Tonicia corticata. sp. nov.

Oval; margin naked; valves much depressed; posterior margins slightly concave; lateral areas bounded on either side by a flatly nodulose ridge, the space between being obliquely striated, the striæ running outward and backward; median areas rugose, without either distinct lines or granules.

Length, 1·25 inch; breadth, 1·13 inch.

Colour.—Margin black when dry; valves grey; inside white, covered over with white coralline growth, and small marine algæ.

Founded on a specimen in the Colonial Museum, locality not stated.

Genus *Acanthopleura.*

Mantle covered with long spines.

ACANTHOPLEURA COMPLEXA. sp. nov.

Chiton aculeatus, Quoy and Gaim., *nec* Lin. *nec* Barnes. *Acanthopleura aculeatus*, Gray, "Dieff. N.Z.," Vol. II., p. 245.

Oval; margin broad, velvety, with long spines scattered over it; valves depressed, flattened on each side, sub-carinate; posterior margins not covering the next at the corners, rather convex, and pointed in the centre; anterior valve with radiating moniliform ridges; lateral areas of intermediate plates granulose with two prominent, radiating, slightly curved ridges on each side; median areas with finely granular transverse waved lines, which pass imperceptibly into the larger lateral granulations; posterior valve small, like the intermediate ones; centres of valves punctate internally.

Length, 1 inch; breadth, ·5 inch.

Colour.—Margin reddish brown, varied with darker; valves greyish, more or less varied with yellowish white, yellow, or brown.

From the collection of the late Mr. W. Swainson, locality not stated.

ACANTHOPLEURA NOBILIS.

Acanthopleura nobilis, Gray, "Dieff. N.Z.," Vol. II., p. 245.

Mantle rugose, rough, with scattered long tapering brown bristles; valves brown, convex, evenly rounded, with very minute dots like shagreen, the lateral area slightly marked with three or four indistinct rays; inside white; length three inches (Gray).

I have only seen a single valve.

Genus *Acanthochœtes.* Leach.

Margin of the mantle spinulose, with nine bundles of spines along each side.

Australia, Europe.

ACANTHOCHÆTES BIRAMOSUS.

Chiton biramosus, Quoy and Gaim., "Voy. Astrol.," Vol. III., p. 378. *Chiton biramosus*, Desh., "Anim. sans Vert.," Vol. VII., p. 516. *Acanthochœtes biramosus*, Gray, "Dieff. N.Z.," Vol. II., p. 246.

Oval, reddish, surrounded with twice branched hairs, margin rough; valves nearly flat, greenish red or white, transversely striated in front. Remarkable for having its mantle covered with very short hairs of an intense brownish red. Upon the mantle are placed rough and bifurcating hairs, forming a double rank; the valves are nearly straight, and have no keel on the back; they are greenish white and surrounded by a circle of reddish brown (Deshayes).

I have seen no specimens.

Acanthochætes ovatus. sp. nov.

Ovate, attenuated in front; margin spiny, with nine small bundles along each side; valves flatly triangular, sub-carinate, posterior valve very narrow, apex re-curved; posterior margins of the anterior plate sloping backwards into a point, those of the posterior plates nearly straight; anterior valve with ten, and lateral areas with two on each side, radiating nodulose ridges; median areas with slightly waved longitudinal ridges; dorsal line smooth.

Length, ·6 inch; breadth, ·5 inch.

Colour.—Mantle pale reddish brown; spines white; valves greenish white; yellowish on the dorsal line.

Several specimens in the Colonial Museum, locality not stated.

Acanthochætes Hookeri.

Acanthochætes Hookeri, Gray, "Dieff. N.Z.," Vol. II., p. 262.

Oblong; mantle spiny with nine large radiating tufts of spines on each side; valves flatly triangular, sub-carinate; posterior margins slightly convex, with an obtuse central point; terminal and lateral areas granulose; median areas smooth; lateral areas very large.

Length, 1 inch; breadth, ·4 inch.

Colour.—Mantle brown; spines pale green; valves generally greyish black, more or less varied with yellowish; often yellowish or reddish on the dorsal line; occasionally greenish.

Several specimens in the Colonial Museum, Wellington Harbour; it is not uncommon on stones below low water mark.

Genus *Katharina*. Gray.

Valves partly hidden on each side by an expansion of the mantle, sides smooth; uncovered portions of the valves as broad as long.

West Coast of South America.

Katharina violacea.

Chiton violaceus, Quoy and Gaim., "Voy. Astrol.," Vol. III., p. 403. *Chiton violaceus*, Desh., "Anim. sans Vert.," Vol. VII., p. 519. *Acanthochætes violaceus*, Gray, "Dieff. N.Z.," Vol. II., p. 246.

Elongated oval; margin smooth; valves rounded, depressed; posterior margins waved; anterior valve granulose, six-sided, separated by flat nodulose lines; posterior valve small, rounded, granulose; lateral areas small granulose; dorsal line smooth, with several irregular rows of longitudinal punctures on each side; sides granulose; nine bundles of spines on each side.

Length, 1·5 inch; breadth, ·65 inch.

Colour.—Mantle brown, valves violet.

In rock basins near low water mark, Cook Straits.

Genus *Cryptoconchus*. Guilding.

Mantle large, enveloping the greater part of the valves; exposed portions of valves longer than broad.

California.

CRYPTOCONCHUS ZELANDICUS.

Chiton Zelandicus, Quoy and Gaim., "Voy. Astrol.," Vol. III., p. 400.
Chiton Zelandicus, Desh., "Anim. sans Vert.," Vol. VII., p. 518.
Chitonellus Zelandicus, Gray, "Dieff. N.Z.," Vol. II., p. 246.

Elongated oblong; margin scaly, with a row of short spines round the edge; mantle large, continuous under the apex of each valve; valves depressed, rounded, sub-carinate; posterior margin concave with an acute point; exposed portions of valves small, smooth on the dorsal line, granulose on each side; nine tufts of spines on each side, situated over the valves.

Length, ·45 inch; breadth, ·15 inch.

Colour.—Blackish brown; exposed portion of the valves yellowish; spines yellowish brown.

Two specimens are in the Colonial Museum, locality not stated; obtained by dredging.

CRYPTOCONCHUS MONTICULARIS.

Chiton monticularis, Quoy and Gaim., "Voy. Astrol.," Vol. III., p. 406.
Chiton monticularis, Desh., "Anim. sans Vert.," Vol. VII., p. 519.
Amicula monticularis, Gray, "Dieff. N.Z.," Vol. II., p. 246.

Oblong; mantle smooth, covering the whole body except a small linear opening at the apex of each valve; valves depressed, rounded; posterior margins convex and emarginated; exposed portions of valves smooth; nine bundles of spines on each side, situated over the valves.

Length, 1 inch; breadth, ·45 inch.

Colour.—Dark reddish brown when dry; inside greenish grey.

Two specimens are in the Colonial Museum, locality not stated; obtained by dredging.

ART. XXIV.—*Description of a Specimen of* Mus rattus, *L. in the Colonial Museum.* By Captain F. W. HUTTON, F.G.S.

[*Read before the Wellington Philosophical Society, 28th October*, 1871.]

FRONT feet with four, and hind feet with five toes; thumb of the hind foot with a short claw. Tail considerably longer than the head and body, scaly, covered with short black hairs to the tip. Ears long, rounded at the tip, yellowish brown, sparingly covered with minute black hairs. Nose rather sharp, hairs of moustaches long (2·25 in.), all black. Teeth yellow. Legs and feet covered with short brownish grey hairs, whitish on the toes, forming, just above each nail, small tufts, which equal the nail in length.

Colours.—Top of the head and back bluish black, mingled on the back with many white hairs, giving it a somewhat grizzled appearance. On the sides the black passes gradually into blackish grey, which is the colour of the whole under parts. Hairs of the body white or grey at the base; fur blackish grey. Hairs on the back long (1·25 in.) and soft, but not silky. The upper incisors yellowish orange, the lower ones yellowish white.

Length from snout to root of tail, 6·5 in.; of tail, 8·5 in.; of head, 2 in.; breadth of head between the ears, ·75 in.; length of ear, .87in.; breadth, ·62in.; length from nose to ear, 1·44 in.; hind foot, 1·3 in.; fore foot, ·75 in. Weight a little more than two ounces.

This specimen is a female, and was caught by a dog in the Tinakori Road, Wellington, on the 24th August, 1871.

Mr. J. A. Allen, in his "Mammalia of Massachusetts," remarks that "this species changes from black to grey, very old individuals becoming very light coloured."

Art. XXV.—*On the Bats of New Zealand.* By Capt. F. W. Hutton, F.G.S.

[*Read before the Wellington Philosophical Society, 26th August,* 1871.]

Only two species of bat are at present known to inhabit New Zealand, and neither of these are found anywhere else. The commoner kind, or the Short-eared Bat, belongs to a large genus widely spread over the old world, and containing four species from Australia; it is, therefore, probable that other species of this genus will be found in New Zealand. The rarer kind, or the Long-eared Bat, is so different from any other known species, that Dr. J. E. Gray has placed it in a separate genus. Its nearest allies inhabit South America, so that in New Zealand representatives of the bats of both the old and new worlds meet.

In the following descriptions the characters of the families have been taken from Dr. J. E. Gray's arrangement of the bats in the "Ann. and Mag. Nat. Hist.," Vol. XVII., pp. 89-93, as quoted in the "Zoological Record" for 1866:—

Family *Vespertilionidæ.*

Face simple; nostrils simple, on the front of the nose; the cutting teeth separated in the middle by a space, and placed near the canines; grinders acutely tubercular, three on each side in each jaw, the hinder ones short and broad, with one, two, or three false grinders in front of them; inter-maxillaries separate from one another in the front of the palate, leaving a notch between the cutting teeth.

Genus *Scotophilus*. Leach.

Face short and broad, nearly bald; a short groove behind the nostrils; forehead flat; ears separated, of medium size; only two incisors in the upper jaw, and none in the lower one; tail long, extending to the end of the inter-femoral membrane, and enclosed the whole way.

SCOTOPHILUS TUBERCULATUS. Forst.

Short-eared Bat.

Fur long; above reddish brown, darker on the head, neck, and shoulders; below yellowish-brown, darker on the throat and breast; membrane brown; a few short bristles on the muzzle; ears rounded; tragus short, thick, and rounded at the tip. Length, from the snout to the root of tail, 2 inches; of tail, 1·5 inches; extent of wings, 11 inches; length of head, ·6 inch; of ear, ·4 inch; of tragus, ·2 inch.

Spread over both islands.

Family *Noctilionidæ*.

Nostrils on the sides of the nose; the cutting teeth in the middle of the inter-space between the canines; canines wide apart in front; grinders acutely tubercular, three on each side in each jaw, the hinder upper short and broad, with one or two small false grinders in front of them; forehead flat; inter-maxillaries small, close in front.

Genus *Mystacina*. Gray.

Muzzle elongated; face simple; ears separated; two incisors above and two below, the upper ones large; tail short, the tip protruding from the upper surface of the inter-femoral membrane; claw of the thumb divided.

MYSTACINA VELUTINA.

Long-eared Bat.

Mystacina tuberculata. Gray.

Fur short, erect; greyish-brown, lighter on the under surface; membrane greyish-brown, transversely grooved near the body; a row of short bristles round the muzzle; ears oval, tragus long, subulate; inter-femoral membrane truncated; length from snout to the root of the tail, 2·35 inches; of tail,

·5 inch; extent of wings, 11·5 inches; length of head ·7 inch; of ear, ·7 inch; of tragus, ·36 inch.

Of the two specimens in the Colonial Museum, one was obtained in the Hutt Valley, near Wellington, and the other in Milford Sound, on the south-west coast of the South Island.

Dr. Gray named this bat *tuberculata,* under the impression that he was describing the *Vespertilio tuberculatus* of Forster; but it is evident from Forster's description that his bat was the short-eared kind. As, therefore, Dr. Gray's name was given in error, and as confusion is likely to arise if both our bats have the same specific name, I propose to call this species *velutina,* from the velvet like nature of its fur.

Art. XXVI.—*Observations on the New Zealand Bats.*

By F. J. Knox, L.R.C.S.E.

[*Read before the Wellington Philosophical Society,* 16*th September,* 1871].

Bats take a high place among the Mammalia, and are chiefly distinguished from the other orders of this great family, by an extension of the common integuments on the pectoral and pelvic extremities, in or on which hair is not developed. Even in the Bimana the inter-space between the fingers is more or less palmated, and in the aquatic Mammalia, as in the seal, the integumentary envelope extends to the roots of the nails. In the *Cheiroptera,* however, although the human type of the skeleton has been strictly adhered to, the skeleton of the pectoral extremities is so developed by elongation, more especially of the bones of the hand, that the bat can soar in the free expanse of the heavens, and thus look down upon his less-favoured brethren. This, however, must be only taken figuratively, for it is a question whether he regulates his aerial movements by means of sight or touch, the eyes being extremely minute, defying even microscopic inspection, and it is supposed that the sense of touch is rendered exceedingly acute by the extent of the tegumentary tissues with nerves and blood-vessels, and thus supplies the want of sight.

An equally interesting modification may be observed in the construction of the pelvic extremities, and more especially in that of the foot. Had the whole Bat family ceased to exist during any of the sweeping changes which have taken place on the earth's surface, and bats become extinct—in other words fossil—and a footprint, or even the bones of the foot, been discovered in some cave, even a Cuvier would have been greatly puzzled to reconstruct the animal. The foot of the bat resembles the quadrumanous or monkey type. The toes are all of equal length, the first or great toe on a line with the others, all furnished with sharp claws, and consequently not fitted to move on *terra firma,* or to grasp the branches of trees, although it should be remarked that one of the specimens I have to describe was caught amongst the rigging of Her Majesty's Ship 'Clio' in Milford Sound. The ears in this specimen measured ·5 inch from base to tip, the tragus was about half the length, narrow, but admirably formed to protect the meatus from the entrance of any minute insect.

In July, 1843, a similar bat was kindly presented to me, and after examining it with great care, I sent the skeleton, skin, and other parts, to the British Museum. Of this specimen I possess pencil sketches, and a tolerably minute anatomical description. I remark from my Ms. observations—and by making a reference to the pencil sketches—that the tail projected free from the interfemoral integumentary expansion. A well-defined line ran from the wrist-joint, sweeping round to the elbow, knee, and setting on of the tail, dividing the wing-shaped pectoral extremity, so that on the internal segment hair was developed, whilst on the external segment, the integumentary expansion was perfectly smooth, so that when the fore-arm and hand was completely drawn in or retracted, the tail being free, the animal resembled in every respect, even in that of colour and soft silky hair, a little mouse, and the small short thumb, with its peculiar nail, would rest on the ground. Numerous strong hairs surrounded the upper lip on each side, and formed a very respectable moustache. The stomach was nearly globular, the wall being extremely thin; intestines seven inches in length, with a calibre of three lines, and walls stronger than that of the stomach. No cæcum. A small quantity of *débris* of a black inky colour floated in the intestine; liver, human type; spleen, ·75 inch long by ·08 inch broad; kidneys large, ·33 inch long, smooth, indicative of the carnivorous character; the tongue was 0·75inch in length, narrowing from the base to the apex, and crossed by nine ridges of such a nature as to prevent the escape of any insect, however minute.

A short time ago (August, 1871), another specimen of the same bat was kindly put into my hands by Dr. Hector, with a request that I would examine it anatomically. The examination of this specimen has not been so complete, in consequence of its having been immersed in a solution of carbolic acid, which had hardened the whole, but more especially the viscera, into a solid mass, which also rendered it impossible to prepare the skin in an entire state. The skeleton, however, which is now before the Society, has turned out better than I could have anticipated, seeing that it had escaped the destructive clutches of the "stuffer." This mode of exhibiting the skeleton of the bat was adopted by me many years ago, as being the best to display its very remarkable construction, and at the same time obviate the necessity of handling.

The other bat, which is placed by Dr. Gray in the genus *Scotophilus*, appears to be the more common of the two species as yet found in New Zealand. There are now many specimens of this bat in the Museum, varying, however, considerably in size and even colour; and the skeleton now before the Society will, it is hoped, facilitate the determination of any future species which may be met with. The skeleton having been prepared from a specimen which had been deviscerated for the purpose of stuffing, prevented my examination of the viscera or ascertaining the sex. The tongue has, however, escaped, and presents a marked distinctive character from that of the *Mystacina*, being shorter, broader, and almost free from the above-mentioned transverse ridges.

Upon referring to the measurements annexed to this paper, the chief differences between the skeletons of the two New Zealand bats, although not very striking, clearly determine a generic distinction. It is interesting to remark that, although the number of vertebræ in all the regions of the spinal column are the same, the proportional length of the tail is peculiar, the excess in the length of that of *Scotophilus* being made up by the elongation of the bodies of the vertebræ composing it. Again, in the dentition, the total number of the teeth is the same, although the formula shows a well-marked generic distinction.

The number of vertebræ in both is :—7 cervical, 12 dorsal, 5 lumbar, and 8 coccygeal. There are also 12 ribs in both.

The dentition presents a marked difference, there being in *Mystacina* :—

$\frac{2}{2}$ incisors; $\frac{2}{2}$ canines; $\frac{10}{10}$ maxillary;

And in *Scotophilus* :—

$\frac{2}{6}$ incisors; $\frac{2}{2}$ canines; $\frac{8}{8}$ maxillary.

GENERAL DIMENSIONS COMPARED.

	Mystacina.	*Scotophilus.*
Total length	2·8	3·5
Expanse of wing	12·0	10·8
Pectoral extremity—		
Arm	·9	·9
Fore-arm	1·6	1·5
Hand	3·1	2·6
Pelvic extremity—		
Thigh	·6	·5
Leg	·6	·6
Foot	·6	·4

Art. XXVII—*Notes on the Anatomy of the* Kanae. *(Mugil, sp.)*
By F. J. Knox, L.R.C.S.E.

[*Read before the Wellington Philosophical Society, 14th October,* 1871.]

On the 29th December, 1870, when on a professional visit to the Maoris residing on the shores of Porirua Bay, I accidentally procured a fish which I had not seen previously in that locality. Three specimens had just been captured in a powerful net by Major Edwards, and he kindly put one at my disposal.

The general colouring of the fish resembled, at first sight, that of a salmon just landed; there was no apparent lateral line, but the body was divided by the dorsal segment, presenting a greenish shade, passing gradually to a silvery white on the abdominal surface; the dorsal, pectoral, and caudal fins, partook of the greenish shade, whilst the ventral (pelvic) and anal fins were of a silvery white. The scales, measuring when detached ·5 inch by ·33 inch adhered firmly to the skin. The eyes were surrounded by a complete circle of a semi-cartilaginous tissue, adhering to the margin of the orbit, not moveable, and consequently in no way resembling eyelids.

The anatomical examination of this fish presented many interesting features, being altogether new to me.

The stomach was remarkable, not only in shape, but in its organization. When first removed from the body it presented a firm solid mass, and upon being divided longitudinally it was found full to distention of a greenish, earthy looking, pasty substance, which, upon being turned out, continued to retain the shape of the stomach. The pyloric extremity was composed of a powerful mass of muscular fibres, resembling the gizzard of a bird, and about its centre measured one inch in thickness. The intestines were of extreme delicacy. The pancreatic cæca, two in number, were distended with a brownish mucous. Liver weighed 320 grains, and was composed of numerous lobes. Gall bladder free, 1 inch in length, filled with a bright green bile. Spleen weighed 60 grains, was 1·25 inches in length, resembling a clot of blood in colour.

Milt, 4 inches in length by 1 inch in breadth, weighed 320 grains; the artery supplying it and the blood-vessels, more especially near the cloaca, were enlarged, indicating that the organ was in an active state previous to the spawning season.

The muscular system presented an appearance not unlike the curd of milk, or what I used to know as French-white colour. I obtained from the specimen one and a half pounds (avoirdupois) of muscle, free from bone, and had it placed upon the gridiron forthwith. Having many times partaken of the finest kinds of the salmon, cooked in the most approved style, I hesitate not to say that this fish was infinitely superior in delicacy, richness, and flavour, to that of the *Salmo salar*.

The dentition in the Mugil family exhibits a striking instance of the direct connection it has with the structoral type of stomach, and the kind of food the animal lives upon. Indeed, the fish may be said to be toothless, a series of almost microscopic ciliæ supported upon the lip surrounding the mouth, and a small patch on the palate bones, constituting the entire system of dentition.

The gills, having four arches, are fully developed, consisting of the usual branchiæ, closely placed, and of great length, measuring, about the centre of the arches, one inch in length, and occupying, as usual, the external or convex margin of branchial arches, whilst the inner or concave margin supports a series of laminæ of extreme delicacy, placed transversely to the axis of the arch, and forming, no doubt, a filter of the most artistic description.*

The pharyngeal bones differ entirely from those of most other fishes. The lower (two in number) are delicate, and may be viewed as a modification of the branchial arch, being covered internally with similar laminæ. The upper pharyngeal bones (two in number) are of an irregular cone shape, one side of the cone rounded and covered with exceedingly minute ciliæ. This part evidently corresponding to, and in certain actions of the throat will be in contact with, the concave aspect of the lower pharyngeal bones.

The entire apparatus is saturated with a fine oil, and the action of this remarkable structure it is difficult to suggest, more especially when we have ascertained the nature of the food.

In the carnivorous fishes, as in the *Sparoidæs*, Cuvier, (such as the Snapper, *Pagrus unicolor*) the teeth present nearly every variety of shape or form for holding, tearing, and crushing, notwithstanding which they swallow the fry of other fishes entire, so that the stomach has to select and reject, and thus the intestines are generally loaded with *debris* of bones, fins, etc.

In the *Sciænadæ*, as, for instance, the Moki (*Latris ciliaris*), a row of minute teeth are placed on the margin of the inter-maxillary bones and lower jaw, whilst the branchial arches and pharyngeal bones present a most complex, and, at the same time, beautiful system of dove-tailing, and a variety of teeth in shape and form. Those in the pharyngeal bones are mostly rounded, blunted, cones. The food of the Moki I have found to consist of the testacean mollusca,

* "The fishes of this genus feed on organic substances which are mixed up with the sand or mud; a considerable indigestible portion of the latter is swallowed; and in order to prevent larger bodies from passing into the stomach, or substances from passing through the gill-openings, these fishes have the organs of the pharynx modified into a filtering apparatus."—Dr. Günther's "Catalogue of Fishes," Vol. III., p. 410.

more especially the Mutton fish or Pawa (*Haliotis iris*), of which, if of large dimensions, the shell is crushed, if small swallowed entire.

Having, when treating of the stomach, alluded to the food, I now resume the subject. Whilst engaged, many years ago, in investigating the natural history of the Estuary Trout, Salmon, Char, Trout, Vendace, and Herring, and more especially the Vendace, the food when found in the stomach presented the appearance of a dry pasty earth. The remarkable delicacy of the fish as an article of food appeared to me difficult to understand, and being at that time in the constant habit of examining all doubtful tissues or substances under the microscope, this earth turned out to be entirely composed of *Entomostraca*, and microscopic *testacea.*

I acccordingly subjected the sand or mud found in the stomach of the *Kanae* to the searching properties of a drop of fresh water and a compound microscope, and could distinctly trace various organic forms, which, however, I failed to identify. I thereupon availed myself of the assistance of Mr. Buchanan and his microscope, and give the result in his own words, and beautiful sketches of these forms, which proved to be chiefly *Diatoms* :— "I received your small packet, and, at your desire, have examined the contents under the microscope. You gave me no instructions what to look for in the earthy matter sent, so I can only report what I made out. It is richer in *Diatoms* than any earth I have seen. I send you sketches of six species, hurriedly done from a small quantity, without, I believe, exhausting the number. There is nothing besides but silicious grains and mud."

The skeleton, I may remark, presents the peculiarity observable in that of most fishes prized for their richness and superiority as an article of food. The bones of the Salmon, Estuary Trout, Char, etc., can by no process of bleaching be made white. A rich oil penetrates into every tissue, even that of the elementary cartilages of the skeleton and the bones themselves.

Weight, recent, 3lbs. 9ozs. ; weight of skeleton, 2oz. 246grs. ; and of soft parts, 3lbs. 6ozs. 234grs. Twenty-four vertebræ ; twelfth the largest, ·42 inch in length, diminishing very slightly towards the tail. Nine pairs of ribs ; fourth the largest, 2·25 inches in length. The specimen dissected presented the abnormal character of having five instead of four spines in the first dorsal fin, which is a departure from the family character of the *Mugilidæ.*

Art. XXVIII.—*Notes on* Harpagornis Moorei, *an Extinct Gigantic Bird of Prey, containing Description of Femur, Ungual Phalanges, and Rib.*

By Julius Haast, Ph.D., F.R.S.

(With Illustrations.)

[*Read before the Philosophical Institute of Canterbury, 3rd May,* 1871.]

Amongst the discoveries made during the last few years in the turbary deposits of Glenmark, in which the remains of the different extinct gigantic species of *Dinornis* abound, none can be of greater interest to the student or lover of the natural history of these islands, than the occurrence of bones belonging to a raptorial bird of enormous dimensions, contemporaneous with the Moa.

During the progress of excavations undertaken in the month of March of this year on the Glenmark property, Mr. F. Fuller, Taxidermist to the Christchurch Museum, found, amongst a considerable quantity of moa bones, mostly belonging to specimens of *Dinornis casuarinus, crassus,* and *didiformis,* five to six feet below the surface of the swamp and over a space of about thirty feet square, a few smaller bones in an excellent state of preservation, which he at once correctly referred to a gigantic raptorial bird.

These remains include a femur, a few ungual phalanges, and one rib, all belonging doubtless to the same individual, and although the discoverer used all possible care and diligence during his subsequent researches, he was unfortunately unable to obtain any other portion of this very interesting species.

Before proceeding I wish to observe that we need not infer, from the absence of the larger species of the *Dinornithes* in that locality, that they did not exist at the same time, the fact being simply that the bones of larger species, such as *Dinornis giganteus* and *robustus,* are found in this portion of the swamp nearer to the base of the hill, the water-courses, which brought them down from the hill sides, not being powerful enough to move the heavier bones to such distances as the smaller ones.

In attempting a description of these unique specimens, which, for fear of accident, it would be unwise to send away to be described by a more competent authority, I have only been guided by the wish to make such an interesting fact as the occurrence of a gigantic bird of prey in New Zealand during the *Dinornis* age more fully known, and I trust, therefore, that any shortcomings will be leniently overlooked.

Fortunately, I could avail myself of the pencil of our talented honorary secretary, Dr. L. Powell, who has prepared the necessary illustrations for this paper, and thus, if the descriptions are deficient, the faithful drawings will, in many respects, amply make up for such shortcomings.

In order to pay a just compliment to my friend, Mr. P. H. Moore, of Glenmark, who has always afforded me every facility in his power to pursue my researches upon his property, I propose the name of *Harpagornis Moorei* for this extinct species, and I only hope that further excavations will enable me to obtain at a future date a larger portion of its skeleton than the Canterbury Museum at present possesses.

The principal bone in the collection is a left femur, it is a portion of a mature bird, as shown by the excellent preservation of the articular extremities and the strongly developed muscular ridges.

The dimensions are as follows:—

	Inches.
Total length of bone	6·66
Circumference of proximal extremity . . .	4·66
„ „ distal „ . .	5·58
„ „ shaft where thinnest . .	2·50

On Plate X., fig. 1., is given a faithful representation in natural size of this femur (back view), and it conveys better than any measurements or descriptions can do, an idea of its enormous size, principally if compared with the contours also drawn in natural size of the femur of *Polioaëtus leucogaster* (fig. 2), the white-bellied Sea Eagle of Australia, and (fig. 3) of *Circus assimilis*, the New Zealand Harrier.

This bone has all the characteristics of the femur of a diurnal bird of prey, some of them developed in a remarkable degree owing to its enormous size.

The cylindrical shaft is bent forward as usual, and above the distal extremity it is slightly curved back (fig. 1 at *a*). I find that both the *Polioaëtus* and *Circus* possess this curve, but the latter exhibits this peculiarity much more distinctly than the Australian species. The hollow on the top of the head is very large, and measures ·42 inch across.

The trochanteric ridge is well developed, and the outer side is very rough, showing that muscles of great strength and thickness must have been attached to it.

The inter-muscular linear ridges are well raised above the shaft, of which the one extending from the fore and outer angle of the epitrochanteric articular surface to the outer condyle is the most prominent.

The pits for the attachment of the ligaments in the inter-condyloid fossa are strongly marked. The femur is pneumatic, the proximal orifice is large and ear-shaped, resembling in form more the air passage of the New Zealand *Circus* than that of the Australian Sea Eagle, the only two bones I possessed for comparison. The junction of the head with the shaft is more deeply cut and more distinctly defined than in *Polioaëtus*, the same being the case with *Circus*, so that the trochanter of both are more rounded and distinct than in the Australian Eagle.

On Plate X., fig. 4, is represented the articular surface of the proximal end with the large oval depression on the head of the bone, and at fig. 5 that of the distal end. On the latter the angular concavity on the outer condyle is of considerable size and depth.

Also in this point the close resemblance of the fossil bone to the corresponding limb bone of our present Harrier is very striking, suggesting that as *Apteryx* is the diminutive representative of the extinct gigantic *Dinornis*, so the New Zealand Harrier is that of *Harpagornis.* If this hypothesis is accepted, two important considerations may be deduced therefrom, which will assist us in understanding better the mode of life of the different extinct species of the *Dinornithes.*

In the first instance we have ample evidence, as I have shown elsewhere, that the principal feeding grounds of the gregarious Moas were either the open plains, or the grassy downs and low hills, they eschewing, for many reasons, the forests with their dense undergrowth, which not only would have opposed almost insurmountable obstacles to their locomotion, but would not have afforded such quantities of suitable food as the more open districts covered with *Phormium tenax*, *Coriaria*, and *Cordyline* offered.

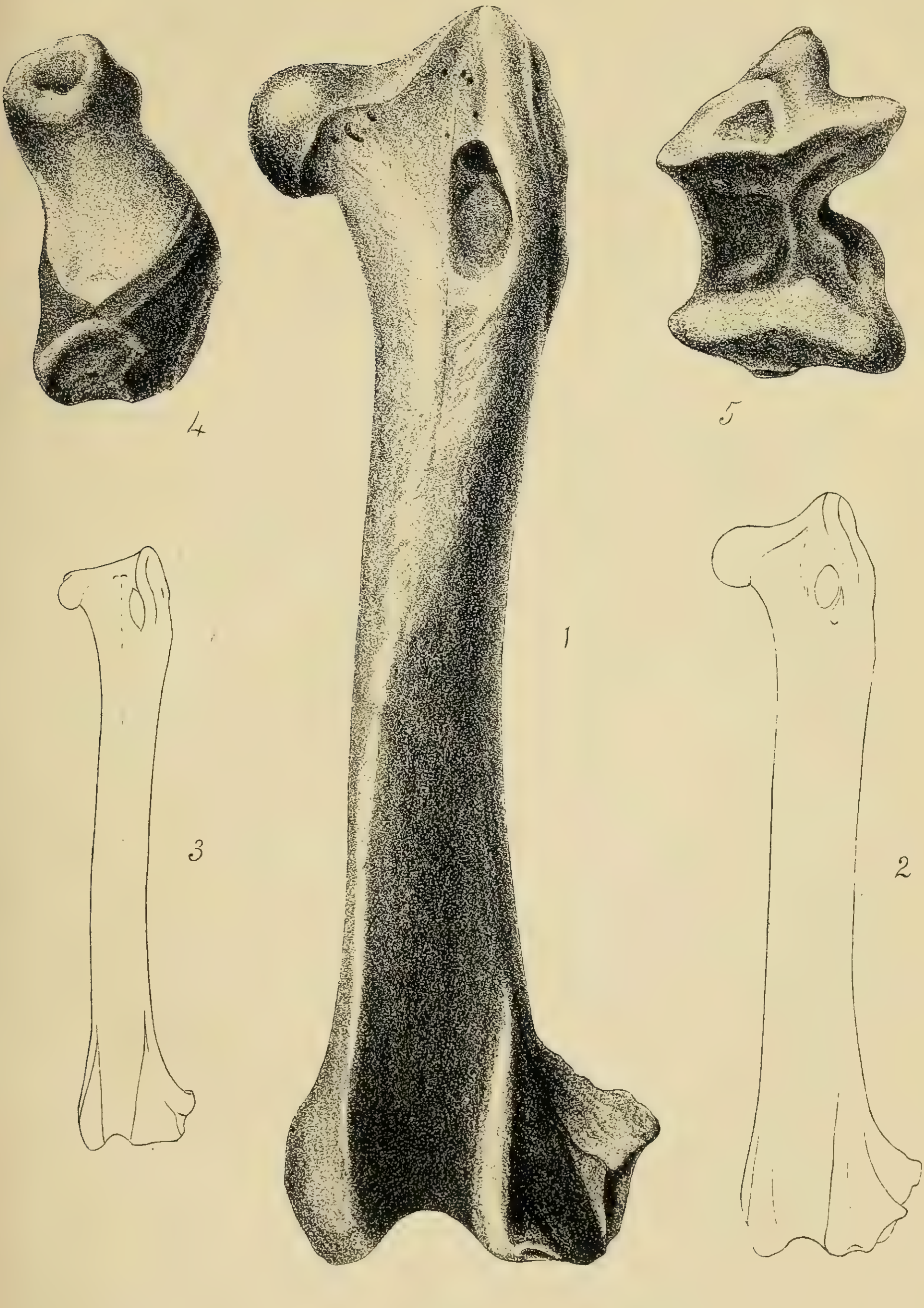
The presence of a proximal orifice for the admission of air proves at the same time that the *Harpagornis* was a diurnal bird of prey, the owls having the femur filled with marrow; and from this fact we may conclude, without being too hazardous in our deductions, that at least the greater portion of the different species of *Dinornis* were also diurnal in their habits, and not nocturnal as the *Apterygidæ* of the present day.

And thus, as the small Harrier now flies leisurely during the day time over the plains and downs in search of food, consisting of carrion, birds, lizards, and insects, so the *Harpagornis* doubtless followed the flocks of Moas, feeding either upon the carcases of the dead birds, or killing the young and disabled ones.

Another bone which belongs to the same species is a rib. It is the third rib on the right side, the first after the pleurapophyses or two floating ribs, and articulates with the hæmapophysis or sternal rib, and through the latter bone with the sternum.

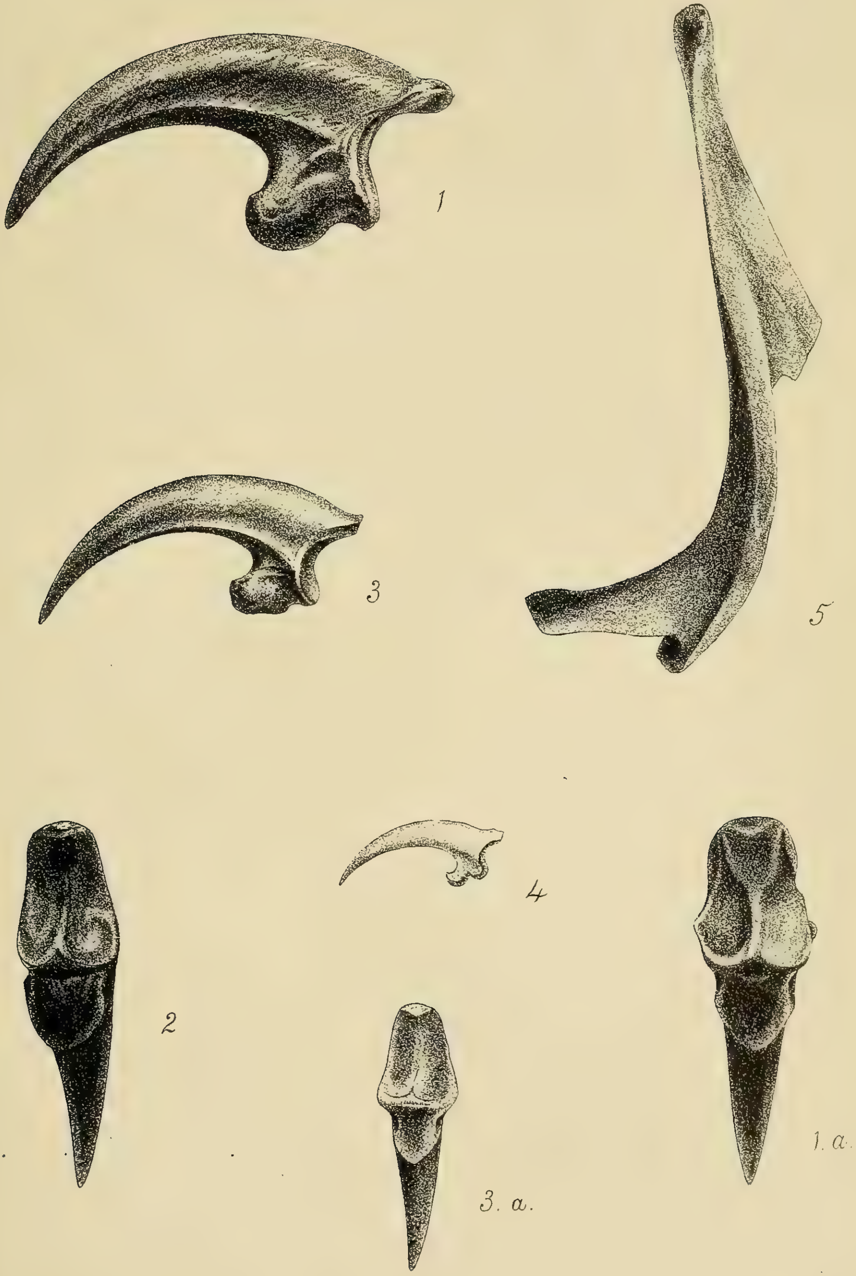
Pl. XI., fig. 5, represents in natural size this well preserved bone, of which only at *b* the upper portion of the epipleural appendage is broken off. The coalescence of this latter portion of that bone, which is a well marked peculiarity of raptorial birds, is well shown in this specimen, thus offering additional evidence as to the specific character of the specimen under review.

Two other bones, found close to each other in the same locality, and belonging without doubt to the same skeleton, are full of suggestive interest, as they, better than any other portion of the skeleton could do, exhibit the



Ll. Powell del. J.B. lith.

HARPAGORNIS MOOREI, *Haast*.



HARPAGORNIS MOOREI, *Haast.*

Ll. Powell, del. J.B. lith.

remarkable size and strength of the raptorial bird of which they are a portion. They consist of two ungual phalanges, of which the largest one (Pl. XI., figs. 1 and 1*a*), measures as follows:—

	Inches.
Length from summit of articular end to point .	2·92
Circumference near articular end, including lower process	3·17

As far as the scant material for comparison will allow, I believe that this bone is the ungual phalanx of the hallux or first toe of the left foot.

A comparison with fig. 3, Pl. XI., the ungual phalanx of the left foot (hallux) of the *Aquila audax*, the great Wedge-tailed Eagle of Australia, and with fig. 4, the corresponding bone in the New Zealand Harrier, will not only prove the close resemblance between that bone, belonging to these birds and the *Harpagornis*, but also their striking difference in size, and gives evidence of the enormous strength this extinct moa-hunter of the feathered tribe must have possessed. Only the lion and tiger, amongst the recent carnivorous mammalia, perhaps have larger ungual phalanges than this extinct raptorial bird, and after having seen its curved talons, the fable of the bird Roc no longer seems so very extravagant and strange, and I may add, that a human being, if not well armed or very powerful, not to speak of children, would have stood a very poor chance against such a formidable foe, if it had chosen to attack him.

In former publications I have, as I believe, conclusively shown that the native race who hunted and exterminated the different species of *Dinornis*, was a pre-historic people, and that the Maoris, the present aboriginals of New Zealand, probably the direct descendants of the former, have not the least tradition about them.

The discovery of these bones offers additional confirmation to my conclusions, as there is no doubt in my mind that, if reliable traditions about the *Dinornis* had been handed down to us, the still more alarming existence of this gigantic bird of prey, contemporaneous with the former, would most certainly have also been recorded.

A second ungual phalanx, applying the mode of measurement previously used, is 2·75 inches long, and has a circumference of 2·92 inches. It belongs probably to the second toe of the right foot. Plate XI., fig, 2, shows its articular proximal surface.

The Canterbury Museum possesses also the fragment of a right humerus, with both apophyses broken off, 7 inches long and 2·25 inches in circumference, found together with a considerable quantity of moa bones in a small water-course about two miles from Glenmark.

This fragmentary bone is most probably also a portion of the wing of this or of another bird of prey of very large dimensions.

As I intend to have further excavations made for the discovery of other portions of this unique species, I hope soon to be able to offer some additional information on the same subject.

Description of Plates X. and XI.

Plate X.—Fig. 1. Femur of *Harpagornis Moorei*, back view of left leg. Fig. 2, Femur of *Polioaëtus leucogaster*, back view of left leg. Fig. 3. Femur of *Circus assimilis*, back view of left leg. Fig. 4. Proximal end of femur of *Harpagornis Moorei*, left leg. Fig. 5. Distal end of femur of *Harpagornis Moorei*, left leg.

Plate XI.—Fig. 1. Ungual phalanx (of hallux, left leg) of *Hapagornis Moorei.* Fig. 1*a.* Proximal articular surface of fig. 1. Fig. 2. Ungual phalanx, probably of second toe of right foot. Fig. 3. Ungual phalanx of hallux, left leg of *Aquila audax.* Fig. 3*a.* Proximal articular surface of fig. 3. Fig. 4. Ungual phalanx of hallux, left leg of *Circus assimilis.* Fig. 5. Third rib right side of *Harpagornis Moorei.*

Note.—All these figures are of the natural size.

Art. XXIX.—*Notes on the Fur Seal of New Zealand,* Arctocephalus cinereus, *Gray* (?) By James Hector, M.D., F.R.S.

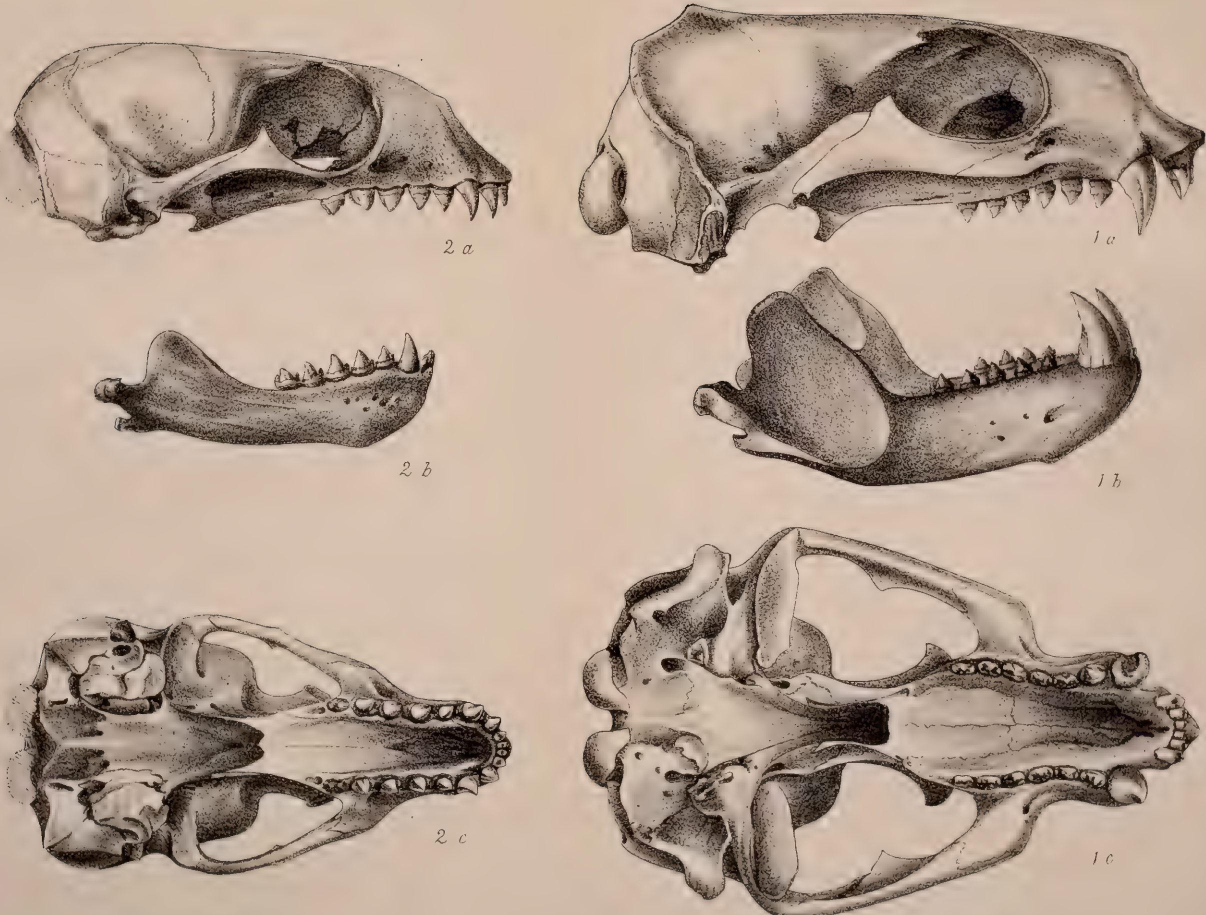
(With Illustrations.)

[*Read before the Otago Institute,* 31*st October,* 1871.]

On 13th February last, during the visit of H.M.S. 'Clio,' to Milford Sound, on the west coast of the South Island, several seals were shot by His Excellency Sir George Bowen, which proved to be the Eared Seal or Fur Seal of New Zealand, as it is termed by the traders. They were shot from a boat while basking on ledges of rock, and although several were mortally wounded, their great activity enabled them to scramble into deep water, so that only three were secured. I took the following measurements of the two largest, which were male and female adults.

Both had the same form, colour, and general appearance, the male being the larger in every respect, except the length of the hind flippers and tail, which were of slightly greater proportional dimensions in the female. The male weighed 258 pounds, and the female 208 pounds.

In both the snout was obliquely truncate, the upper surface being prolonged so as to overhang the mouth; nostrils vertical elongated slits; nose jet black; a few stout black bristles on the snout, which is short and not separated from the head. Head round; the eyes lateral. Ears with slender pointed tubular



Young. *Auckland I^s.*

Adult: *Milford Sound.*

ARCTOCEPHALUS CINEREUS. *Gray.*

½ size

conch. Colour uniform, black when wet, but when dry rusty in the male, and grizzle in the female. Fur of two layers, the upper part being formed of scattered hairs rising from the under fur. These hairs, which are longest on the back, where they are three-quarters of an inch, have a flatted form, generally with white tips, but frequently altogether white. The under fur is confined to the back, and is almost wanting on the flanks and belly. It is formed of a very fine woolly layer, close, dense, and about half an inch deep on those parts where most abundant. Tips of the whole fur, as laid open by the hand, black; middle parts chestnut brown, and pure white at base.*

Flippers naked, with a few chaffy scales. The anterior flippers with small nails, immersed on the first four digits, and only a faint mark on the fifth. Posterior flippers with strong nails immersed on the three central digits, the first and fifth being feeble. Toe flaps rather longer than the toes.

TABLE OF MEASUREMENT IN INCHES.

	Male.	Female.
Total length	82·0	80·0
Nose to ear	9·0	8·5
,, angle of mouth	8·0	7·8
,, eye	4·5	4·5
Length of ear	1·8	1·7
Width of nose	1·7	1·7
Anterior flipper—		
Length of exterior surface from shoulder joint	31·0	29·0
Length of interior surface from axilla .	17·0	16·0
Posterior flipper—		
Length from hip joint	15·0	16·0
Length of tail	4·0	4·0

The skull of the third specimen, which was a male, weighing 270lbs, was preserved for examination, and is figured in Pl. XII., fig. 1, *a*, *b*, and *c*.

Incisor teeth $\frac{6}{4}$, the external in upper jaw being much stronger than the others, which are small and feebly implanted in the jaw. Canines very strong, and locking, 1·7 inches long. Molars $\frac{6}{5}$ simple, conical, compressed, with slightly lobed crown.

Palate moderately concave, narrowed in front, most expanded opposite the last molars, and again contracted to a deep posterior aperture bounded by a truncate semicircular margin.

* In the tanned skin now in the Museum the under fur is red, but paler near the skin, having probably been stained in the tan-pit.

	Old.	Young.*
Extreme length of skull along the base .	9·6	7·5
Length of palate	4·5	3·5
Width at first molar	1·2	·8
" fifth "	1·6	—
" of posterior aperture . . .	·6	·6
Breadth of face at ear bones . . .	5·0	3·5
" at zygomatic arch . . .	6·0	4·0
Length of lower jaw	6·8	—
Width across condyles	5·0	3·5

Lower jaw moderate, with a blunt hook-like process projecting on the inner side in front and below the condyle.

The short palate places this seal in the genus *Arctocephalus* (as distinguished from *Otaria*), of which genus ten species are mentioned in Dr. Gray's "Catalogue of Seals and Whales."

Of these it most nearly approaches, in some characters, *A. Hookeri*, such as in the form of the base of the skull, and white colour of the basal part of the fur. There are, however, several important points in which it does not agree with this seal, such as the pointed nose and general colour of the surface; and as there is no mention in Dr. Gray's work of an Eared Seal having reached Europe from New Zealand, it is possible that this may prove to be an undescribed species, or perhaps one of several that appear to be known very imperfectly from their skins alone. It is, however, now certain that it is a very different animal from the true Fur Seal of the Falkland Islands, *Otaria nigrescens*, with which it has been confounded by the sealers, according to Dieffenbach "New Zealand," Vol. II., p. 182. The difficulty of determining from descriptions the different eared seals may be judged of from the fact, that while Dr. Gray divides them into twelve species, he gives a list of more than 100 synonyms, under which the same animals have been described by different persons.

[The officers of H.M.S. 'Blanche' have presented to the Colonial Museum, since the above was written, the skull and skin of the head of a young Fur Seal which they shot in the month of October at the Auckland Islands. They described it as quite a small seal of a jet glossy black with very soft fur. The form of the muzzle and ear conch is identical with the young seals I have seen of the species above described, from the west coast of Otago, so that there is no reason to doubt its being the same species. The skull is therefore valuable for comparison, as it shows how well the essential characters are preserved. The chief difference is found, as might be anticipated, in the

* Specimen obtained in the Auckland Islands by officers of H.M.S. 'Blanche.'

absence of the crests on the skull, the greater proportional size of the brain cavity in the young animal, and the large canines in the old. All the other measurements are proportionally the same, with the exception of the width of the posterior aperture of the palate, which is the same as in the adult.

The measurements of this young seal's skull, which is also figured, (Pl. XII., fig. 2, *a*, *b*, and *c*) are given above, along with those of the adult.—J. Hector, Dec., 1871.]

Art. XXX.—*On the Fur Seal of New Zealand.* By J. S. Webb.

[*Read before the Otago Institute, 31st October,* 1871.]

At Dr. Hector's request I have examined two specimens of the Fur Seal which are now in the Otago Museum, in order to add to the paper just read any remarks which they may suggest. Mr. Purdie has obliged me with the measurements, which are as follows:—

Table of Measurements in Inches.

	Male.	Female.
Total length	64·5	51
Nose to ear	10	7
,, to angle of mouth	6	4
,, to centre of eye	5·75	4·6
Length of ear	1·75	1·8
Width of nose	1	1
Anterior flipper—		
Length of exterior surface from shoulder joint	23	16
Length of interior surface	15	10·25
Posterior flipper—		
Length from hip joint	15·75	11
Length of tail	4	2

Though these measurements do not show an exact correspondence, they are sufficiently like those of the seals described by Dr. Hector in their proportions for each specimen, to leave no doubt that they all belong to one species. The only large proportional difference is in the measurements from nose to ear, which are greater in our male specimen than in Dr. Hector's, although the latter is more than one fourth larger in general measurement. In other respects the differences are also slight. No proper comparison of the skulls can be made without destroying the stuffed specimens, but the general contour of the head in these corresponds with the proportions of the skulls which Dr. Hector measured. The general description given by him will also, in the main, serve for our specimens. The chief differences are:—1st. The general lighter colour of our small female seal (which is particularly noticeable about the head). 2nd. The more slender proportions of the head in the same specimen. And 3rd. The bristles of both specimens, which are not black like those of Dr. Hector's seals. In our male specimen the bristles are yellowish white, and in the female the majority of them are so, some of the longer ones varying by being black for about two inches from the base. It should be stated that the condition of the teeth in our male specimen, and its general appearance when it reached him, led Mr. Purdie to the conclusion that it was a comparatively aged seal. The lengths of the canines from their apparent bases upwards are, in the male 1·1 inch, and in the female only ·6 inch.

It is singular that there should be any doubt about the scientific name of an animal which has been known so long, and appears to be so common on the New Zealand coast. The reason of this, no doubt, lies in the fact that so few specimens of these bulky mammals reach Europe that various species are confused with one another by naturalists, who have necessarily to trust to the descriptions given by casual and unscientific observers. On carefully comparing such authorities as we have access to here, I have come to the conclusion that what we are in the habit of calling the Fur Seal of New Zealand is most certainly that described by Forster as the Sea Bear or Ursine Seal. Forster accompanied Captain Cook on his second voyage, and it was in Dusky Bay that he first saw these seals. He tells us that they were afterwards met with, of much larger size, at New Year's Island, in Staten Land. The males seen there "being eight or nine feet long, and thick in proportion." Subsequently he speaks of the same animal as found in New Georgia, and it appears to have been taken for granted that this was the Sea Bear seen by Dampier at Juan Fernandez, and by others at the Gallapagos. He appears to have believed this seal to be identical with the Sea Bear of the Northern Pacific and Behring Straits, *Eumelopias Stelleri*, which had been described by Steller. There can be no doubt now that the animals are distinct. Dr. Hector's examination of the skull is decisive on that point. It is also open to question whether naturalists have been right in supposing the Sea Bear, which Forster found on the New Zealand Coast and in Staten Land, to be the same as that seen by other voyagers elsewhere.

Peron, a most careful and indefatigable naturalist, who accompanied the French exploring expedition to the southern seas in the first years of this century, says, "we are convinced that under the name Sea Bear there really exist more than twenty seals which differ from each other in all their minute characteristic points."* Subsequent researches lead to the conviction that this

* "Ann. des Mus. d'Hist. Nat," t. XV., p. 293.

was an exaggerated estimate, but it is probable that there are still several forms confused under this general name. Owen calls *Arctocephalus Australis* "the Ursine Seal."* This seal Dr. Gray assigns to King George's Sound, and describes as "yellow grey above, fulvous beneath, whiskers white." This may be but a variety of our seal. As I have said, the whiskers of the specimens we have here are, for the most part, nearly white, and the female is much lighter in colour than appears to be common with these seals in this part of the world.

Formerly the name *Otaria ursina* was given in common to our seal and the Northern Fur Seal. From the lists, as they now stand, the former appears to have dropped out. Dr. Hector's examination of the skulls of the specimens captured at Milford Sound has shown that it belongs to the genus *Arctocephalus.* The Northern Seal, with which it had been confused, has different characters, and is now called *Callorhinus ursinus.* Since the two are distinct generically, there seems to be no reason why they should not both retain the old and familiar specific name *ursinus.* They have one important feature in common in their fur, and since they are, on the other hand, thoroughly distinct, both in important structural characteristics and in habitat, there can be no fear that the adoption of the name *Arctocephalus ursinus* for our New Zealand seal will lead to any confusion.

Since the above was written I have had the opportunity of consulting Mr. J. A. Allen's paper on the Eared Seals.† Although it is chiefly with the *Otariadæ* of the northern hemisphere that Mr. Allen is concerned, this paper contains incidentally a good deal of information about southern forms, and the very confused and uncertain character of the descriptions which naturalists have hitherto received of them. From this source I learn that Dr. Gray has, in one of his monographs on the subject, distinguished our New Zealand Sea Bear as a separate species, calling it after Forster, but being evidently without any information with regard to it of later date than that given by this naturalist. He himself considers that there is but one Fur Seal in these seas, and that the New Zealand species is the same as that which has been found on the coast of Australia, *Arctocephalus cinereus.* He restricts the seals of the southern hemisphere, which have true fur, to three species, one (*A. Falklandicus*) belonging to the South American region, another to the seas in the vicinity of the Cape of Good Hope (*A. antarcticus*), and the third to the Australasian region. He suggests that these may all be mere varieties of one species, but having no acquaintance with any of them, except through descriptions, has nothing of importance to offer in support of this opinion. *A. cinereus* is described by Gray as "yellowish with the under fur red." If

*Comp. "Anatomy of Vertebrates," Vol. II., p. 496.

† "Bulletin of the Museum of Comparative Zoology at Harvard College," Vol. II., No. 1.

the Australian and the New Zealand Sea Bears prove to be the same, Mr. Allen's hypothesis that there is but one true fur seal in the southern hemisphere, as in the northern, may also prove correct. In the meantime we may take leave to doubt both propositions. Until a comparison is instituted by some one who has seen both, or at least good specimens of both, the question will probably not be settled.

Art. XXXI.—*Notes on a New Species of Rail,* Rallus pictus, *Painted Rail.* By T. H. Potts.

[*Read before the Philosophical Institute of Canterbury, 5th April,* 1871.]

Early in the month of March there was received at the Canterbury Museum a fine specimen of the Rail family, which had been obtained in the neighbourhood of the Okarito lagoon, Westland. This handsome bird at first sight bears a strong resemblance to *Rallus pectoralis*, Gould, from the similarity in the colours and markings of its plumage ; a closer examination discloses its superior size and more slender figure, some difference in the shape of the bill, and a well defined garter above the tarsal joint, thus showing a marked departure from the form of its better known congener.

The bill differs from that of *R. pectoralis,* in presenting a form less wedge-like, more produced, with the culmen slightly raised, the shallow furrows in which the lateral nostrils are pierced are less angular, the organ also possesses a greater degree of flexibility ; that it is comparatively weaker one may judge from the relative measurements of the bills of the two species.

	R. pectoralis. Inches.	*R. pictus.* Inches.
Length of upper mandible from gape	1·42	1·58
Length of under mandible from gape	1·31	1·54
Width of bill at base	0·29	0·25
Depth of bill at base	0·38	0·29
Entire length from point of bill to the end of tail	12·25	15·75

In addition to the peculiarities of the bill thus pointed out, it possesses a leg better adapted for wading than that of the closely allied species, the tibia is bared of feathers to the width of half an inch above the tarsal joint. It is not surprising that amidst the dense tangled thickets of rush, grasses, or *Carex* that border the swampy lagoons of the West Coast, it has hitherto generally eluded observation ; the shy, retiring habits of the group to which it is allied would there find abundant shelter for concealment, whilst its slender form, its compressed almost canoe-like figure, is wonderfully well fitted for rapidly threading the intricate mazes of the rank aquatic or semi-aquatic vegetation amidst which it finds its food. From its short concave wing, it is evident it must depend less on securing safety by flight than on the rapidity with which it can conceal itself from notice amongst the marshy vegetation of its favourite haunts. If the bill of *R. pectoralis* may be said somewhat to resemble that of *Ocydromus*, that of *R. pictus* rather shows an approach to that of *R. aquaticus*, Penn., less produced. We have heard on very good authority that a larger species of rail is yet to be found amongst the morasses of Westland.

Bill, upper mandible dark horn colour, lower mandible lighter; crown, occiput, and nape, olive brown marked with black; from the base of the upper mandible, a narrow line of white passes in almost a straight line above the eye, merging into pale grey as it descends obliquely towards the nape; a broad stripe of chestnut commences at the base of the bill, passes through the eye, across the cheek, and meets in a broad band at the back of the neck, forming a richly coloured tippet widest on the back of the neck; lower part of the cheek and throat pale grey and brownish grey; chin greyish, almost white; lower part of throat and breast black, each feather marked transversely with two bars of white indistinctly tipped with pale brown; breast crossed with a band of rich but light brown, with a chesnut spot in the centre, basal portion of each feather black, apical portion crossed with two narrow black bars, shafts white; greater wing coverts, olive brown, with occasional white and black spots; point of shoulders nearly white; primaries, of which the second, third, and fourth are nearly of the same length and longest, third and fourth chestnut, barred on inner and outer web with black, first and second marked with bars of white, which, on inner web are slightly crescentic; abdomen black, barred with white; lower abdomen pale fulvous; front of thighs fulvous; back of thighs slaty black; tail, shafts black, webs olive brown, darkest in the centre, middle feather with four spots of white, centre feather of under tail coverts black, with three white bars tipped with fulvous; vent black, tipped with deep fulvous.

Bill, from gape to tip of upper mandible, 1·58 inches; wing, from flexure, 6·17 inches; tarsus, 1·67 inches; middle toe and claw, 1·58 inches; hind toe and claw, ·5 inch; tail, 2·75 inches; extreme length from tip of mandible to tail, 15·75 inches.

Art. XXXII.—*Notes on a New Species of Gull*, Larus (Bruchigavia) Bulleri, *Potts*. By T. H. Potts.

[*Read before the Philosophical Institute of Canterbury, 3rd May*, 1871.]

Plumage white; wings silver grey; primaries, first feather black with white shaft, first and second feathers having an oar-shaped dash of white on the inner web, this mark slightly impinges on the outer web, third feather has the basal portion chiefly white, fourth feather has the inner web silver grey, margined with black, all primaries except the first tipped with white spots; bill yellowish, slightly stained near the point on each mandible with horn colour; tarsi and feet yellowish; claws black.

	Inches.
Bill from gape	1·75
Depth of bill at base	·29
Width of bill	·25
Wing from flexure	11·25
Tarsus	1·58
Middle toe with claw	1·42
Total length from point of bill to extremity of tail .	14·5

In structure this species exhibits a gradual departure from the typical form of *Larus*, as seen for instance in *L. Novæ Hollandiæ*, Step., and with which and *L. pomare*, Bruch., it has here been hitherto confused. An examination and comparison of the bill, tarsus, and foot, shows an evident approach to the group of *Sternidæ*, in their more slender proportions, this is equally manifest in the comparatively slight bill, delicate tarsus, and feeble foot.

Should this sea bird be allowed by ornithologists a place in our fauna as a new species, I propose to name it after Mr. Walter Buller.

Two specimens in the Canterbury Museum were obtained by Mr. Fuller, near the mouth of the Waimakariri River; both are young birds that have nearly attained the adult state; in looking at the description of *B. Jamesoni*, in Gould's "Handbook of the Birds of Australia," I do not find that the bird there described answers for the species *L. Bulleri*. It is probable that a more intimate acquaintance with this pretty gull will cause it to be identified as the one known to some of our shore-folk as the "painted gull" sometimes seen about Port Levy rocks.

[Not *L. Bulleri*, Hutton, No. 110, "Cat. Birds N.Z.," p. 41, but appears to correspond with *L. Jamesoni*, Wils., No. 111 of Catalogue.]—Ed.

Art. XXXIII.—*Notes on a New Species of* Apteryx. (A. Haastii, *Potts.*)

By T. H. Potts.

[*Read before the Philosophical Institute of Canterbury, 2nd August,* 1871.]

In the collection of the Canterbury Museum the *Apterygidæ* are well represented, more especially in the species which are peculiar to the Middle Island.

Some time last summer, amongst a consignment of skins received from Westland, was a specimen of a large *Apteryx*, which presented such peculiarities that it was considered to be a new species by the writer, and named *A. Haastii* in compliment to Dr. Haast. From a note by the collector it appears to have been obtained high on the ranges. Subsequently a second specimen was procured, the precise locality not given, but probably from the ranges above Okarita. The first specimen (No. 1) which we take to be that of an adult female, may be described thus :—Face, head, and neck, dull brown, darkest in a line from the gape to, and immediately behind the ear, and on the nape ; upper surface indistinctly barred with blackish brown and rich fulvous, each feather crossed with marks of dark brown, and fulvous, approaching to chestnut on the apical bars ; chin greyish brown ; throat dull brown, indistinctly marked with fulvous ; breast and abdomen dull brown, barred with pale fulvous ; straggling hairs about the base of the bill, black, some produced to the extent of 3·5 inches ; bill yellowish ivory, measuring from the gape to the end of the upper mandible, 5·6 inches ; upper mandible over-reaching lower mandible by 0·3 of an inch ; tarsus, 2·5 inches ; middle toe, with claw, 2·6 inches.

Specimen No. 2.—Face, head, and neck, dark brown, blackish brown on the nape ; entire plumage richer in colour than specimen No. 1 ; on the back of the thighs a chestnut bar, a bar of chestnut crossing the plumage above the tarsal joint ; upper mandible measuring, from the gape to point, 5·4 inches ; tarsus, 2·5 inches ; middle toe, with claw, 2·75 inches.

NOTE.—In the "Cat. Birds N.Z.," Hutton, Colonial Museum, Wellington, 1871, the compiler appears anxious to refer the new species to *A. maxima*, Verr., on the strength of a foot and tarsus of a *very large* species of *Apteryx*, the plumage and other characteristics of which are unknown. It is there stated that the bird to which the said tarsus and foot pertained, was as large as a turkey, and weighed nearly 14 lbs. Now for *A. Haastii*, we cannot claim the possession of such grand proportions, both the specimens of the new species, described in this paper, are equalled, sometimes excelled, by fine examples of *A. Australis*, Shaw, which, in the flesh, would not exceed 7lb. ; this, an *outside* weight, is given on the authority of the collector, who has literally slain his thousands of *Apterygidæ*, and through whose exertions colonial and foreign museums have been supplied with examples of the Middle Island *Apterygidæ*.—Nov. 23.

Art. XXXIV.—*Notes on the Habits of Some of the Birds of New Zealand.*
By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 30th September,* 1871.]

The following notes on the habits of some of our commoner birds (including a few which are only to be found at considerable altitudes), and chiefly compiled from observations made during periodical visits to my cattle station at Lake Guyon, in the Nelson province, may not be uninteresting to those who are engaged in investigating the ornithology of this country. Lake Guyon, as I have on other occasions mentioned, occupies a depression in a mountain ridge lying between the valleys of the Waiau-ua, and of its tributary the Stanley, and has been formed by the deposit of a large moraine at the end of the depression furthest from the valley of the Waiau, which dams in the waters flowing through this depression. These waters, which formerly ran into the Stanley, now flow out of the lake over a rocky barrier on the Waiau side, considerably lower than the moraine at the other end. Although situated at an altitude of 3,000 feet above sea level, this lake is never frozen over, and, even during the severest winters, its waters preserve a remarkable degree of warmth. It abounds in fish of the genus *Galaxias,* whilst the weeds growing below its banks swarm with *Physa variabilis* and the *larvæ* of Dragon flies, and in the sandy nooks formed by the wash of the waves are found considerable numbers of a small *Cyclas.* This abundance of life, and the warmth of the water, attract a great variety of aquatic birds at all seasons of the year, amongst which the principal are the *Casarca variegata* or Paradise Duck, the *Anas superciliosa* or Grey Duck, the *Hymenolaimus malacorhynchus* or Blue Duck (the Whio of the natives), the *Fuligula Novæ Zelandiæ* or Black Teal, the *Podiceps cristatus* or Crested Grebe, the *Podiceps rufipectus* or Lesser Grebe, two species of Cormorant, *Graculus carbo* and *Graculus brevirostris,* and the *Larus melanorhynchus* or Black-billed Gull. On the northern side of the lake patches of level land occur, formed by the deposition of the *detritus* brought down by its feeders, and covered with *Fagus* forest. In this forest a number of our ordinary land birds are found, including the *Nestor meridionalis* or Kaka, the *Ocydromus Australis* or Weka, the *Platycercus auriceps* or Yellow-headed Parroquet, the *Prosthemadera Novæ Zelandiæ* or Tui, the *Anthornis melanura* or Mako-mako, the *Petroica albifrons* or Robin, the *Athene Novæ Zelandiæ* or More-pork, and the rarer *Glaucopis cinerea* or Kokako, commonly called the New Zealand Crow. Amongst the rocky glens in the vicinity of the lake, the *Falco Novæ Zelandiæ* or Sparrow-hawk of the settlers is not uncommon, whilst on the shingle-beds of the larger rivers the *Hæmatopus* *longirostris* or Oyster-catcher, the *Himantopus Novæ Zelandiæ* or Pied Stilt, the Black Stilt and the Black-billed Gulls occur, though not in large numbers. This list by no means exhausts the birds of the district in question, but comprises all upon which I intend to offer any remarks in this paper.

The Paradise Duck is usually found in the valleys, feeding more upon the tender shoots of young grass and upon herbs of various kinds, than upon fish or other forms of animal life. Indeed, this bird is especially destructive to young pasture, and I have been compelled to wage war against it on that account. It breeds from October to January, and not unfrequently rears two broods during the season. I have, in fact, more than once seen two broods of different ages running with the same pair of parent birds. The single broods vary in number, the largest I ever saw being ten. Both parents are anxious and watchful about their young, resorting to the ruse of pretending lameness and inability to rise from the ground, in order to draw off any animal which they think likely to be mischievous. It is excessively amusing to see an old duck waddling away as if with the greatest difficulty, her wings drooping and flapped occasionally, in order to assist her apparently struggling efforts to escape, whilst all the time she manages to keep in advance of even a fleet dog, until at last, having drawn him to what she deems a safe distance from her nest, she at once rises from the ground, screaming out her harsh danger signal, to the complete discomfiture of the panting dog. Upon the danger signal being uttered by the parent birds, the young ones usually make at once for the nearest flowing water, down which they float close to the bank, seeking cover and availing themselves with great sagacity of every opportunity of shelter or concealment, in which they are assisted by their similarity in general colour to the soil and vegetation. During the moulting season large numbers of the old birds frequent the lake, associating together in a fleet, and usually occupying a gravelly bank at its upper end, from whence they take to the water upon the least symptom of danger, and invariably make for the middle of the lake, which is far out of gunshot from any part of its banks. In diving they use their wings for propulsion, and can travel a considerable distance under water. These birds are easily tamed, and I believe that if they could be kept within bounds for two or three seasons, they would breed freely in a quasi-domesticated state. In the young birds the sexes are undistinguishable by their colour, the distinctive feathering of the sexes only appearing in the beginning of the winter succeeding their birth.

The Grey Duck in the wild state, is, in some respects, less shy than the Paradise Duck, at all events in localities in which it is not persecuted or much shot at. Several young birds have been brought up by the children of my manager, which, although frequently absent for considerable intervals from the lake, continue so tame as always to resort to the house for food when upon it.

Nor do these tame birds appear to distinguish between those to whose presence they are most accustomed and casual visitors, indicating that their sense of security is due to the circumstance that they have never been molested by anyone. When rearing young of their own, however, they are usually more shy, one of the parent birds at a time then only coming to the house, the other keeping at a respectful distance in charge of the brood. We lately took up some tame ducks and placed them upon the lake. The wild ones had not mixed with them when I left the station last March, the tame ducks evidently being masters of the position from their greater size and strength. The brood of the Grey Duck rarely exceeds five in number. I have found its nest in the large tussocks of snow grass on the moraine at the upper end of the lake, close to the ordinary horse-track, and at a considerable distance from any shelter.

The Black Teal are usually associated in small flocks, and those which occupy the lake are generally to be found sitting on half-submerged logs close to the bank, from which they appear to watch the small fish, etc., upon which they chiefly feed. Like the other birds upon the lake they are by no means shy, quietly dropping into the water and swimming away if approached too closely. I have no knowledge of their mode of nidification or breeding.

The Whio, or Blue Duck, is rarely found upon the lake, except during heavy freshes in the feeders, when they occasionally come down to the mouths of the streams in search of food. They ordinarily occupy the deeper pools of the rivers, close to a rapid, their peculiar shrill and sibilant note being distinctly heard over the noise of the loudest cataract. Indeed, they appear specially to have been endowed with this note, in consequence of their frequenting such localities. These birds are very tame, looking with an appearance of wonder and surprise, mixed with a dash of stupidity, at intruders upon their privacy, and rarely taking to the wing unless closely pursued, and and then only flying to a short distance. They breed in November and December, and, like the Paradise Duck, sometimes bring up two broods in the year. The largest number of young birds I have seen of a single brood was six. In seeking for food they usually stand upon a stone in the middle of some rapid, from which they pick up any stray article of diet which is being carried by, whilst they are also constantly seen busily engaged in searching for food below the water in the rapids, in doing which they use their wings like hands, to cling to the stones in order to assist them in overcoming the rush of the water. They appear to be much attached to their young, but, unlike the Paradise Duck, use no stratagem to draw off an enemy, whilst the young ones merely move from spot to spot to escape danger, rarely diving.

I have seen nothing peculiar in the habits of the Cormorants which frequent the lake. They leave the district in the breeding season, resorting, as I believe, to the sea coast for that purpose. During their sojourn at the lake, they roost on some large dead tree on its margin.

I have fully noted the habits of the Crested Grebe (so far as I have been able to observe them) in the third volume of the *Transactions* of the New Zealand Institute.

The Black-billed Gull breeds on the main river-bed, and one or more pairs usually frequent the lake after the breeding season is over. On one occasion a pair of these birds, having by some means or other lost their own brood, returned to the lake earlier than usual. I brought up a young bird belonging to another brood, and placed it on the lake, and the bereaved parents at once took to it, tending it with the greatest care and solicitude. It is extremely interesting to watch these birds in their ordinary search for food during windy weather. The prevalent winds blow either up or down the lake, and when seeking food the birds soar against the wind along the margin of the lake on one side, until they reach its extremity, when they at once turn and run down before the wind to the other end, from whence they again recommence their soaring flight. But the most singular circumstance is, that in the main valley they pursue various species of moths, which occur in large numbers amongst the tussock grasses, and especially in sedgy patches occupied by standing water. I could not for some time make out the object of their peculiar flight, but a friend of mine (Mr. R. W. Fereday, of Christchurch), who was lately on on a visit with with me for the purpose of collecting the *Lepidoptera* of the district, whilst pursuing a large moth, observed one of these gulls swoop at and capture it. We then noticed that some five or six of the birds were busily engaged in feeding on the moths, pursuing them very much as other insectivorous birds would do. The birds which frequent the lake become very tame, one pair in particular readily taking a worm from my outstretched hand, and constantly coming close to the house for food. Nothing can exceed the pureness and delicacy of their plumage when in full feather. It is doubtful whether this kind ever visits the sea-coast.

The Pied and Black Oyster-catchers, and Pied and Black Stilts, all occur on the main river beds; but it seems to be doubtful whether the entirely black birds in each case belong to different species, or merely represent different conditions of plumage. Upon this point I am at present unable to offer any opinion. Their habits are precisely similar to those of cognate species in Europe and elsewhere.

The habits of the Kaka are in many respects remarkable. In its absolutely wild state it is fearless and inquisitive. I have often, whilst resting on the banks of a stream which falls into the lake and runs through forest frequented by these birds, seen several of them gravely take post upon some tree close to me, eying me with the utmost apparent curiosity, and chattering to themselves, as if discussing the character and intentions of the intruder. After the lapse of a few minutes they have darted away, uttering loud cries, as if proclaiming to the rest of the forest the presence of a stranger, who was either to be avoided or not, as the case might be. During the winter season the wild birds often unhesitatingly enter the house for food, making themselves thoroughly at home, and even roosting on the cross-beams in the kitchen on specially inclement nights. Two of these in particular soon learnt how to open the door of the dairy, which they were fond of getting into, in order to regale themselves on cream and butter, both of which they appeared to like excessively. I have had several of these wild birds billing on the eaves of the house in the evening, waiting to be fed, and coming readily to receive from the hand pieces of bread spread thickly with butter and strewed with sugar. But they rarely eat any of the bread itself, dropping it as soon as they had cleared off the butter and sugar. If one bird happened to have finished his portion before the others, he unhesitatingly helped himself to a share of some neighbour's goods, which was always yielded without the slightest demur. They are fond of raw flesh, and I have seen them hovering in front of a sheep's pluck hung on a tree, precisely as a humming bird hovers in front of a flower, eating fragments which they tore off, giving the preference to the lungs. When anxious to get into the house, they take post on the window-sills and beat at the window with their beaks until admitted. They are very mischievous, however, invariably cutting off all the buttons from any article of clothing which may happen to be left within their reach. I regret to say, indeed, that in some instances their familiarity degenerated into such gross impudence, that my manager was obliged to kill them in order to prevent their constant mischief. In the seasons when the great mass of the *Phormium tenax* flowers, these birds, feeding on the honey, become very fat, and are then delicious eating. At this time too they are nocturnal in their habits, and may be heard on moonlight nights to a very late hour. They were extremely numerous before the arrival of the Europeans, the natives catching and potting down immense numbers of them. The mode of catching them was as follows :—A Kaka whare was erected in some conspicuous place in, or in the neighbourhood of, forest much frequented by the birds, and thus, by means of a decoy bird, they were attracted and snared. These whares were usually from six to eight feet square, and about five in height, and were constructed of the fronds of some tree fern, placed upright at the sides and across the top of a framework of saplings. At each corner the saplings projected about eighteen inches above the level of the roof, having a cross-piece about eight inches long fastened nearly at the top, and sloping slightly upwards. To the end of this cross-piece a noose was attached, passing through a guy at the point of junction, which, slipping readily when pulled by the watcher below, entangled the feet of any bird sitting on the cross-piece. The Kakas, attracted by the cries of the decoy, naturally alighted on one of these cross-pieces, and were at once caught. I have known as many as two hundred caught at a single whare in a day. These being plucked were potted down in their own fat, and in that condition kept for a considerable time. The natives always eat the trail of the Kaka, as we do that of the Woodcock or Snipe. I have not tried it myself, and am unable to pronounce upon the merits of this mode of cooking the bird.

The habits of the Weka have been noticed in Mr. Potts' interesting papers published in the second and third volumes of the *Transactions* of the New Zealand Institute, but a few points which he has not mentioned may probably be acceptable. It will have been observed by those who have examined the structure of this bird, that the metacarpal and phalangial bones are represented by a single sharp spur about half an inch in length. When irritated it extends its wings with the backs turned forward, and it then uses this spur as a weapon of offence. It delights in prowling about the low bushes at the edge of the forest, and on the banks of rivers, creeping along with a stealthy cat-like tread, and preying on any small bird which may come within its reach. It is specially destructive to eggs and young poultry. I have seen a Weka drive its beak into an egg, and then, raising its head to a nearly upright position, run away into the bush with the egg impaled upon it. This bird is easily snared in the following manner:—Tie a small bird to the end of a stick about a yard long; I generally used a stuffed specimen for the purpose in my exploring excursions. To the end of another stick, slightly longer, fix a running noose of green flax, which keeps well open and slips readily. This noose should be from three to four inches in diameter. Dangle the bird in sight of the Weka, taking some little precaution to conceal yourself, although but little is required, except in the case of a very old and knowing bird. When the Weka makes for the dangling bird, place the noose immediately in front of the latter, and as the Weka pecks at the bird through the noose it is easily caught. With a little coolness you cannot fail. When taken into the hand after being first caught, this bird at once discharges a quantity of extremely fetid fæcal matter, whether from fright, or upon the same principle on which the skunk discharges its pestilential fluid, I cannot say. I differ from Mr. Potts in one point, and believe that the Weka, so far from diminishing in numbers, is increasing all over the Middle Island. Even the cattle dogs on my station do not care to kill it. Except in the vicinity of poultry-yards and gardens this bird is very useful, destroying large numbers of noxious grubs, as well as mice and young rats. They pair for the breeding season, the male bird assisting in the work of incubation, and accompanying the female and her young ones until the latter are weaned. I have seen seven and eight young ones in a single brood. I may add that many persons, some of whom must be considered of high authority, have stated that this bird breeds with the common domestic fowl. The statement, if correct, is so extraordinary, that all the facts in support of it ought to be made known. As the case has never come under my own observation I merely mention this statement, in the hope that those who possess any knowledge on the subject will publish the facts.

The *Glaucopis cinerea*, or Crow, of the Middle Island, is rarely found below an altitude of two or three thousand feet, and, indeed, is found in greatest numbers at and above the higher of these altitudes, in the glens of the *Fagus* forest. I am inclined to think that these birds pair for life, as they are almost invariably found in couples at all seasons of the year.* They are extremely active, hopping with long strides along the ground, and from branch to branch, in their search for insects. Their chief food, however, consists of sow-thistle and other succulent herbs, and it is remarkable that, in eating such substances, they hold them with the fist precisely as a parrot holds his food, tearing off and swallowing large fragments. The young birds thrive well in confinement, feeding freely on bread and milk and greenstuff, with a few grubs now and then. Unfortunately, some birds which were being thus brought up for me, were accidently killed, and no opportunity has since occurred of repeating the experiment. The note of this bird is wonderfully sweet and plaintive, and, during the breeding season, its song is one of the most varied and beautiful of all the New Zealand birds. It appears, however, always to be pitched in a minor key. The male birds are very pugnacious, fighting, whenever they meet, with the greatest determination. They are still numerous in the forests adjoining my station, but I fear the wild cats are likely to clear them out within a few years.

The Robin (*Petroica albifrons*) is a very bold bird, its tameness evidently springing not merely from a sense of security, but also from an absence of fear. It is to be found in every part of the forest, and the traveller rarely rests for a few minutes before one of them is to be seen seeking for insects on the ground disturbed by his footsteps, or upon the site of some piece of decayed wood which he may have moved. I have had these birds more than once sitting

* Since the foregoing was written, I have found the following statement in Dieffenbach's "Report to the New Zealand Company," dated October, 1839 :—"The bird called Kokako, and Wattle Bird by the Europeans, from its two gold-coloured and indigo maxillary flaps, I found only at Ship Cove, in the middle region of the hills and upon trees. It seems to be a kind of *Gracula*, of the size of the Jay, has a strong black beak, with a slightly curved upper maxilla, and measures 16 inches from the tip of the beak to the end of the tail. Its feet are black like those of the former. Its plumage is soft silk-like and glossy black. It has a penetrating, not disagreeable voice, feeds upon seeds, and lives in pairs upon the trees." The account above given is in many respect inaccurate, and is only quoted in support of my suggestion that the male and female Kokako pair for life.—W. T. L. T.

on my head as I lay on the ground, and hopping about me pecking at my watch chain, or at anything else which took their fancy. On one occasion I fed one with crumbs of bread, which it ate readily. After satisfying its hunger, it proceeded to hide what it could not eat under the edges of foliaceous lichens upon a gnarled old tree close to where I was sitting, no doubt resorting to this store when it next felt hungry. As Mr. Potts has observed, the song of this bird is sweet, but, as I think, wanting in continuity. However, it is an amusing little fellow, and its familiarity diminishes that sense of loneliness which is always more or less inspired by the stillness and monotony of the great Beech forests.

ART. XXXV.—*On a Supposed New Species of Duck.* By A. C. PURDIE.

[*Read before the Otago Institute, 16th September,* 1871.]

THE duck in question was shot some time ago at Kaitangata, and sent to town by Mr. J. P. Maitland, Clutha. It was one of a flock of fourteen, which was seen on the Lake there, and supposed to be a new species, at least to the district, none of the settlers having seen it previously. This duck differs from all the *Anatidæ* in our collection, which includes all those mentioned in Buller's list but two, viz., the white-winged duck, identified by Buller as *Nyroca Australis*, of Gould, and one which Buller named *Anas gracilis*, identified by Dr. Finsch as *Anas gibberifrons*.

Extreme length from tip of beak to tip of tail, 15·4in.; beak, 1·75in.; tail, 3in.; colour of beak yellowish brown mottled with black, tip hooked and horny; top of head greenish brown, sides of head lighter, shading into light grey on throat; front of neck and upper part of breast greenish yellow, running into rich yellowish brown with bars of black (on breast); belly to vent white; under tail coverts, yellowish white; over thighs (tibia) a yellow band, with black margins meeting at tail coverts, a few of which are long and turn over the back, giving a rather gay appearance, meeting in a yellow spot on the back above the tail; tail black, with ten primary feathers 3 inches long; tail coverts yellow, tipped with black; back dark brown, with a greyish tinge; wing coverts greenish brown, fringed with white; greater wing coverts greenish brown; primaries of wings brown, with no speculum; wing, from flexure to tip, 9·6in.; legs and feet reddish brown colour; length of tarsus 2·1in.; tibia, 1·9in.; middle toe, 1·5in.; back toe, ·9in.; well webbed.*

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* *Dendrocygna Eytoni*, Gould. No. 95, "Cat. of N. Z. Birds," 1871.—ED.

Art. XXXVI.—*Observations on a Paper read by Mr. A. Bathgate before the Otago Institute, 11th January,* 1870, "*On the* Lepidoptera *of Otago.*" By R. W. Fereday, Corresponding Member of the Entomological Society of London.

[*Read before the Philosophical Institute of Canterbury, 11th October,* 1871.]

The following brief remarks on the above paper are presented to this Society solely with a view of assisting the promotion of truth and accuracy in the investigation of the Fauna of New Zealand, and as a record of the results of my own observations compared with those of Mr. Bathgate, to whom we are greatly indebted for opening up a subject which has been sadly neglected in the scientific researches of this country.

My knowledge of entomology is so limited, that I feel it almost presumption on my part to attempt to contradict, or question, Mr. Bathgate's statements or inferences; but from differences of opinion springs the confirmation of truth.

I intended contributing long ago to the *Transactions* of the Society what little information I possess on the *Lepidoptera* of these islands, but have been hindered by the very limited time at my disposal, and the difficulty of classifying my collection in the absence of typical specimens and descriptive catalogues of European and Exotic insects for reference. I hope, however, to submit to you, during the course of next year, some general notes upon the subject. I regret the delay which has already occurred, not that the information to be afforded by me would have been of much intrinsic value, but because its defects might have called forth the criticism of able and eminent entomologists, and thereby indirectly aided in the advancement of science. Unfortunately for the advancement of entomology, its votaries are derided by the ignorant vulgar—ever ready to laugh at what they do not understand—and many an active mind, that would otherwise have been devoted to this study, has been led to choose some other field for its energies. To vulgar prejudice alone must be assigned the low rank held by the study of insects in the several branches of natural history; for no other animals exercise such a vast influence for good or evil on the human race, or afford so great a fund of interest and enjoyment in the investigation of their wonderfully various habits and instincts.

Happily the time is past when Lady Granville's will was attempted to be set aside on account of lunacy, simply on the ground of her fondness for collecting insects; and we may hope that, ere long, entomology will gain its legitimate place beside the sister sciences.

In the preface to the first edition of "Kirby and Spence's Entomology," the writer, referring to the value of the study of entomology in the education of youth, says, "All modern writers on this momentous subject unite in recommending, in this view, natural history; and, if 'the quality of accurate discrimination, the ready perception of resemblances amongst diversities, and, still more, the quick and accurate perception of diversity in the midst of resemblances, constitute one of the most important operations of the understanding; if it be indeed the foundation of clear ideas, and the acquisition of whatever can be truly called knowledge depends most materially on the possession of it;' if 'the best logic be that which teaches us to suspend our judgments,' and 'the art of seeing, so useful, so universal, and yet so uncommon,' be 'one of the most valuable a man can possess,' there can be no doubt of the judiciousness of their advice. Now, of all the branches of natural history, entomology is unquestionably the best fitted for thus disciplining the mind of youth."

It will be digressing too much from the particular object of this paper to enter further into the *merits* of entomology, a subject which you will find fully and powerfully, and, in fact, exhaustively argued in the work to which I have just referred.

The *title* of Mr. Bathgate's paper has reference only to the *Lepidoptera* of *Otago*, but we find his remarks extend to New Zealand generally, and to other insects besides *Lepidoptera.*

Of the insects inhabiting Otago I have no personal knowlege, never having had an opportunity of visiting that province, and it must therefore be understood that I have no intention of questioning any of Mr. Bathgate's statements which relate solely to that province.

In referring to the niggardliness of nature in providing for New Zealand, Mr. Bathgate says, "She has been far from liberal so far as insects are concerned." This, I think, is a mistake, unless he compares New Zealand with a tropical country. It is true that certain classes of insects are extremely poorly represented; for instance, the Diurnal *Lepidoptera* (butterflies). But, on the other hand, there are others which are abundant; and I believe that, if New Zealand were thoroughly searched, it would be found anything but poor in insect fauna.

It must be remembered that the insects we see flying and creeping about in the daytime, are not a tithe of those which exist around us. Anyone camping out in New Zealand will have observed in his tent the swarms of moths attracted at night by the candle-light, sometimes to such an extent as to nearly extinguish the candles.

Of the Nocturnal *Lepidoptera* (moths), the families *Pyralidæ*, and *Crambidæ* appear to me to be abundantly represented both in genera and species, and the *Noctuæ* family are far from scarce on the Canterbury plains; but, so far as my experience extends, the *Bombycidæ*, a family of moths whose habitat is generally more confined to woodland localities, have very few representatives here. At the same time it must be understood that, with one or two exceptions, Riccarton Bush (a few acres in extent) and some of the bush in the neighbourhood of Wellington, are the only woods (of varied vegetation) in which I have had an opportunity of collecting. I have collected in some of the black birch forests, but with very little success, as might be expected from the small variety of vegetation existing in them.

The *Geometræ* family I believe to be very fairly, if not abundantly represented, and also the *Pterophori* (plume moths); but of the *Tineæ* (the minute moths) except three or four species of those household pests, clothes moths, which are unfortunately most abundant, there appear to be but few representatives.

The extraordinary number of genera as compared with that of species is a remarkable peculiarity in the *Lepidoptera* of New Zealand, as also the general sombreness of their colours.

The larvæ referred to by Mr. Bathgate as so destructive to grass by eating the roots, "to such an extent as to cause large patches of it to wither up as if scorched by fire," I have not the least doubt are of the same genus and species as those which commit a similar depredation in this neighbourhood, and, if so, belong to the *Melolonthidæ* family (cockchafers), and not to the *Elateridæ* (click-beetles). I am acquainted with three species of *Melolonthidæ* inhabiting this province, but all totally distinct from any British species.

In speaking of our insect pests, I am surprised that Mr. Bathgate does not mention the larvæ of a moth of the *Noctuæ* family, an insect which has committed such depredations on the grass and corn in this province. Perhaps it has not occurred so plentifully in Otago.

The application of the word "Phasiuma" to the insect commonly called a "walking-stick," is probably an error of the printer. It should be "Phasma," and the hyphen placed between "walking" and "stick" should be omitted—the common name having been given from its resemblance to an animated twig, and not (as the hyphen would suggest) from any resemblance to a stick we use in walking.

Mr. Bathgate mentions one, but there are several species of *Cicada* in these islands; the claws of the larvæ of this insect are used for cutting the roots of plants upon which it feeds; the larva is not, neither is the perfect insect, carnivorous.

As to a classified list of New Zealand insects, I believe there is nothing in existence worthy of the title.

Although I have had but little time or opportunity I have collected, of butterflies at least eight, and of moths quite 300 different species, and it is seldom that I return from a day's or evening's excursion, even in oft-visited localities, without adding many new species to my collection; and any new locality invariably affords me a rich harvest.

Of some 200 or more specimens that I have sent to England, seven-eighths, at least, were undescribed and new to science.

The butterfly mentioned as so much resembling the English Red Admiral (*Vanessa atalanta*) is the *Pyrameis gonerilla* of Fabricius. It differs from *V. atalanta* in having a marginal row of ocellated spots, instead of crescent-shaped markings, on the hind wings, and a very beautifully coloured ocellated spot beyond the middle of the fore-wing, on the under side. I am not quite prepared to admit that there are two broods of this insect during the year, for those which appear in spring are almost invariably worn and dilapidated, and have, doubtless, hybernated.

The butterfly with the silvery markings on the under side, must be *Argyrophenga antipodum* of Doubleday. It is rather common in some of our river beds, particularly the Waimakariri; the genus is distinct from *Satyrus*. That seen by Mr. Bathgate in the interior of the province of Otago, and supposed by him to be of the Fritillary genus, was probably a "Painted Lady" (*Vanessa cardui*), which is found in these islands as well as in almost every part of the globe.

There is a handsome butterfly (*Vanessa itea*) not mentioned by Mr. Bathgate, of which I have specimens taken by Mr. F. H. Meinertzhägen in Hawkes Bay. It would appear to be intermediate between *P. gonerilla* and *V. cardui*.

I may also mention a black butterfly, found on the bare summits of the snowy mountains, and of which I have several specimens, taken on the range near Castle Hill Station, west of Porter's Pass, at an altitude of over 6,000 feet. Mr. J. D. Enys was, I believe, the first* person to discover this species, and pointed out to me its locality. It has since been found by Mr. W. T. L. Travers on the mountains at Lake Guyon, in the Nelson province. I believe it to be a species of *Erebia*, and have named it *E. pluto*.

There are three, if not four, distinct species of the *Chrysophanus* genus, namely, *C. edna*, of Doubleday, *C. Feredayi* (a new species taken by myself at Kaiapoi Bush, and so named by Mr. H. W. Bates, in compliment to myself) a new species not yet named (taken by me at Wellington), and another which I believe to be new, but am not certain about.

Of the *Lycœna* genus we have at least two species—*L. Oxleyi*, of Felder, and *L. boldenarum*, of White.

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* I have since been informed by Dr. Julius Haast that he took this butterfly on the 14th March, 1866, on Whitcombe's Pass at an altitude of 4,212 feet above the sea level. —R.W.F.

The moth mentioned as having black wings with white spots, and the abdomen annulated with orange, is *Leptosoma annulatum* of Boisduval, belonging to the *Leptosomidæ* family. It is very abundant here, and its larvæ are common on a species of ragwort—I have never found them on any other plant.

The light fawn-coloured moth noticed by Mr. Bathgate only where spear-grass abounded, I have no doubt is identical with that found on these plains, and which I have myself bred from larvæ taken out of the heart of "Wild Spaniard" (*Aciphylla sqarrosa*) on which it was feeding. M. Guenée has named and described it from some specimens I sent home, *Alysia specificata*, considering it both a new genus and new species belonging to the *Apamidæ* family.

There are several species of *Hepialidæ* here, but whether they are identical with those referred to by Mr. Bathgate I am unable from his description to make out. M. Guenée has named two new species of the *Pielus* genus of *Hepialidæ*, sent home by me, the one *umbraculatus* and the other *variolaris*. In describing these in the "Entomologists' Monthly Magazine, (Vol. V., p. 1), he appends the following note :—"The British Museum Catalogues indicate many species proper to New Zealand, a country which appears to be rich in *Nocturni*. I am able to recognise some of them, but the greater part of those sent to me seem new ; it may be that the locality where Mr. Fereday collects is different to those which Messrs. Bolton, Colenso, and Sinclair visited, or that I have not been able to recognise many of them from the too often little precise descriptions by Mr. Walker."

I conclude these few remarks by expressing my regret that the study of entomology, and the collection of insects is so little followed in this country, for the change which is rapidly taking place in the herbage and vegetation will assuredly render many species extinct a few years hence. Every one may materially assist in promoting a knowledge of our insect fauna, even by merely forwarding to the museum, or to myself, any uncommon insect he may happen to meet with. As for myself, I shall be only too grateful for such contributions, and I have to thank many friends for assistance already afforded me in that way.

Art. XXXVII.—*Description of a New Shell found at Nelson.* By E. Stowe.

[Read before the Wellington Philosophical Society, 1st July, 1871].

Imperator Davisii, Stowe. n. sp.

Shell conical, solid, imperforate, where abraded highly nacreous. Axis, 4·5 inches; breadth, 3·25 inches ; whorls 5 to 6, convex ; aperture pearly, in part tinged with green, four times the size of the operculum, the form of which it resembles in general outline ; lip thin ; throat nacreous ; operculum shelly, ear-shaped, closely resembling that of *I. Cookii.* The base appears to lack the ornamentation peculiar to this last-named shell, though the whorls show traces of the wavy corrugation. The principal distinguishing marks between the two would seem to be the difference in the form of the aperture, and the far more marked tendency toward the conical form presented by the contour of the present specimen.

This shell, the only example at present obtained,* was discovered at low water at the cliffs at Nelson, N.Z., by the late Mr. E. H. Davis, of the New Zealand Geological Survey.

ART. XXXVIII.—*A Rock Pool and its Contents.* BY P. THOMSON.

[*Read before the Otago Institute, 18th April,* 1871.]

FROM some remarks made by our vice-president about the wants in our local museum, and the difficulty of getting them supplied, I am inclined to think that the best means of doing so, as well as an excellent means of making our members practically acquainted with out-door science generally, would be by the establishment, in connection with our Institute, of a Field Naturalists' Society. Such associations are not unfrequent in the home country, and have proved of considerable benefit, not only to the districts in which they labour, but to the members themselves. They generally meet once or twice a month during the summer, and fix upon some locality over which to extend their researches, the scene of the next excursion being generally fixed before the breaking up of the last one. During these excursions each member is free to follow his or her peculiar branch of study. While one may push his way into a thicket to look for some fern or other plant, another may have come provided with net and other apparatus for catching moths, butterflies, or other insects. Another, again, may have found the outcrop of some rock, and, with hammer in hand, will go chipping off specimens ; while another still may explore the thick bushes for birds' nests, etc. It is rather late in the season now for initiating such a society as that proposed ; but even yet a good deal may be done. At all events the society may be organised, so that work might be begun at any time. There are numerous localities round about Dunedin which abound with interesting objects of every kind. I need only mention the shores of the harbour, the ocean beach, the valley of the Leith, the Pine Hill bush, Flagstaff, etc., to show that a Naturalists' Society has

* Another specimen has since been obtained in the same locality.—ED.

plenty of scope for variety of study. By way of illustrating what may be seen in a very small space, I venture to lay the following remarks before the Institute, premising that they were written several months ago.

It is a well-known fact, that though all men have been provided with eyes, it does not follow that they all make the same use of them. Some men walk through the world with their eyes pretty widely open, yet after all they see very little ; while others are perpetually finding something to interest them. It is given to some men to be curious or inquisitive, not to be content with merely looking at a thing; they must see into it, see what sort of a thing it is. Other men are content with knowing that a tree is a tree, a rock a rock, and so on. Place two men on the sea beach : one sees only tumbling water on the one hand, and rocks or sand on the other; while the other sees a difference in every wave that comes rolling in to his feet—its force, its colour, its height, are all noted ; while the sand tells its story of pounded shells or disintegrated rock. It is with the view of noting what may be seen by careful and minute observation, even in such an apparently trifling thing as the subject of my remarks, that I proceed to tell of what may be found in one of the most familiar objects that meet the eye on the sea-shore—a Rock Pool. I may say that the idea of writing this paper occurred to me during a recent visit to the Heads, in company with one of those men who have not the faculty of observing.

We were standing on a low point of rock looking at the ebbing tide rushing past, when he complained of weariness, and there being nothing to see. Against this I exclaimed, stating there were thousands of things all round us well worthy of study, and, casting my eye around, fixed on a little pool at our feet as an illustration. My friend was rather startled when I made him sit down on the rock beside me while I tried to describe to him the microcosm contained in the little pool of water left by the tide. It was a depression in the surface of a flat piece of rock, about two feet or so above low water mark, about fifteen inches in length by eight or nine wide, of an irregularly oval shape, and might contain two or three gallons of beautifully clear water. The first feature noticeable was that the pool was fringed with vegetation, and on a narrower inspection there were found three distinct sorts. The first and most beautiful was a bright green broad-bladed plant—the green laver—which belongs to the class of Chlorosperms; there were also some tufts of a grassy looking plant, belonging to the same class. In the darker nooks grew several plants of a hard tough texture, of a dark red colour, belonging to the Rhodosperms, not unlike the dulse of the old country, but harder and not at all palatable. There were also some tufts and patches of that common and very pretty plant, the Coralline or Rosetangle, a plant which is more than one half lime. It was also observed that on the borders of the leaves of these plants there were crowds of little globules of air—this being oxygen gas, which the plants elaborate from the carbonic acid given off by the animals which lived in the pool.

Carefully removing some of the vegetation, so as to allow of more light getting into the water, we disturbed a small brown fish, evidently a member of the Goby family, from its bluff-shaped head, and from a habit of attaching itself to the perpendicular sides of the pool, the ventral fins being shaped something like a sucker. The little fellow eluded capture very cleverly, and glided hither and thither until it was finally lost in a dark nook at one end. Below the weed at one point there was a colony of those pretty animals the *Serpulæ*, which live in calcareous tubes, twisted like a snake. They are annelids, and have a number of beautiful feather-like tentacles round their head, protruding from their shell, by which they grasp their prey. One of these tentacles is swelled out, and placed on a slightly longer stalk than the others, and forms a sort of cork, by which the animal shuts itself into the shell when alarmed. The *Serpulæ* are said to have no eyes, but they must have something which serves them quite as well, for if the hand is drawn quickly across the surface of the water so that the shadow falls upon them, they instantly disappear. After waiting a little the cork will be seen to protrude, slowly followed by the rest of the organs. There were plenty of the common Barnacle in the pool, the rock being studded with them here and there. They are cirrhipeds, throwing out a number of bent arms covered with fine hairs, placed something like the fingers on one's hand; these they are constantly opening and shutting, of course conveying to the stomach whatever articles of sustenance they may happen to inclose. Adhering to the rock were some small molluscs, much resembling a *Nerita*, and one Limpet (*Patella*), These are gasteropods, and creep over the rocks on a broad foot; their mouths are furnished with a very peculiar tongue, rough like a file, and with it they scrape the surfaces of the rocks and plants as they travel hither and thither, so keeping down the growth of plants, which would otherwise fill the pool to the exclusion of all else.

Carefully lifting and turning over a stone which lay at the bottom, quite a crowd of crustaceans was discovered. However, they mostly scuttled away so rapidly that they were lost sight of; but one sort remained: this was the Porcelain crab, of which there were several specimens. These crabs are very peculiarly constructed, and are so named from the under sides of the bodies resembling porcelain. They mostly inhabit dark places, under stones, etc., and are armed with large powerful nippers, though they are quite harmless, and may be handled with impunity. These little creatures are wonderfully adapted to the circumstances in which they live. Their bodies are quite thin and compressed, so as to be able to wriggle themselves into any hole or under a stone, where they lie quite out of the reach of any harm. A very minute crab, with a carapace about the size of a pea, was discovered on the mud at the bottom where the stone had lain, and when taken out of the water was found to be a very pretty object, having light red legs; it was very active, and escaped back to the water again. On examining the stone, its lower surface was found to be partially covered by a species of sponge, of a yellowish colour, rising here and there into tubercles, each of which had a hole communicating with the interior. Close beside the sponge were several small semi-transparent globules, evidently the ova of some animal.

Turning now to the other end of the pool, under the clear water were seen a number of those interesting animals, Actinias, which form a link as it were between the animal and vegetable worlds. They much resembled a small single *Chrysanthemum*, of a pale whitish shade, with here and there on the tentacles a bright red spot. Some of them were very little, not over a quarter of an inch in diameter, while others measured about an inch across. To test their voracity we dropped one of the *Neritas* on one of them, and though nearly as big as itself, it closed its tentacles on it, and soon gorged it out of sight. There were several other singular organisms in the pool, particularly a long worm, with what looked like fringes on its sides, probably a *Nereis*; but as we had no means of carrying anything away for further investigation, it was impossible to say definitely what they were. Anyone who may wish to explore for himself in this direction should take with him a clear sided glass dish and a magnifier, and he will find plenty to interest, amuse, and instruct him in any one of the numerous pools on the rocky parts of the coast.

In recapitulating the contents of this little patch of water, it will be observed that we found representatives of all the great divisions of the animal world. Beginning with the lowest—the sponge, we have a member of the fifth sub-kingdom—the Protozoa. A stage higher and the *Actiniœ* represent the fourth—the Radiata. Then the Mollusca—the third sub-kingdom—are represented by the *Patella* and the *Nerita*; while the second—the Articulata—claims the various crabs, etc., and the highest—the Vertebrata—claims the fish.

Over this little pool my friend and I spent a very pleasant hour, and on leaving the spot he honestly confessed he had no idea that these pools contained anything but water; and said that he had arisen not a sadder but a wiser man. After all, I do not think I have mentioned more than half of what was contained in the pool; but have ventured to run the foregoing remarks together with the view of showing that even the commonest things are worth investigation. Now to compare the contents of this pool with a similar one in the old country, I find that there is very great resemblance. The plants are nearly identical, the *Serpulœ* and the Barnacles are exactly so; the fish, or a near relative, the Blenny, would be sure to be found; while the

Nerita would be represented by a *Trochus.* The Porcelain crab is the very same as the one found at home, both as to colour and size ; while the *Actiniæ,* though differing in colour, very much resemble the *Actinia mesembryanthemum,* which studs the rocks so plentifully along the coast in the neighbourhood of St. Andrews.

III.—BOTANY.

Art. XXXIX.—*On some New Species of New Zealand Plants.* By John Buchanan, of the Geological Survey Department.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 6th July,* 1871.]

Haloragis aggregata, Buchanan. n. sp.

A slender much branched herb, procumbent at the base. Branches very narrow, erect, 4 angled, 4–5 inches high, scabrid. Leaves $\frac{1}{4}$–$\frac{1}{2}$ inch long, opposite, distant, ovate oblong, acute, tapering into a short petiole, with 3–5 deep cut pungent serratures on each side, margin thickened and scabrid, both surfaces hispid with scattered appressed hairs, scarcely membranous. Flowers hermaphrodite, pedicellate, in pairs with bracteate leaflets, aggregated at the ends of the branches into dense round heads or corymbs, by the union of three or more heads; sepals 4, triangular acute; petals 4, hood shaped, with a few scattered long hairs, reddish, rather longer than the sepals; stamens 8, anthers linear, filaments equal in length to the anthers, exserted between the calyx lobes with the 4 large plumose stigmas, and persistent after the fall of the petals. Fruit 1 line long, 4 angled, with 4 intermediate costa, smooth and shining, 4 celled, 4 seeded.

This addition to an already large southern genus differs much from any of the described species either in New Zealand or Australia. The specific name has been chosen to indicate the most prominent character, the aggregation of the heads.

Collected by H. H. Travers, near Lake Guyon, Nelson Province, February, 1871.

Plate XIII.—Fig. 1. Plant *natural size.* 2. Fruit with persistent stamens and stigmas. 3. Stamen. 4. Plumose stigma. 5. Hood-shaped petal. 6. Section of fruit with 4 suspended seeds. 7. Leaf with thickened margin and appressed hairs. 8. Seed. All *magnified.*

Danthonia Raoulii, Steud.

a. australis, *Buchanan. n. sub-sp.*

A small rigid grass growing in dense tussocks; culms 8–16 inches long,

J.B. del. et lith.

Haloragis aggregata, *Buchanan, n. sp.*

slender, glabrous. Leaves 3–4 inches long, involute, filiform, rigid, setaceous; secund on the outer culms, glabrous; ligule none; sheaths broad, with long silky hairs at mouth; panicle 1–1½ inches long; spikelets 3–4 on short pilose pedicels 6–7 lines long, 4–7 flowered. Flowers unisexual; empty glumes unequal, oblong lanceolate; flowering glumes not included 4–5 lines long; hispid on the margins, and with long silky hairs at base and on sides, deeply bifid; awn one half longer than glume, recurved, flattened, and twisted like a corkscrew; scale fimbriate on the top.

This grass is found at considerable altitudes, and covered by the snows of winter during several months in the year; it forms a very coarse herbage for sheep, although like other species, of the genus, the early growth of spring is more grateful and nutritious; the close compacted mass of stems, leaf sheaths and roots, in this and other *Danthoniœ* become blanched and succulent, and are relished much by wild pigs, which root them up; this food is also extensively eaten by rats, which swarm on the grass lands of the South Island, and are vegetable feeders in those districts.

Collected by J. Buchanan, on the Kaikoura Mountains, and by H. H. Travers, near Lake Guyon, Nelson.

Danthonia semi-annularis, Br.

d. alpina, *Buchanan. n. sub-sp.*

Culms numerous, 12–16 inches high, slender, rigid, glabrous. Leaves as long as the culms, glabrous, filiform, setaceous, excessively numerous; ligule none; mouth of sheath with a very few erect hairs; panicle 1½–2 inches long, of 2–3 short, erect, branches, broad; spikelets ½ inch long, 3–5 on each branch, 4–6 flowered; empty glumes ½ inch long, white, nearly equal, longer than the spikelet; lower flowering glume villous, with tufts of hair at the base and on the sides to above the middle, deeply bifid; lateral awns shorter than the glumes; central awn slightly twisted, flat, as long as the glume, with lateral awns included, reflected or inflected; upper glume truncate or scarcely bifid, not villous; margins of glumes and awns scabrid; the anthers are much longer than in the other varieties.

This variety of *D. semi-annularis* is an abundant grass on the bald-headed mountains of the South Island, near Dusky Bay, forming a close sward of harsh pasture above the limits of bush, the mountains being covered by snow during winter, and its weight bearing so long on the grass, it shows flattened and appressed to the ground on their melting in spring.

The varieties of this species are very wide spread grasses in New Zealand, more common, however, at low altitudes, where they are found diffused over the pastures in single plants or small tufts, and are considered excellent feed for sheep and cattle.

It may perhaps be judged unnecessary to add another variety to the many already known of this variable species, but the habit of this Alpine form, with its succulent roots and confluent tussocks, demands notice.

Collected by J. Buchanan, at Dusky Bay, 1863.

Acœna glabra, Buchanan. n. sp.

A prostrate, perfectly glabrous herb, branches ascending, leafy. Leaves $\frac{3}{4}$ inch long; leaflets 3–4 pairs, coriaceous $\frac{1}{4}$ inch long, obovate or cuneate at the base, deeply cut into 2–3 obtuse teeth on each side; scapes 3 inches long, leafy at the base, with often one small leaf near the middle; heads large, globose; calyx much compressed, unarmed, 4 angled, 2 angles very small, the other 2 much produced, wing-like; petals 4, united at the base, persistent, green, tipped with dark red; bracteolæ entire, or 3 cleft at the point, fimbriate or lacerate on the margins; stamens 2; filaments long; stigma dilated upwards, fimbriate or lacerate on both margins; achene 1, pyriform, suspended from the point.

This very distinct species may easily be distinguished by the regular ascending branches, small coriaceous leaves and large capitulum of flowers, its more exact specific distinctions will be found in the much compressed calyx, the 2 lateral expansions, which are almost produced into wings, and the perfectly glabrous state of all its parts.

Collected on the mountains near Lake Guyon, Nelson, at an altitude of 3,000 feet, by H. H. Travers, February, 1871.

Plate XIV.—Fig. 1. Plant *natural size.* 2. Front view of flower with section at *a b*. 3. Side view of flower with 2 bracteolæ, *c d*. 4. Section of ripe fruit and carpel, showing the suspended seed. 5. Dehisced stamen. 6. Stigma dilated upwards with fimbriate or lacerate margins. All *magnified.*

Celmisia lateralis, Buchanan. n. sp.

A small prostrate, glandular, pubescent plant; rhizome creeping, covered with appressed sheathing scales, branched. Branches ascending, $\frac{1}{2}$ inch long, densely covered with small sheathing leaves. Leaves rigid, erect, $\frac{1}{4}$–$\frac{1}{2}$ inch long, entire, linear, acuminate or obtuse, broader at the sheathing membranous base, acerose, pungent, glabrous on both surfaces, or hispid on the backs of young leaves; margins glandular ciliate. Scapes 2–3 inches long, slender, lateral, solitary or in pairs towards the ends of the main branches; bracts few; linear subulate, very narrow; 2–3 alternate bracteate leaves at base of scape; the whole glandular pubescent. Heads large for the size of the plant, $\frac{1}{2}$–$\frac{3}{4}$ inch diameter involucral scales in 3 series, linear lanceolate, subulate; outer series glandular, inner series glandular and silky; borders white, mem-

J.B. del. et lith.

Acæna glabra, *Buchanan: n. sp.*

Celmisia lateralis *Buchanan, n. sp.*

J.B. del. et lith.

J.B. del. et lith.

Rostkovia novæ Zelandiæ *Buchanan, n. sp.*

branous. Florets numerous, those of the ray $\frac{1}{4}$ inch long, straight or spreading, revolute in old flowers; disc flat, deeply pitted; achene silky.

Collected by H. H. Travers, on the mountains near Lake Guyon, Nelson, March, 1871.

Plate XV.—Fig. 1. Plant *natural size.* 2. Head newly opened. 3. Floret of the disc. 4. Floret of the ray. 5. Arms of style. 6. Gland of style. 7. Stamen. 8. Pappus. 9. Outer involucral scale. 10. Inner involucral scale. All *magnified.*

Rostkovia Novæ Zelandiæ, Buchanan. n. sp.

Culms rising from a creeping rhizome, tufted, rigid, very narrow, 6–8 inches long, terete, finely grooved. Leaves numerous, rigid, very narrow, shining, plano-convex, terete near the top and pungent, each culm sheathed by three leaves to above the middle; leaves $\frac{1}{3}$ longer than the culms, enveloped below by 3 blunt apiculate sheaths. Flowers solitary, terminal, $\frac{3}{4}$ inch long, 1 bracteate; bract membranous $\frac{1}{10}$ inch long, very broad, entire, or sometimes bifid to the base. Perianth of 6 leaflets, pale brown, unequal, 3 outer longest; leaflets linear oblong, acute, with a membranous border; stamens 6, included; anthers long linear; stigma not seen, apparently falling off on the splitting of the capsule; capsule $\frac{1}{2}$ inch long, oblong, acute, bluntly triangular, coriaceous, dark brown, shining, 1 celled, loculicidally dehiscing by splitting at top into 3 valves. Seeds numerous, small, pale coloured, narrow, outer membrane produced at both ends, and thickened on one side, forming a white pearly ridge.

New to New Zealand, and closely allied to *Rostkovia gracilis,* a plant of the Auckland and Campbell Islands, from which it differs in having three short leaves on each culm instead of one long leaf, as described in Hooker's "Antarctic Botany."

Collected by H. H. Travers, on the Nelson mountains, at an altitude of 3,000 feet; and by Dr. Haast, on the mountains of Canterbury.

Plate XVI.—Fig. 1. Plant, *natural size.* 2. Flower. 3. Ripe capsule. 4. Section of capsule. 5. Seed. 6. Old stamen. All *magnified.*

Carex pyrenica, Wahlenburg. n. sub-sp.

A marked variation from this species is found on the mountains of the South Island.

Culms 5–8 inches high. Leaves about equal in length to the culms, soft and erect; spikelet pyriform, dark brown; glumes with a stout nerve; utricle with the beak dark brown and acute; stigmas 2, twisted back in fruit; nut ovate, flattened, smooth, pale brown.

Collected by me on the mountains of Otago; found previously only on the mountains of the North Island. See description of sp. in "Handbook of N.Z. Flora."

Art. XL.—*On the Flora of the Isthmus of Auckland and the Takapuna District.* By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 29th May,* 1871.]

PART II.*

In preparing the account of the flowering plants and ferns of the Isthmus and North Shore, which was laid before our Institute during its last session, a feeling of satisfaction was experienced at the approximation to completeness which was found attainable in that department of botanical investigation: it was obvious that although a few additional species might from time to time be added to the catalogue as the outside corners of the district were more minutely examined, yet no material additions could be expected to the number of forms enumerated. Our knowledge of the flowerless plants of the district is in a much less satisfactory condition, so that this paper must be taken less as an account of the members of this section, than as a statement showing the actual extent of work accomplished in this department of phytological research; although the number of species enumerated greatly exceeds that of the flowering plants, there can be no doubt that at least an equal number remain to be collected.

So far as I am aware, no attempt has hitherto been made to draw up an account of the cryptogamic plants found in the neighbourhood of any of the seats of settlement in this colony. The only account for any district is that published by Dr. Lindsay in his "Contributions to the Botany of New Zealand," for a portion of the Province of Otago, "sixty miles long by an average of five and a maximum of thirty-five broad," and which includes a part of the vicinity of Dunedin. It cannot, however, be taken as a fair account of the cryptogamic flora of that locality, as all mention is omitted of many Cryptogams known to occur within its limits. Making, however, all needful deductions for this and other defects so freely stated by its author, its rich lists of Lichens and Diatoms are invaluable. It can hardly be expected that lists for these families, equally copious and reliable, will, at present, be compiled for any other locality.

In the following catalogue the orders most defective are the Fungi and Algæ. Of the former, it may safely be said that not a tithe of the actual number of the existing forms has been ascertained. The Marine Algæ are nearly confined to forms deposited on the beach after storms, with the addition of the few kinds found growing between tide-marks in the harbour: no attempt at dredging has yet been made.

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* For Part I. see *Trans.* N.Z. Inst., Vol. III., p. 148.

The lists of Mosses and Hepaticæ, as might be expected, are the most complete, and comprise many interesting forms. *Hypnum inflatum,* one of the handsomest mosses in our flora, occurs here, although sparingly. *Campylopus appressifolius,* which appears to be rare in other parts of the colony, is abundant in this limited district. *Didymodon papillatus* is plentiful alike on the scoria hills, the stiff clays, and the sands of the sea shore. *Bryum curvicollum* is common wherever fresh water trickles down the sea cliffs. Several species are extremely local; *Dicranum clathratum* is confined to a solitary habitat: *Hedwigia ciliata,* a common European moss, is restricted to less than a single square yard in its only known habitat in the North Island. *Anomodon Huttoni,* n.s., (originally discovered at Omaha, possesses special interest as being the only member of the genus hitherto discovered in the Australian Colonies. It appears to be confined to New Zealand, but has not been found south of Auckland.

Gales from certain points often deposit particular species of marine Algæ on the shores of the harbour; thus, after easterly gales *Mesogloia intestinalis* is often found in large quantities in Freeman's Bay, accompanied by the curious mollusc, *Solenomya Australis,* northerly gales often bring *Landsburgia quercifolia,* and *Codium tomentosum.* Tidal rocks in the harbour form a favourite habitat for *Hormosira Billardieri,* and rocky tidal pools exhibit a rich growth of *Corallina* and *Jania.* One or two species of *Polysiphonia,* and possibly a *Bostrychia,* are found in situations where they are partially exposed to the influence of fresh water. It must be allowed that the impurities necessarily washed into the harbour from the large city which adorns its banks are unfavourable to the growth of the most attractive members of this order. The terrestrial and fresh-water Algæ are few in number, and unimportant; the paucity of the latter is only what might be expected from the absence of any large streams or canals in the district, and the rarity even of ponds.

Many of the Lichens are extremely local in their habitats. Of the numerous *Graphidæ* collected in the district by Dr. Knight, I have only observed two or three species of *Opegrapha* and *Arthonia.* This is to some extent owing to the destruction of the low-growing shrubs and small trees, which, until within the last six or seven years, adorned many spots on the scoria fields, and partially clothed the base of several of the volcanic hills.

The interesting question of the introduction and diffusion of cryptogamic plants in new countries has been suggested by the occurrence of *Bryum argenteum,* a common European moss, under peculiar circumstances. Although abundant in this district it appears to be extremely rare elsewhere in the colony—the only recorded instance of its discovery being by Dr. Lyall, who obtained a scrap amongst other mosses collected by him in the South Island more than twenty years ago. It is not included in Dr. Lindsay's "Catalogue of Otago mosses," and Mr. Buchanan, who has paid much attention to the bryology of the South Island, informed me that he had searched for it in vain. It was originally discovered in Auckland by Dr. Knight, and subsequently by Captain Hutton and myself, about four or five years ago. Since that time it has become plentiful by road-sides, walks, and on walls, etc., but has not been found at any great distance from the city. When growing on scoria it usually presents a remarkably dull and depauperated appearance, instead of its normal shining aspect, so that, when not in fruit, it is possible for even a good observer to walk over large patches of the plant without noticing it, but when growing on walls it exhibits the glossy and silvery look from which it derives its trivial name.

Its evident rarity in the South Island, and the restricted area to which it appears to be confined in the North, together with its rapid local increase during the last four or five years, when considered collectively, are certainly calculated to suggest the idea of its exotic origin ; an idea which is apparently strengthened by the fact of its comparatively recent recognition in the north, and by its exhibiting no departure from the ordinary European type of the plant; but the slightest examination of these conditions in detail will suffice to show that alone they can afford no support to the theory. Other plants, both Phænogams and Cryptogams, whose nativity here cannot be called in question, occur under exactly similar conditions of abundance in Europe, and rarity in New Zealand ; and if it be further urged that the climatal conditions of these islands would lead us to expect a wide distribution of our plant, the same statement would still apply. I will content myself with citing *Hedwigia ciliata*, the rarity of which in the North Island has been already mentioned, as an instance in point. The apparent rapid increase of our plant, as well as its recent recognition in this locality, may be accounted for by the increase of habitats more suitable for its luxuriant growth than the natural scoria, especially if we remember that, from their nature and situation, plants growing upon them are brought prominently into notice.

But even if this plant exhibited a more rapid increase, extending over a wider area, this could not be taken as evidence of its exotic origin ; for causes attendant upon the progress of settlement have led to the local increase of many plants whose nativity stands unquestioned, but which would be open to suspicion on exactly the same ground. *Azolla rubra*, which some years ago was stated by Mr. Travers to have increased in the province of Canterbury to such an extent as to impede drainage, affords a marked instance of the local increase of a Cryptogam which is decidedly rare in many districts. *Ceratodon purpureus*, a cosmopolitan moss, has increased largely with the development of settlement in the north, and probably throughout the colony. It is, however, a remarkable fact, that, with the exception of certain moulds and other microscopic fungi, we have no cryptogamic plants which can fairly be supposed to have been introduced, although there is no evident obstacle to the introduction of many forms, especially of the annual *Phasca*, *Gymnomitria*, and other genera copiously represented in the northern hemisphere.

From the imperfect state of our knowledge of this section of our local Flora, the important subject of the relation of the number of its species to the Phænogams, and of the various orders of Cryptogams to each other, cannot be touched upon at present; but I may be permitted to indicate the marked contrast afforded by the two sections,—the first comprising species, many or most of which are endemic, while but a few have a wide geographical range, and the last possessing comparatively few endemic species, with many having a wide and even cosmopolitan range.

I have the pleasure of acknowledging my obligations to Dr. Knight, F.L.S., for copious lists of the Mosses and Lichens collected by him in the district. From the following list it will be seen that many of his species have not been observed by me. My thanks are also due to Captain F. W. Hutton, F.G.S., for similar aid with the Mosses.

III.—CRYPTOGAMIA—(*Continued*).*

MUSCI.

Sphagnum.
- cuspidatum, *Ehr.*
- subsecundum, *Nees and Horns.*
- cymbifolium, *Dill.*
- acutifolium, *Ehr.*

Gymnostomum.
- alcareum, *Nees and Horns.*
- tortile, *Schw.*

Weissia.
- controversa, *Hedw.*
- flavipes, *H. f. and W.*
- irroratum, *Mitt.*, Dr. Knight

Symblepharis.
- perichætialis, *W.*

Fissidens.
- asplenioides, *Swartz*
- tenellus *H. f. and W.*
- rigidulus, *H. f. and W.*
- viridulus, *Wahl.*
  - var. acuminatus
- brevifolius, *H. f. and W.*, Dr. Knight
- æruginosus, *H. f. and W.*

Conomitrium.
- Dillenii, *Mont.*

Dicnemon.
- calycynum, *W. and H.*

Leucobryum.
- candidum, *Hampe.*

Dicranum.
- incanum, *Mitt.*, Dr. Knight
- Tasmanicum, *H. f.*
- clathratum, *Mitt.*
- Billardieri, *Brid.*
- Menziesii, *Tayl.*

Dicranodontium.
- flexipes, *Mitt.*

Campylopus.
- introflexus, *Hedw.*
- appressifolious, *Mitt.*
- clavatus, *Br.*, Dr. Knight
- torquatus, *Mitt.*
- leptodus, *Mont.*

Trematodon.
- suberectus, *Mitt.*
- arcuatus, *Mitt.*

Trichostomum.
- mutabile, *Bruch.*
- rubripes, *Mitt.*
- laxifolium, *H. f. and W.*

* See *Trans.* N.Z. Inst., Vol. III., p. 157.

Trichostomum—*continued.*
setosum, *H. f. and W.*
strictum, *Bruch.*
australe, *Mitt.*
Tortula.
Muelleri, *Br. and Schimp.*
australasiæ, *H. f. and W.*
Knightii, *Mitt.*
calycina, *Schw.*
Didymodon.
papillatus, *H. f. and W.*
Ceratodon.
purpureus, *Brid.*
Encalypta.
australis, *Mitt.*, Dr. Knight
Hedwigia.
ciliata, *Ehr.*
Grimmia.
pulvinata, *Sm.*
Schlotheimia.
Brownii, *Schw.*, Dr. Knight
Macromitrium.
longipes, *Schw.*
gracile, *Schw.*
ligulare, *Mitt.*
orthophyllum, *Mitt.*
microphyllum, *H. and Grev.*, Dr. Knight.
prorepens, *Schw.*
Zygodon.
Brownii, *Schw.*
Leptostomum.
gracile, *Br.*
inclinans, *Br.*, Dr. Knight
macrocarpum, *Br.*
Bryum.
truncorum, *Bory.*
campylothecium, *Tayl.*
billardieri, *Schw.*
obconicum, *Horns.*
lævigatum, *H. f. and W.*
argenteum, L.
tenuifolium, *H. f. and W.*, Dr. Knight
blandum, *H. f. and W.*
torquescens, *B. and S.*
curvicollum, *Mitt.*
creberrimum, *Tayl.*
crassum, *H. f. and W.*
cæspiticium, *L.*
chrysoneuron, *C. Muell.*
atro-purpureum, *W. and M.*
Mnium.
rostratum, *Schw.*

Bartramia.
papillata, *H. f. and W.*, Dr. Knight
australis, *Mitt.*
tenuis, *Tayl.*
affinis, *Hook.*
pendula, *Hook.*
sieberi, *Mitt.*
comosa, *Mitt.*
divaricata, *Mitt.*
Funaria.
hygrometrica, *Hedw.*
glabra, *Tayl.*
cuspidata, *H. f. and W.*, Dr. Knight
Physcomitrium.
apophysatum, *Tayl.*
pyriforme, *Bruch. and Schimp.*
Eremodon.
robustus, *H. f. and W.*
octoblepharis, *H. f. and W.*
purpurascens, *H. f. and W.*, Dr. Knight
Polytrichum.
Magellanicum, *Hedw.*
tortile, *Swartz.*
aloides, *L.*
juniperinum, *Hedw.*
commune, *L.*
Cladomnion.
ericoides, *H. f. and* W.
sciuroides, *H. f. and W.*, Dr. Knight
Meteorium.
molle, *H. f. and W.*
cuspidiferum, *Tayl.*
flexicaule, *H. f. & W.*, Dr. Knight
Cryphæa.
Tasmanica, *Mitt.*
Cyrtopus.
setosus, *Brid.*
Phyllogonium.
elegans, *H. f.*
Neckera.
pennata, *Hedw.*
Anomodon.
Huttoni, *Mitt.*, n.s.
Trachyloma.
planifolium, *Brid.*
Isothecium.
sulcatum, *H. f. and W.*
pandum, *H. f. and W.*
arbuscula, *H. f. and W.*
ramulosum, *Mitt.*

Isothecium—*continued*
angustatum, *Mitt.*
pulvinatum, *H. f. and W.*
gracile, *H. f. and W.*
Menziesii, *H. f. and W.*
Kerrii, *Mitt.*
spininervium, *H. f. and W.*
comosum, *H. f. and W.*
comatum, *C. Muell.*

Hypnum.
furfurosum, *H. f. and W.*
fulvastrum, *Mitt.*
læviusculum, *Mitt.*
uncinatum, *Hedw.*
brachiatum, *Mitt.*
hispidum, *H. f. and W.*
umbrosum, *Mitt.*
amœnum, *Hedw.*
crassiusculum, *Brid.*
Jolliffii, *Mitt.*
homomallum, *C. Muell.*
leptorhynchum, *Brid.*
chrysogaster, *C. Muell.*
pubescens, *H. f. and W.*, Dr. Knight
cupressiforme, *L.*
mundulum, *H. f. and W.*
muriculatum, *H. f. and W.*
austrinum, H. *f. and W.*
remotifolium, *Grev.*
tenuifolium, H*edw.*, Dr. Knight
aristatum, H. *f. and W.*
rutabulum, *L.*
plumosum, *Swartz.*
Polygamum, *Br. and Schimp.*
aciculare, *Lab.*
cochlearifolium, *Schw.*

Hypnum—*continued.*
chlamydophyllum, *H. f. and W.*
inflatum, H. *f. and W.*
divulsum, H. *f. and W.*
extenuatum, *Brid.*

Omalia.
pulchella, H. *f. and W.*
oblongifolia, H. *f. and W.*, Dr. Knight
falcifolia, H. *f. and W.*
auriculata, H. *f. & W.*, Dr. Knight

Rhizogonium.
Novæ Hollandiæ, *Brid.*
bifarium, *Schimp.*
mnioides, H. *f. and W.*

Hypopterygium.
viridulum, *Mitt.*
Novæ Zelandiæ, *C. Muell.*
discolor, *Mitt.*
tamariscinum, *Sull.*
struthiopteris, *Brid.*

Cyathophorum.
pennatum, *Brid.*

Calomnion.
lætum, H. *f and W.*

Racopilum.
strumiferum, *C. Muell.*
lætum, *Mitt.*
robustum, H. *f. and W.*

Hookeria.
amblyophylla, H. *f. and W.*
adnata, H. *f and W.*
pulchella, H. *f. & W.*, Dr. Knight
microcarpa, H. *f. and W.*
quadrifaria, *Sm.*
nigella, H. *f. and W.*
cristata, *Arn.*

HEPATICÆ.

Jungermannia.
monodon, H. *f. and T.*
colorata, *Lehm.*

Temnoma.
pulchella, *Mitt.*

Chandonanthus.
squarrosus, *Mitt.*

Trigonanthus.
dentatus, *Mitt.*

Solenostoma.
inundata, *Mitt.*

Plagiochila.
Stephensoniana, *Mitt.*
fasciculata, *Lindb.*

Phogiochila—*continued.*
microdictyum, *Mitt.*
annotina, *Lindb.*
Sinclairii, *Mitt.*

Lophocolea.
pallida, *Mitt.*
Novæ Zelandiæ, *Nees*
bidentata, *Nees*
spinifera, *H. f.*

Gottschea.
Balfouriana, *H. f. and T.*
repleta, *H. f. and T.*
unguicularis, *H. f. and T.*
appendiculata, *Nees*

Chiloscyphus.
    Billardieri, *Nees*
    fissistipus, *H. f. and T.*
    decipiens, *Gottsch.*
    chlorophyllus, *Mitt.*
Tylimanthus.
    saccatus, *Mitt.*
Balantiopsis.
    diplophylla, *Mitt.*
Saccogyna.
    australis, *Mitt.*
Lepidozia.
    prænitens, *Lehm. and Lindb.*
    spinosissima, *Mitt.*
    capillaris, *Lindb.*
Mastigobryum.
    Taylorianum, *Mitt.*
    Novæ Hollandiæ, *Nees*
    Novæ Zelandiæ, *Mitt.*
Trichocolea.
    tomentella, *Nees*
    lanata, *Nees*
Sendtnera.
    attenuata, *Mitt.*
    flaggelifera, *Nees*
Polyotus.
    claviger, *Gottsch.*
Radula.
    plicata, *Mitt.*
    complanata, *Dum.*
    marginata, *H. f. and T.*
Madotheca.
    Stangeri, *Gottsch.*
Lejeunia.
    lævigata, *Mitt.*
    olivacea, *H. f. and T.*
    papillata, *Mitt.*
    rufescens, *Lindb.*
    tumida, *Mitt.*
Frullania.
    squarrosula, H. *f. and T.*
    pycnantha, H. *f. and T.*
    spinifera, H. *f. and T.*
    reptans, *Mitt.*
    pentapleura, H. *f. and T.*
Fossombronia.
    pusilla, *Nees*
Podomitrium.
    phyllanthus, *Mitt.*
Steetzia.
    Lyellii, *Nees*
    tenuinervis, H. *f. and T.*
Symphyogyna.
    leptopoda, H. *f. and T.*
    hymenophyllum, *Mont.*
    rhizobola, *Nees*
    sub-simplex, *Mitt.*
Metzgeria.
    furcata, *Nees*
Aneura.
    alterniloba, H. *f. and T.*
    palmata, *Nees*
    pinnatifida, *Nees*
    multifida, *Dumort.*

MARCHANTIEÆ.

Plagiochasma.
    australe, *Nees*
Marchantia.
    tabularis, *Nees*
Dumortiera.
    ? hirsuta, *Nees*
Reboulia.
    hemisphærica, *Raddi.*
Fimbriaria.
    australis, H. *f. and T.*
Targionia.
    hypophylla, *L.*
Anthoceros.
    lævis, *L.*
    Jamesoni, *Tayl.*
    Colensoi, *Mitt.*
Riccia.
    natans, *L.*

CHARACEÆ.

Nitella.
    hyalina, *Agardh.*
    Hookeri, *Braun.*
Chara.
    fragilis, *Desv.*

LICHENES.

Collema.
- flaccidum, *Ach.*
- leucocarpum, *Bab.*, Dr. Knight
- plicatile, *Ach.* ,,
- contiguum, *Knight and Mitt.* ,,

Leptogium.
- tremelloides, *Fries.*

Calicium.
- curtum, *Borr.*

Sphærophoron.
- compressum, *Ach.*
- tenerum, *Laur.*

Bæomyces.
- rufus, *DC.*
- roseus, *Pers.*

Cladonia.
- pyxidata, *Fries.*
- fimbriata, H*offm.*
- gracilis, H*offm.*
- rangiferina, H*offm.*
- aggregata, *Gschw.* Dr. Knight
- macilenta, H*offm.* ,,

Stereocaulon.
- ramulosum, *Ach.*

Usnea.
- barbata, *Fries.*
  - var. florida
  - ,, articulata
  - ,, ceratina

Ramalina.
- calicaris, *Fries.*
  - var. fraxinea
  - ,, fastigiata
  - ,, farinacea
  - ,, Eckloni, Dr. Knight

Platysma.
- cæpincola, H*offm.*

Nephroma.
- australe, *A. Rich.*, Dr. Knight

Peltigera.
- rufescens, H*offm.* var. spuria
- polydactyla, H*offm.*

Sticta.
- argyracea, *Delise.*
- fragillima, *Bab.*, Dr. Knight
- crocata, *Ach.*
- carpoloma, *Delise.*
- damæcornis, *Ach.*
- variabilis, *Ach.*
- cinereo-glauca, *Tayl.* Dr. Knight
- orygmæa, *Ach.*
- aurata, *Ach.*

Sticta—*continued*
- fossulata, *Duf.*
- Freycinetii, *Delise*, Dr. Knight

Ricasolia.
- coriacea, *Nyl.*, Dr. Knight.
- Montagnei, *Nyl.*

Parmelia.
- caperata, *Ach.*
- perforata, *Ach.*
- perlata, *Ach.*
- saxatilis, *Ach.*
- conspersa, *Ach.*
- olivacea, *Ach.*, Dr. Knight.
- physodes, *Ach.*
- pertusa, *Sch.*, Dr. Knight.
- parietina, *Ach.*
- speciosa, *Ach.*
- stellaris, *Ach.*

Psoroma.
- sub-pruinosum, *Nyl.*, Dr. Knight
- sphinctrinum, *Nyl.* ,,

Pannaria.
- nigrocincta, *Nyl.*, Dr. Knight.

Placodium.
- elegans, *DC.*

Lecanora.
- chyrosticta, *Tayl.*, Dr. Knight
- aurantiaca, *Ach.*, v. lignicola ,,
- vitellina, *Ach.*
- parella, *Ach.*
- subfusca, *Ach.*
- varia, *Ach.*
- atra, *Ach.*, Dr. Knight

Urceolaria.
- scruposa, *Ach.*

Thelotrema.
- lepadinum, *Ach.*

Cœnogonium.
- inflexum, *Nyl.*, Dr. Knight

Lecidea.
- intermixta, *Nyl.*, Dr. Knight
- vernalis, *Ach.*
- rosella, *Ach.*
- mamillaris, *Duf.*
- parasema, *Ach.*
- atro-alba, *Flotow.*
- contigua, *Fries.*

Graphis.
- scripta, *Ach.*, Dr. Knight.
- anguina, *Mont.* ,,
- elegans, *Ach.* ,,
- sculpturata, *Ach.* ,,

Graphis—*continued.*
confinis, *K. and M.*, Dr. Knight
insidiosa, *K. and M.* „
inquinata, *K. and M.* „
Opegrapha.
varia, *Pers.*
atra, *Ach.*
herpetica, *Ach.*, Dr. Knight
cinerea, *K. and M.* „
prominula, *K. and M.* „
Platygraphis.
microsticta, *K. and M.* „
inconspicua, *K. and* M. „
tumidula, *K. and* M. „
occulta, *K. and M.* „
Plagiographis.
devia, *K. and* M., Dr. Knight
rubrica, *K. and* M. „
Arthonia.
lurida, *Ach.*, Dr. Knight
pruinosa, *Ach.*
astroidea, *Ach.*, Dr. Knight
lobulata, *K. and* M. „
indistincta, *K. and M.* „

Arthonia—*continued.*
albida, *K. and M.*, Dr. Knight
ramulosa, *K. and M.* „
ampliata, *K. and M.* „
nigro-cincta, *K. and M.* „
Melaspilea.
deformis, *Nyl.*, Dr. Knight
Endocarpon.
hepaticum, *Ach.*
Verrucaria.
maura, *Wahl.*
epidermidis, *Ach.*, Dr. Knight
minutella, *Knight* „
binucleolata, *Knight* „
magnospora, *Schrad.*, *Knight* „
glabrata, *Ach.* „
var. cinereo-alba
nitida, *Schrad.* „
moniliformis, *Knight* „
deliquescens *Knight* „
pyrenastroides, *Knight* „
cellulosa, *Knight* „
Haultainii, *Knight* „

FUNGI.

Agaricus.
clypeolarius, *Bull.*
umbelliferus, *L.*
adiposus, *Fries.*
campestris, *L.*
arvensis, *Schœff.*
campigenus, *Berk.*
Panus.
stypticus, *Fries.*
Schizophyllum.
commune, *Fries.*
Polyporus.
lucidus, *Fries.*
adustus, *Fries.*
igniarius, *Fries.*
australis, *Fries.*
versicolor, *Fries.*
Thelephora.
vaga, *Berk.*
Stereum.
phæum, *Berk.*
latissimum, *Berk.*
Clavaria.
lutea, *Vitt.*
arborescens, *Berk.*
crispula, *Fries.*

Hirneola.
auricula-Judæ, *Berk.*
polytricha, M*ont.*
Aseroe.
rubra, *Lab.*
Ileodictyon.
cibarium, *Tul.*
Secotium.
erythrocephalum, *Tul.*
Lycoperdon.
Fontanesei, *Dur. and Lér.*
cælatum, *Fries.*
gemmatum, *Fries.*
Scleroderma.
vulgare, *Fries.*
Æthalium.
septicum, *Fries.*
Didymium.
australe, *Berk.*
Cyathus.
Novæ Zelandiæ, *Berk.*
Colensoi, *Berk.*
Crucibulum.
vulgare, *Berk.*
Phoma.
acmella, *Berk.*

Pilidium.
 coriariæ, *Berk.*
Puccinia.
 graminis, *Pers.*
Uromyces.
 scariosa, *Berk.*
Ustilago.
 urceolorum, *Tul.*
 endotricha, *Berk.*
Æcidium.
 Ranunculacearum, *DC.*
 disseminatum, *Berk.*
Epicoccum.
 pallescens, *Berk.*
Peziza.
 endocarpoides, *Berk.*
 stercorea, *Fries.*
 calycina, *Fries.*
Asterina.
 torulosa, *Berk.*
Excipula.
 nigro-rufa, *Berk.*
 gregaria, *Berk.*
Cordiceps.
 Sinclairii, *Berk.*
Xylaria.
 Hypoxylon, *Fries.*
Dothidea.
 filicina, *Mont.*
 Colensoi, *Berk.*
Sphæria.
 fragilis, *Berk.*
 pullularis, *Berk.*
 rasa, *Berk.*
 herbarum, *Pers.*
 cryptospila, *Berk.*
Chætomium.
 amphitrichum, *Corda*
 elatum, *Kunze*

ALGÆ.

Sargassum.
 plumosum, *A. Rich.*
 Sinclairii, *H. f. and W.*
Carpophyllum.
 Maschalocarpus, *H. f.*
Phyllospora.
 comosa, *Agardh.*
Cystophora.
 retroflexa, *J. Agardh.*
Landsburgia.
 quercifolia, *Harv.*
Fucodium.
 gladiatus, *J. Agardh.*
Hormosira.
 Billardieri, *Mont.*
Splachnidium.
 rugosum, *Grev.*
Sporochnus.
 stylosus, *Harv.*
Desmarestia.
 ligulata, *Lam.*
Ecklonia.
 radiata, *J. Agardh.*
Dictyota.
 Kunthii, *Agardh.*
 dichotoma, *Lam.*
Chorda.
 lomentaria, *Lyngb.*
Scytothamnus.
 australis, *Hook. f. and Harv.*
Mesogloia.
 intestinalis, *Harv.*
Sphacelaria.
 paniculata, *Suhr.*
Ectocarpus.
 granulosus, *Agardh.*
 siliculosus, *Lyngb.*
Bostrychia.
 mixta, *H. and Harv.*
Polysiphonia.
 Colensoi, *H. f.*
 dendritica, *H. f. and Harv.*
 pennata, *Agardh.*
 variabilis, *Harv.*
 isogona, *Harv.*
 aterrima, *H. f.*
Laurencia.
 elata, *Harv.*
 virgata, *J. Agardh.*
Cladhymenia.
 Lyallii, *Hook. and Harv.*
Corallina.
 armata, *Hook. f. and Harv.*
 officinalis, *L.*
Jania.
 Cuvieri, *Dec.*
Melobesia.
 calcarea, *Harv.*
Delesseria.
 Leprieurii, *Mont.*

Nitophyllum.
palmatum, *Harv.*
denticulatum, *Harv.*
Phacellocarpus.
Labillardieri, *J. Agardh.*
Gracilaria.
confervoides, *Grev.*
Gelidium.
corneum, *Lam.*
Caulacanthus.
spinellus, *Kuetz.*
Pterocladia.
lucida, *J. Agardh.*
Apophlœa.
Sinclairii, *Harv.*
Rhodymenia.
linearis, *J. Agardh.*
Plocamium.
costatum, *H. f. and Harv.*
angustum, *Hook. f. and Harv.*
coccineum, *Lyngb.*
Stenogramme.
interrupta, *Mont.*
Gigartina.
pistillata, *Gmel.*
Dumontia.
filiformis, *Grev.*
Ceramium.
virgatum, *H. f.*
rubrum, *Agardh.*
uncinatum, *Harv.*
Ptilota.
formosissima, *Mont.*
Griffithsia.
setacea, *Agardh.*
Ballia.
callitricha, *Mont.*
Callithamnion.
Rothii, *Lyngb.*
brachygonum, *Harv.*
Codium.
tomentosum, *Agardh.*
Vaucheria.
Dilwynii, *Agardh.*
Porphyra.
laciniata, *Agardh.*
vulgaris, *Agardh.*
Ulva.
latissima, *L.*
crispa, *Lightf.*
Enteromorpha.
compressa, *Grev.*
Bangia.
ciliaris, *Carm.*
Batrachospermum.
moniliforme, *Roth.*
Cladophora.
pellucida, *Kuetz.*
Conferva.
ærea, *Dill.*
linum, *L.*
Chroolepus.
aureus, *Harv.*

Art. XLI.—*On the Nativity in New Zealand of* Polygonum aviculare, *L.*

By T. Kirk, F.L.S..

[*Read before the Auckland Institute, 26th June,* 1871.]

At page 336 of the *Transactions* of the New Zealand Institute for 1870, Mr. Travers has given prominence to a difference of opinion that exists between us on the question of the nativity of *Polygonum aviculare*, L., in the colony. As his conclusion that it is of exotic origin does not appear to me to be supported by the facts of the case, I purpose briefly stating the conditions under which the plant occurs, and placing on record one or two interesting points connected with its distribution.

The only alleged or inferential reason adduced by Mr. Travers in support of his view is comprised in the following statement:—"The natives, moreover, who suffer much inconvenience from its spread, call it a 'pakeha' or foreigner."

I must point out that this statement is essentially misleading, as it is true only of a portion of the South Island, and does not in any way apply to the North Island, or to the northern portion of the South Island.

In the North Island this plant exhibits exactly similar characteristics of abundance and luxuriance to those which it manifests in the British Islands. It is commonly found by road sides and on waste land, on cultivated land, and on grassy places in the forest. I have not observed it at a greater altitude than 1,800 or 1,900 feet, but there can be little doubt that it will be found at a greater height on the central ranges. I never met with an instance of its occurring in native cultivations to such an extent as to cause "much inconvenience," and the same remark applies to its occurrence in the more extended cultivations of the settlers. I may add that around the chief seats of settlement in the North Island—Auckland, Napier, New Plymouth, and Wellington—also about Nelson in the South Island, it occurs under the same relative conditions as to extent and luxuriance that have just been described. It nowhere obtrudes itself upon the attention of a new-comer from occurring in greater abundance than in ordinary localities in the British Islands, and I am satisfied, from close observation during the past eight or nine years, that it has not increased in a greater ratio than might fairly be expected from the increase of favourable habitats afforded by the spread of agricultural operations. This view of the case is supported by the direct testimony of old settlers and missionaries; our president states that the plant has, to his personal knowledge, held the same relative position for the past thirty years that it now occupies.

In the middle and southern part of the South Island the Knot-grass has increased excessively: at present, however, it does not appear whether the typical form of the plant participates in this increase or not. So far as the evidence in my possession is precise on the point, it refers only to the var. *Dryandri.* In the "Natural History Review" for October, 1864, Mr. Travers writes:—"This plant (*Polygonum aviculare*) grows with extraordinary vigour all over the country (Canterbury), where the soil has been at all disturbed, completely replacing the native plants. Its roots often penetrate to the depth of three and four feet,"—and in an earlier number of the same periodical it was stated on the authority of Mr. Travers that plants "spread over an area four to five feet in diameter." In the "Handbook of the New Zealand Flora," the typical form is stated to have been collected by M. Raoul on Banks Peninsula, thirty years ago, and the var. *Dryandri* at Port Cooper, by Dr. Lyall, eight or ten years later. I possess a Christchurch specimen of the variety labelled "*P. aviculare,*" collected by Mr. Armstrong, who remarks that it is found "in great abundance and spreading with great rapidity." In the "Handbook" it is also stated that the variety *Dryandri* "covers acres of ground by road-sides in Otago." It is certainly desirable to ascertain whether the typical form exhibits the same power of rapid increase as the variety. In the North Island the variety is recorded from the East Coast on Mr. Colenso's authority, but I cannot learn that it exhibits the strongly marked facility of propagating itself which it manifests in the south. The only locality in which I have collected it is on the Great Barrier Island, where, in 1867, it was rather plentiful on a small patch of ground at Puriri Bay, but was not observed elsewhere; strange to say on searching the locality in March last, I failed to find a single specimen! while the typical form appeared to have neither increased nor diminished since my previous visit.

The peculiar eastern distribution of the variety *Dryandri* is certainly singular, and taken in conjunction with its excessive abundance and rapid increase in the south may possibly justify suspicion as to the exotic origin of this particular form; but, unless supported by more direct evidence, this is quite inadequate to warrant a positive conclusion on the subject, especially in the absence of any similar increase in the north, with its more advantageous climatal conditions. In no case can this affect the question of the introduction of the typical form; even should it be proved that this exhibits in the south the rapid diffusion which is so strongly marked in the variety, the fact will still remain that during actual observation, extending over thirty years, the peculiarity has not been evidenced in at least two-thirds of the colony.

But arguments in favour of exotic origin, based, as in the present case, solely upon the abundance and rapid increase of a plant in certain localities, cannot in any case be considered conclusive in the face of the remarkable increase exhibited by plants whose nativity is unquestioned. Mr. Travers himself has placed a marked instance on record: I select it chiefly from its occurring in the same district as the subject of this paper. In the article from which I have already quoted, Mr. Travers states that "*Azolla rubra* is rapidly increasing, and utterly impedes the progress of draining in the lower and more level tracts of the country." A startling phenomenon, as compared with the conditions under which this plant occurs in the north; yet, I imagine, no one would think of suggesting the great abundance and rapid increase of *Azolla*, in the province of Canterbury, as evidence of its exotic origin in that province, much less in the colony at large.

It is singular that Mr. Travers should adduce the opinion of the natives as evidence of the exotic origin of the Knot-grass, when he has seen fit to reject it with regard to the introduction of the Flesh-fly, of which he has given so interesting an account in the last volume of the *Transactions*. My own experience has led me to the conclusion that native evidence on questions of this kind is usually worthless, and it is commonly stated by the old residents and missionaries that the Maoris of the present day are greatly inferior to those of one or two generations back as observers of natural phenomena. Any person who may take the trouble to inquire the names of even common plants from the Maoris, will quickly find the same name applied to very different plants—no two individuals agreeing in their application. In the Waikato I have heard the common Ngaio (*Myoporum lætum*) called a "pakeha" tree.

The causes of the rapid diffusion of plants in certain localities are often obscure, but in all cases are worthy the attention of observers resident in the localities where their operations are exhibited. Many curious instances of the local diffusion of rare plants will be readily called to mind by the student of European floras—the viatical plants especially, to which the subject of this paper belongs, furnish an assemblage of remarkable phenomena of this kind.

ART. XLII.—*Notes on the New Zealand* Asteliads, *with Descriptions of New Species.* By T. KIRK, F.L.S.

[*Read before the Auckland Institute,* 31*st July,* 1871.]

I HAVE delayed the publication of the following notes chiefly from a strong desire to procure alpine specimens of the genus for comparison with the lowland forms, but so far, I regret to say, with but little success. As few genera of New Zealand plants present greater difficulties than *Astelia* to the student of herbarium specimens only, and on the other hand few are more facile of discrimination when the ripe fruit is available for examination, it seems advisable to place the knowledge already gained on permanent record with a view of facilitating further inquiry.

In the "Flora Novæ Zelandiæ" five species were described, and although numerous dried specimens were forwarded to Dr. Hooker between the publication of that work and the "Handbook of the New Zealand Flora," an interval of twenty years, no positive additions were made to our knowledge of the genus, notwithstanding that special attention was drawn by the learned editor to the desirability of a revision of the characters laid down.

Although the genus, even with recent additions, contains but seven or eight species, it yet occupies a prominent place in the vegetation of the colony. The geographical distribution of the species is at present imperfectly worked out, but it is known that *Astelia Solandri* and *A. grandis* are found from the North Cape to Invercargill. The former, called by the natives "Kaha-kaha," is abundant, usually growing on the limbs of trees, where it forms masses resembling the nests of immense birds; it is equally common on rocks, especially in woods. The latter, called the "Kakaha," is not unfrequent in swamps and marshy gullies, and is the largest species of the genus, its leaves being sometimes 8 to 9 feet in length, and 5 inches in breadth.

Another species, *A. trinervia*, forms a large portion of the forest undergrowth from the extreme north to the Upper Waikato, and probably much further south. *A. Banksii* is abundant on sheltered sea cliffs, within much the same limits, and the diminutive *A. linearis* forms large patches on the mountains from the Ruahine southward to Lord Auckland's group and Campbell Island. All the New Zealand species are endemic.

The general diffusion of the epiphytal *A. Solandri*, and its prominence in all pictures of forest scenery, have doubtless given rise to the erroneous idea that all the large-growing species are epiphytal. In the "Flora, N.Z.," it is stated that "the large kinds usually form striking objects on the lofty New Zealand forest trees," and in the "Handbook" that "the New Zealand species are all diœcious, and from growing on lofty forest trees it is difficult to match the sexes." *Astelia Banksii* is specially stated to occur on the limbs of forest trees, but the fact is that only two species are epiphytic, *A. Solandri* and *A. Cunninghamii*; the latter rarely or never occurs in large masses so as to form a conspicuous object in the forest. *Astelia trinervia*, the most abundant of all the species, in the north at least, is invariably terrestrial, as is *A. Banksii*. *A. grandis* is uliginal, and *A. Hookeriana* rupestral.

All the species are characterized by linear leaves, with broad sheathing bases, more or less silky or shaggy; yet in its habit of growth each species exhibits marked points of difference, which are easily recognized when once pointed out, and in nearly every case the mature fruit alone affords character which cannot be mistaken. The branches of the male panicles are often flexuous and interlaced, especially in *A. trinervia*, *A. Cunninghamii*, and *A. Banksii*; those of the female panicles are rigid and erect, except in *A. Solandri*. In *A. trinervia*, *A. Hookeriana*, and *A. Cunninghamii*, the elongated scapes are weak and prostrate in fruit; in *A. Solandri* the scape itself is erect, and the branches pendulous; in *A. grandis* the stout triquetrous scape, and rigid erect branches, alone suffice to distinguish that species from its congeners, and in *A. Banksii* the scape, although slender, is invariably erect. The leaves of several species are covered on one or both surfaces with a thin pellicle, which can be detached in long strips.

The flowers of *A. Solandri* are highly attractive, their bright lemon colour forms a marked contrast with the surrounding foliage, and the plant itself calls vividly to mind descriptions of tropical forest scenery. Some of its immense female panicles contain from 4,000 to 5,000 flowers, and are succeeded by the bright crimson fruit, no less showy. The bright maroon hue of the flowers of *A. Cunninghamii* is also attractive, but in a much less degree; the handsome erect black purple fruit of *A. Banksii* is remarkably striking; and the orange coloured berries of *A. grandis* may be detected at a considerable distance. All the large kinds are sought after when in flower by bees.

A remarkable phenomenon exhibited by this genus is the varying period required by the respective species for maturing the fruit, which may be roughly stated at from five to fifteen months. *A. Hookeriana* occupies the longest period, the flowers of the present season and the immature fruit of the last may be plucked together about the middle of April. *A. Cunninghamii* flowers in December, and requires a year to ripen its fruit. *A. Banksii* flowers in April; fruit ripens the following March. *A. trinervia* flowers in March and April, and ripens its fruit in January and February. *A. Solandri* flowers in January and February, and requires only five months to ripen its fruit. *A. grandis* usually attains its maximum of flowering about the middle of October, and has shed its fruit by the end of February.

The perianth is more or less persistent in all the species, but can only be said to inclose the ripe fruit in *A. nervosa* and *A. grandis*—the former is described by Dr. Hooker as "having the ovary sunk in the baccate tube of the perianth." In *A. grandis* the perianth is slightly thickened, and surrounds the lower portion of the fruit, becoming reflexed and coloured internally as the berries fall. In all the other species, except perhaps *A. linearis*, the perianth becomes chaffy as the fruit ripens; it is least persistent in *A. Hookeriana*. All the lowland forms produce *staminodia*.

The placentation varies in different species; in *A. Cunninghamii*, *A. Hookeriana*, and *A. linearis*, the berry is one-celled, with parietal placentæ, but in the second of these the placentæ are as a rule rudimentary; the seeds are terete, and attached to the placentæ by short funiculi. In the remaining species the berry is three, or rarely five-celled, with black, shining, angled seeds usually suspended from the upper central angle of the cell. The fruit of all the species contains more or less mucilage.

The remarkable similarity in the structure of the seed to that of *Juncus* has led Lindley and other systematists to refer the genus to *Junceæ*; but this resemblance is confined to the internal structure; in the thick, hard, and black testa it differs from all members of that order, and still further in the diœcious flowers, the perianth united above the base, the terete filaments, short anthers, the minutely granulated pollen, and the short three-lobed stigma.

At present the members of this genus have scarcely been applied to economic purposes in the colony. I have been informed that some years ago considerable quantities of the shaggy leaf-bases of *A. Solandri*, the "tree-flax" of the settlers, were collected in the Kaipara, and purchased by an agent, who shipped them to Melbourne, but no one seems to know the object for which they were collected. The leaves of *A. trinervia* are extensively used for thatching, and the delicate pellicle with which they are invested has been worked into a charming trimming for ladies' bonnets; the same remark applies to *A. Solandri.* This pellicle, I am informed, was also used in the early days of the colony for the wicks of bush-manufactured candles. The shaggy leaf-bases of *A. Banksii,* and other species, are said to have been made into mantles by the Maoris, but I have not had the good fortune to see one* ; in softness their silky covering rivals the finest swan down. The fruit of *A. Banksii* is eaten apparently by birds, but by what kinds is unknown. I have seen hundreds of plants stripped of their fruit within a day or two of its becoming ripe, without a trace being left on the ground ; possibly rats may be concerned in the theft. The fruit of *A. Solandri* makes a clear, pleasant jelly. When the leaves of *A. trinervia* are cut down a large quantity of a dark jelly-like gum is exuded, but I am not aware that it has been applied to any useful purpose ; if of economic value, it may be procured in large quantities at certain periods of the year, as it is often so plentiful along surveyors' newly-cut lines, in districts where the plant abounds, as to prove an inconvenience in walking.

There can be no doubt that *A. trinervia, A. Solandri,* and *A. Banksii,* afford a material superior to *Phormium* for the manufacture of paper, and that it could be supplied in almost unlimited quantities.

Perhaps I may be pardoned for adding that in an account of Cook's New Zealand explorations, published in the colony, the author has strangely identified *A. Banksii,* or *A. Cunninghamii* (I forget which), with the "scurvy-grass," (*Lepidium oleraceum,* Forst.) of that distinguished voyager. *Phormium tenax* would be far more easily masticated.

At a future period I hope to prepare a monograph of the New Zealand species. The uncertainty existing as regards the original specimens of Banks and Solander, and the almost total absence of alpine and subalpine specimens for comparison with the lowland forms, renders this impossible at present. The following descriptions, therefore, relate only to forms not included in the "Handbook of the New Zealand Flora."

Astelia Cunninghamii, Hook. f.

Sub-species, *A. Hookeriana.*

Hamelinia veratroides, A. Rich., Flor. 158, t. 24, (Flower only).

Tufted, leaves linear, 1–3 feet long, clothed with snow-white silky hairs at the base ; points long, hairy or silky below, usually glabrous above ; nerves about ten, one prominent on each side ; scapes slender, with long silky hairs.

*[The following may be useful for reference :—"Leaves and Down from the Kaha-kaka (*Astelia,* sp.), exhibited by T. B. Gillies, Esq.—A North Island plant that grows in poor clay soil. This down makes excellent pillows, quite equal to feathers, and will probably form a useful paper material. The bulbous part of this plant, as exhibited, yields 10 per cent. of this down."—"Cat. N.Z. Exhib., 1865, p. 73.]—Ed.

Male.—1–2 feet long; panicle 6 to 12 inches; branches numerous, slender, ascending, drooping at the tips, usually in threes, or giving off branchlets at the base, with linear acuminate, nerved, concave, silky, or hairy bracts, one foot long or more; flowers numerous, on rather long bracteolate pedicels; perianth rotate; segments glabrate, ovate-lanceolate, membranous, claret-coloured; filaments short, subulate; anthers oblong. *Female.*—Scape, bracts, etc., as in the male, much branched; branches strict; flowers numerous, on slender silky pedicels; perianth small, rotate; segments ovate; ovary conical, one-celled; stigma trifid, somewhat elongated. Berry one-celled, globose, black; placentæ scarcely perceptible; seeds terete.

On rocks, Little Barrier Island, Auckland.

Flowers in April.

The most elegant of the New Zealand forms; the branches of the male panicle are never interlaced as in typical *A. Cunninghamii*, so that it is readily distinguished by the peculiar habit, and by the limited development of the placentæ in the mature fruit. The deep claret-coloured flowers are produced in April, and the fruit requires over a year to arrive at maturity.

Hamelinia veratroides, A. Rich., doubtfully quoted by Dr. Hooker as a synonym of *A. Banksii*, is identical with our plant, as is evident from the fine drawing of the female scape, although the section of the ovary is that of *A. Banksii.* The diagnosis also appears to have been drawn up from specimens of both forms. In Hooker's drawing the lower part of the scape is represented as stouter than the upper; the reverse is the case in all the species, not excepting *A. grandis.*

Dr. Hooker, referring to *A. Cunninghamii*, states, "Very like *A. Banksii*, but differs in the larger flowers, ovary, fruit, and seeds." I find the opposite to be invariably the case. *A. Cunninghamii*, with its globose berry and terete seeds, is of smaller size in all its parts, and of more slender habit than *A. Banksii*, with its ovoid berry and sharply angled seeds.

Astelia grandis, Hook f. Ms. n. s.

Stout, tufted; leaves 2–6 feet long, erect, 2–4 inches wide, many-nerved, with one principal nerve on each side of the leaf, about one-fourth of the entire width of the leaf from each margin. *Male.*—Scape very stout, six inches to $1\frac{1}{2}$ feet high, thickening upwards to the base of the panicle where it is sometimes $1\frac{1}{2}$ inches in diameter, triquetrous, hairy or downy; panicle 4–12 inches long or more, much branched, flexuose; bracts at the base of each branch lanceolate acuminate, many-nerved, silky or downy below; sometimes 2 feet long or more, and over 2 inches wide; branches stout, furrowed; flowers crowded on short pedicels, with ovate-lanceolate bracteolæ; perianth rotate; segments ovate-lanceolate, or ovate, ultimately recurved; filaments subulate; anthers oblong. *Female.*—Scape and bracts as in the male; branches much shorter, erect; flowers crowded; sessile on very short stout pedicels, glabrous or downy; perianth segments small, reflexed; ovary conical, furrowed; style short, divided. Berry three-celled, with a short stout style, partially inclosed by the tube of the perianth, ⅜″ in diameter; seeds black, 1–5 in each cell, sharply angled.

In marshy gullies, etc., North Island, not unfrequent, *T.K.*; South Island, Otago, *J. Buchanan.*

Flowers in October; fruit mature in February.

Easily recognized by its large size, dark green scape, and flowers, and lobed, orange-coloured berries, partially enclosed in the green perianth tube.

Shortly before expansion the male flower buds resemble sun-flower seeds in shape, size, and colour. The remarkable development of the bractlets is characteristic of this species; in the male panicle they are often shaggy and flexuose, or contorted; each branch is usually terminated by a pair of bracteolæ, sometimes 1″ long; pedicels developed on the ridges of the branches. Fruit deep orange, stains paper; the perianth becomes reflexed when the berry falls, and is coloured internally.

A solitary male panicle exhibited a curious aberration. One-third of the flowers on the upper branches had the short segments of the female perianth, with very short filaments and imperfectly developed anthers.

Astelia trinervia, n.s.

Stout, tufted; leaves 2–5 feet long, plaited, broadly recurved, pale green, the strong nerve on each side of the leaves closely supplemented by three others, forming a strong triple nerve. Flowers: *Male.*—Scape slender, woolly; branches flexuose and interlaced; bracts membranous, silky, many nerved; pedicels slender, but apparently stout from being clothed with loose wool; perianth rotate; segments lanceolate acuminate; filaments subulate; anthers broad. *Female.*—Scape as in male; bracts narrower, more leafy than in the male; branches few, short, erect, silky, or woolly; segments of perianth erect, narrow, short; ovary globose. Berry large, globose, deep crimson, three-celled; stigma sessile; seeds sharply angled, suspended from the inner angle of the cell; testa hard; scape prostrate in fruit.

In hilly forests, from the North Cape to the Upper Waikato. The most abundant species. Leaves often so closely interlaced as to impede walking.

Flowers March to April; fruit mature in February.

Distinguished from its nearest ally, *A. Banksii*, by its green plaited leaves, with triple nerves, prostrate fruit scape, and globose crimson berry.

The "Kauri-grass," of the settlers, ascends from the sea level to 2,000 feet.

I am indebted to Mr. H. Travers for an immature fruited specimen of an

Astelia, from the Chatham Islands, doubtless identical with the form mentioned by Dr. Hooker at page 744 of the "Handbook," and referred by him to *A. Menziesii,* Sm. In Baron Mueller's account of the vegetation of the Chatham Islands, he refers a fruited specimen collected by Mr. Travers to *A. Banksii,* as he incidentally points out that *A. veratroides,* Gaud., which is identical with *A. Menziesii,* Sm., is distinct from *A. Banksii* ; it appears that the specimen submitted to him differs from those given to Dr. Hooker and myself, but in any case the specimen in my possession cannot be identified with any known New Zealand species.

Art. XLIII.—*A Comparison of the Indigenous Floras of the British Islands and New Zealand.* By T. Kirk, F.L.S.

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The traveller who may expect to find some of the more remarkable plants of the New Zealand Flora immediately on his arrival in the colony, will be sorely disappointed on his first examination of the vegetation. This is not simply because European plants have largely displaced indigenous kinds in the vicinity of the seats of settlement, nor even because those plants which most steadily resist the progress of the invaders are to some extent of the European type ; it arises from the fact that, with a larger proportion of endemic plants in proportion to its area than any other country, there are but few kinds, more especially in the north, which give character to the landscape, and offer salient points for general observation. The first peculiar plants observed by the new-comer are the toe-toe and *Phormium,* to these in the north must be added the magnificent pohutukawa and the kowhara-whara ; the remainder of the hundreds of plants peculiar to the colony must be sought in the damp forest gullies, or on the lofty mountain ranges.

But after the first feelings of surprise at the general resemblance of the vegetation in the vicinity of the ports to the European type have passed away, and the observations of our traveller are made over a wider range of country, he finds the resemblance after all to be merely superficial, for at every step in the forest he misses the bright forest flowers of the northern hemisphere : no wild hyacinth or wood-anemone ; no primrose or cowslip ; no dead-nettles, wound-worts, or hawk-weeds ; no roses, brambles, or willows ; but in their stead are numerous small trees, shrubs, and ferns, often with flowers of curious structure and strange leaves, from the slender karamu to the giant kauri and totara. And the same rule holds good if the open country is examined. There are none of the charming terrestrial orchids of Britain to be found on the grassy lands or fern-clad hills, and although much of the lacustrine and uliginal vegetation exhibits a closer affinity,—in fact contains a larger proportion of plants common to both countries than the sections at which we have just glanced, still we miss the regal waterlilies, the flowering rush, the white and yellow bog-beans, the loose-strifes, arrow-head, and water-violet, which so often beautify the streams, lakes, and marshes of Britain. The forest vegetation of New Zealand comprises some of the grandest flowering plants known: the same must be unreservedly admitted of its alpine flora; but if we further except a few fine plants peculiar to the Auckland and Chatham Islands, there are scarcely any herbaceous plants remarkable for the beauty of their flowers. The social characters of the trees composing the sylvan flora of Britain contrast forcibly with those of the New Zealand forests. In the former, forests of oak, beech, Scotch fir, hornbeam, holly, etc., are, or rather were, not uncommon; but few of our trees exhibit this characteristic, more especially in the north. The kahikatea certainly forms large forests in the swamps Southwards, the beech on the hills, the tawa, and taraire, not unfrequently form large portions of the forest; the totara, the kauri, and a few other trees, occur in groves or patches; but, excepting the southern beeches, there is no tree which grows almost exclusively for miles, as was the case with the oak, Scotch fir, etc., etc. Our forests are highly varied, and not unfrequently exhibit a larger number of species of ligneous plants in a single district, than could perhaps be found in the greater part of Europe; but this almost tropical variety in itself detracts from the sense of grandeur which is inspired by continuous masses of any one kind of arboreal vegetation.

Ligneous plants form one-eighth part of the phænogamic Flora of New Zealand, but less than one forty-seventh part of the same section of the British Flora; and of this small proportion a limited number only can be called trees—the oak, ash, beech, hornbeam, birch, aspen, white and grey poplars, white and bedford willows, wych elm, holly, small-leaved lime, alder, maple, Scotch fir, and yew,—a number fully equalled by the New Zealand pines and beeches alone. Of British trees not a single species is marked by conspicuous flowers,* and only one by attractive fruit,—there is no representative of our pohutukawa and the various ratas (*Metrosideros* sp.), the rewa-rewa (*Knightia excelsa*), hinau (*Elæocarpus dentatus*), ixerba (*I. brexioides*), towai (*Weinmannia silvicola*), toro (*Persoonia Toro*), kohe-kohe (*Dysoxylum spectabile*), puriri (*Vitex littoralis*), ackama (*A. rosæfolia*), hohere (*Hoheria Sinclairii*), kowhai (*Sophora tetraptera*), lace-bark (*Plagianthus Lyallii*), and many others with their showy flowers—or, excepting the holly, of the tawa (*Nesodaphne Tawa*), taraire

*Possibly the male catkins of the white willow (*Salix alba* L.) may be considered sufficiently attractive to qualify the above statement: those of the bay willow (*S. pentandra* L.) are very handsome, but it can scarcely be called a tree.

(*Nesodaphne Taraire*), kahikatea (*Podocarpus dacrydioides*), miro (*Podocarpus ferruginea*), matai (*Podocarpus spicata*), titoki (*Alectryon excelsum*), and hedycarya (*H. dentata*), with their attractive fruit.

The striking characteristic arising from a rich variety of species, not seldom belonging to orders unrepresented in Britain, is intensified by the peculiar habits and mode of growth of many New Zealand forms. In the lower parts of the forest we find the pukatea (*Atherosperma Novæ Zelandiæ*), with the base of its trunk developed into wide-spreading buttresses, its white bark contrasting strangely with its bright green foliage : near it the maire-tawhake (*Eugenia Maire*), clothed from base to summit with white myrtle-like flowers and leaves, by the side of the tall shafts of the kahikatea, with its sparse foliage : on drier ground the tanekaha (*Phyllocladus trichomanoides*), and the striking toa-toa (*Phyllocladus glauca*) display their highly developed phyllodia ; the grand columns of the kauri (*Dammara australis*) rise to the height of from sixty to eighty feet without a branch, and, from their bulk and symmetry, fairly claim the supremacy of the forest ; the totara, remarkable amongst New Zealand pines for its peculiar bark, and oftentimes of huge girth, the much branched hinau with its flowers of creamy white, by the side perchance of an immense rimu (*Dacrydium cupressinum*), with its peculiar pendent branchlets, the kawaka (*Libocedrus Doniana*) or arbor-vitæ, recognised at a distance by its bark hanging in broad ribbon-like flakes and the young plants at its base, showing how apposite was its old trivial name "plumosum ;" the puriri with its white slippery bark and glossy foliage ; the huge, often mis-shaped northern rata (*Metrosideros robusta*), which, commencing life as an epiphyte on some forest giant, sent down aerial stems, and developed them into large trunks which have strangled the fostering tree, above the remains of which its branches wave, often a hundred feet from the ground, and laden with flowers of fiery crimson ; the rawiri (*Leptospermum ericoides*) or tea-tree, with spray-like branches laden with myriads of white flowers, its loose bark waving in the wind ; the miro and matai with their yew like foliage ; the tawa, with leaves resembling some of the British willows, and its sister-tree, the taraire, perchance, with the dusky tints of its fine foliage appearing still browner from the close proximity of a glossy karaka (*Corynocarpus lævigata*). Here, fine panicles of white flowers break from the uneven bark of the kohe-kohe (*Dysoxylum spectabile*), with its walnut-like foliage, there a fine arborescent lily-wort (*Cordyline* sps.), the only plant that can be said to impart a special character to the New Zealand landscape, waves its palm-like leaves, every branch tipped by an immense panicle of fragrant flowers. Mingled with all the southern palm (*Areca sapida*) attains its extreme height of fifty feet, and exhibits at once both the grace and stateliness of its order, only surpassed in beauty by the noble arborescent ferns (*Alseuosmia macrophylla*) which abound in the moist gullies.

The same richness and variety of form and habit is manifested in the undergrowth. The British woods exhibit but few species: the hazel, buckthorn, dogwood, crab, hawthorn, service, black thorn, alder, and dwarf willows, form the chief portion of its underwood, which is margined with thickets of brambles and roses. New Zealand exhibits a vast series of shrubby plants and small trees, often producing showy flowers, and varying in kinds—from those found in the warm latitudes of Auckland to those of the cool moisture of Otago and Southland. Most conspicuous in the province of Auckland is the large leaved *Alseuosmia,* with its pendent fuchsia-like flowers varying from white to crimson, one of the most social plants in the colony. The white-flowered wharangi-piro (*Olearia Cunninghamii*), varying from a bush to a small tree, is the chief representative in the North Island of the numerous shrubby composites of the south. In rocky places the puka-puka (*Brachyglottis repanda*), recognised at a considerable distance by its hoary leaves, is abundant, and perchance growing amongst it the rhabdothamnus (*R. Solandri*), with its fairy-like bells of orange and scarlet. The hange-hange (*Geniostoma ligustrifolia*), the kawa-kawa (*Piper excelsum*), the ngaio (*Myoporum lætum*), the pennantia (*P. corymbosa*), with its waxlike flowers, various coprosmas (*C. grandifolia etc.*), several species of senecio (*S. glastifolius*), with their white or yellow corymbs, shrubby veronicas (*V. ligustrifolia,* etc.), sometimes attaining the height of fifteen feet, and laden with snowy or lilac-coloured flowers; the lance-wood (*Panax crassifolia*), which at first is only a straight rod, perhaps, ten feet high, with linear, toothed, and mottled leaves eighteen inches long, growing *downwards* at an acute angle with the stem, then becoming slightly branched, it developes trifoliate leaves of a similar character, and ultimately as a small tree exhibiting simple linear-obovate, entire leaves, and unisexual umbels of green flowers. The whau-whau-paku, another araliad, with its broad handsome green foliage; the whau (*Entelea arborescens*), the ake-ake (*Dodonæa viscosa*), and numerous other kinds intermingled with a dense growth of a social asteliad (*Astelia trinervia*), and numerous "cutting-grasses" (*Gahnia setifolia,* etc.), whose serrated edges speedily scarify the unprotected hands of the traveller.

But a still more striking point of contrast is afforded by the garniture of the trees. In British woods the solitary ivy is the only climbing plant which attains to the summits of the higher trees. A solitary clematis (*C. vitalba*) and the woodbine (*Lonicera Periclymenum*) complete the list of ligneous climbers. Rarely the polypody (*Polypodium vulgare*) may be seen amongst the forks of the branches, but as a rule, beyond a few mosses and lichens, the trees are bare of vegetable growth.

In the New Zealand forest the huge trees sustain entire assemblages of dissimilar plants. Asteliads (*Astelia Solandri,* etc.) growing on their limbs present a peculiar feature in the landscape, and at a distance "resemble the nests of some gigantic bird;" their drooping scapes of waxy-looking flowers and crimson fruit being alike conspicuous and attractive. Trunks and branches are laden with epiphytic orchids, small pittosporads and other shrubs, ferns, pendent lycopods, and mosses, accompanied by large foliaceous lichens, to an extent which completely beggars description. Scandent ferns, which ascend to the tops of the highest trees present a feature totally unknown in the woods of Britain, and showy loranths adorn the branches with bright coloured flowers strangely out of harmony with thè foliage of the supporting tree. The large white-flowered clematis (*C. indivisa*), with its massive foliage covers the outskirts of the forest during two months of the year, as with a sheet of purest snow; parsonsias exhibit their twisted and inosculated stems, ultimately producing jessamine-like flowers and pendent linear capsules. The well-known supple-jack (*Rhipogonum scandens*), with its flexible stems, often fills up the spaces between the trees, and renders progress both tedious and laborious, while the mange-mange (*Lygodium articulatum*), with its elegant foliage, its singular spore-cases and tough wiry stems, binds trees and undergrowth together in its net-like shrouds to such an extent that the traveller's path can only be cleared by the knife. Like its British allies, the tataramoa (*Rubus australis*), with its three or four strongly marked varieties, often forms impenetrable thickets, or ascending the lower shrubs by means of the hooked prickles with which its leaves are armed, ultimately reaches the tops of the loftiest trees, and with its cable-like stems partly coiled on the ground, partly suspended in mid-air, spreads its branches far and wide, and hangs its branched and elongated panicles of snowy diœcious flowers, absolutely without a rival in the genus to which it belongs. Adding the beauty of colour to that of form, scandent species of *Metrosideros*, a section almost peculiar to the colony, festoon the trees with brilliant flowers of white, red, magenta, and fiery crimson. How cold and sombre by the side of all this wealth of form, and warmth of colour, does the solitary ivy appear?

I have already pointed out the remarkable paucity of showy herbaceous flowers in the New Zealand forests as affording one of the most striking points of contrast between the two Floras. Their place is occupied by a large variety of ferns and allied plants of exquisite form, and often of delicate texture: now resembling miniature tree-ferns—now the shield ferns of Britain—of varied tints, from the tender green of adiantum (*A. æthiopicum*, etc.), the red and purple doodia (*D. media*), to the black *Lomaria nigra*—of all degrees of texture, from the filmy hymenophyllums, resembling delicate algæ, to the leathery todea (*T. barbara*)—now resembling humble mosses—now exhibiting the habit of the stately para (*Marattia salicina*).

In Britain Ferns and their allies form only one twenty-fifth of the Flora, while in New Zealand they equal one-eighth, and the general difference in habit is as strongly marked. The peculiar effect produced by continuous carpets of the pellucid entire fronds of *Trichomanes reniforme*, or the finely cut *Hymenophyllum demissum*, in the cool open part of the forest, cannot be imagined by those conversant only with the Ferns of Britain. Tree-ferns, climbing ferns, and epiphytic kinds, are absent from the British Flora, and it exhibits none of those handsome and delicate filmy ferns, which are so luxuriantly developed in New Zealand ; still, three species, *Adiantum Capillus-Veneris*, *Athyrium Filix-fœmina*, and *Osmunda regalis*, each in its respective habit, surpass all New Zealand forms in grace and beauty. Fifteen genera and thirteen species are common to both countries. The bracken of the British Islands is represented by a closely similar plant, having as wide a range of distribution, but no other Fern common to both countries has a distribution in New Zealand corresponding to its range in Britain; and the same remark applies to the representative forms, with the exception, perhaps, of the patotara (*Botrychium ternatum*). In conformity with the general law of plant distribution, the New Zealand Ferns, and their allies, decrease in number of species as they recede from the equator. In the Flora of the British Islands their distribution is decidedly polar, affording a marked contrast with the austral distribution of the great majority of its Phænogams.

Although many New Zealand Ferns occur at a great altitude, not more than three or four species are so purely montane in their habit as the British *Woodsias*, or *Cystopteris montana*. A few purely tropical species are found luxuriating in the increased temperature afforded by the close proximity of hot springs.

Equisetum, which is a prominent genus in many parts of the British Islands, has no representative in New Zealand.

The open land in Britain is usually covered with a mixed and compact growth of grasses and small forage plants, or with furze, heather, or bracken interspersed with thickets of brambles, sweet-briars, dog-roses, dwarf-willows, and one or two other shrubs which afford cover for a large number of herbaceous plants and a few ferns. In New Zealand, the southern bracken (*Pteris esculenta*), the manuka (*Leptospermum scoparium*), and, restricted to the north, the tauhinu (*Pomaderris ericifolia*), are the chief ericetal plants of social habit. These are dotted with bushes of makaka (*Carmichælia australis*), with its leafless branches, the representative of the yellow broom of Europe, tupakihi (*Coriaria ruscifolia*), karamu (*Coprosma lucida*), koromiko (*Veronica salicifolia*, etc.), pimelias (*P. prostrata*, etc.), epacrids, and other shrubby heath-worts, with a large number of small-growing or stunted shrubs. In favourable spots a few small terrestial orchids are found of types quite unknown to the British Flora. In moist places various species of *Cladium* and *Schœnus* abound, differing widely in appearance from the solitary British representatives of these genera. *Lomaria procera* and, in the south, *L. vulcanica*, often cover large areas. The peculiar appearance of *Gleichenia circinata*, the erect *Lycopodium densum*, and the semi-scandent habit of *L. volubile*, cannot be compared with any British plants in regard to habit of growth. A few willow herbs and other herbaceous plants, especially several species of *Haloragis*, are of frequent occurrence, but insignificant appearance. Many grasses are sparingly scattered amongst the shrubs and fern, but they rarely assume a social character ; even on the plains of the South Island they seldom form a compact sward, unless mixed with introduced species.

Phormium tenax everywhere affords a striking feature, especially when in flower, and the huge tussocks and lofty panicles of the toe-toe (*Arundo conspicua*) at once attract attention ; the cutting toe-toe (*Cyperus ustulatus*) is abundant on moist ground, and is remarkable for its singularly harsh and rigid habit.

It must be admitted that the manuka, although copiously sprinkled with snowy blossoms, offers a poor substitute for the furze and social heaths of Britain, with their attractive flowers. The herbaceous composites of Britain, with the exception of two or three forms, are not represented ; its showy water-crowfoots are unknown ; its charming milk-wort ; its crucifers and clove-worts. The absence of its roses, brambles, and hawthorn, is at once noticed, even by the most careless observer. No trefoil, clovers, vetches, or wild peas, are found here. The showy bell-flowers are poorly represented by two or three species of *Wahlenbergia.* Its lowland forget-me-nots, its mullein and toad-flax, louse-wort and yellow-rattle, primrose and loose-strifes, have no substitutes. One or two speedwells closely resemble English forms, but they are rare and local ; as are the lowland eyebrights. The dead-nettles, bugles, germanders, and other labiates, are represented only by a single species belonging to the order in the North, and by two only in the South Island. Sponge-worts, so numerous in Britain, are represented by a single littoral species. With one exception, the charming terrestial orchids of Britain are represented by widely different forms, which evince a closer affinity with the Tasmanian Flora than is shown by any other group of New Zealand plants. The absence of the showy flowered lacustrine plants of Britain has already been pointed out, I will only add that, with one exception, the New Zealand water-milfoils are more or less sub-aquatic. I have only met with one species that is constantly submerged. *Myriophyllum robustum* especially, which is allied to the British *M. verticillatum*, is never submerged, but may be seen in the country between the Thames and Waikato, growing in immense abundance, three to four feet in height, and resembling a miniature pine forest.

The littoral section of the Flora differs from that of Britain in the presence of several peculiar plants. In the north, the pohutukawa (*Metrosideros tomentosa*), sixty feet high, with gnarled, distorted branches, laden from base to summit with deep crimson flowers, is often found with its trunk washed by the sea; the mangrove (*Avicennia officinalis*) covers mud-flats exposed at low-water, and often attains thirty feet in height; its creeping roots and innumerable suckers present a singular feature. Other trees prefer a littoral habitat, as the pau (*Sapota costata*), which has a similarly restricted range to the above, and others. The ngaio is abundant all round the coast, and is also found inland. A glossy leaved karamu (*Coprosma Baueriana*), and one or two shrubby veronicas and composites, also affect a littoral habitat. The arenarian plants are singularly uniform on all the coasts. The pingao (*Desmochœnus spiralis*) with its interrupted spike, *Spinifex hirsutus*, and *Festuca littoralis*, are confined to loose or shifting sand, and to some extent take the place of the marrem and sand-sedge of Britain, but present a singular appearance. Two other plants of opposite habit give a peculiar character to sandhills and beaches—*Coprosma acerosa*, with its tortuous wiry brown stems and acicular leaves, and the erect *Pimelea arenaria* covered with white silky hairs. *Convolvolus Soldanella*, and several other littoral plants, are common to both countries. The New Zealand spinach (*Tetragonia expansa*) and a large marsh-samphire (*Salicornia indica*) are abundant in salt marshes. Except a large asteliad (*Astelia Banksii*), common on the cliffs, there are but few other forms of special importance. *Zoysia pungens*, a littoral grass, is one of the few New Zealand kinds which form a compact turf.

So little precise knowledge has at present been collected with regard to the altitudinal range of New Zealand plants, especially of their lower limits, that I am only able to point out some of the more remarkable alpine forms, without reference to climatal conditions. Dr. Hector has stated the general features of their distribution in an essay appended to the first volume of the *Transactions* of the New Zealand Institute. I may, however, remark that no mountain in Britain exceeds the altitude of 4,330 feet, the mean temperature of which is computed by Watson at 36·6 deg. Fahr. Not more than twenty-five species are found in Britain at a greater altitude than 4,000 feet. It is probable that one-eighth, or possibly one-seventh, of the New Zealand Phænogams and Ferns occur between 4,000 and 9,000 feet of altitude, although the number of species restricted to these limits would be much smaller. The comparative paucity of ferns at these altitudes contrasts forcibly with their abundance at lower ranges.

Conspicuous amongst the sub-alpine plants are the magnificent *Ranunculi*, *R. Lyallii*, and *R. Traversii*—the "water lilies" of the shepherds. Mr. Potts informs me the peltate leaves of the former are sometimes two feet in diameter;

their erect stems and waxy-white flowers, combined with their peculiar leaves, render them "the grandest species of the genus." *R. Godleyanus* and *R. insignis* are also noble species. *R. Sinclairii* and *R. sericophyllus* are interesting forms of smaller growth. The remarkable genus *Aciphylla* comprises the "spear-grass" and "bayonet-grass" of the colonists, so-called from their rigid pungent leaves, which occasionally inflict uncomfortable wounds on incautious travellers. Many species of *Ligusticum* are found at great altitudes. *Celmisia* is a peculiarly montane genus, comprising twenty-five species, only two of which are found north of the Auckland Isthmus. It is characterized by linear radical leaves surrounding numerous one-flowered scapes, the leaves varying from half an inch in length to nearly two feet; acicular, or broad; membranous, or clothed with densely appressed tomentum; the flowers are almost sessile, or on long scapes, and in some species fully three inches in diameter. Strange looking *Ozothamni* abound, with imbricated appressed leaves, clothed with cottony tomentum, or shining. Perhaps the most singular forms are the species of *Raoulia* and *Gnaphalium*, known to the shepherds as "vegetable sheep;" the stems are so closely compacted that it is impossible to thrust the fingers between them, and the imbricated, closely appressed leaves are clothed with a dense coating of velvety hairs. In the closely allied genus *Haastia* the plants form rounded cushions, several feet in diameter, the leaves being clothed with cottony wool. Several pastoral epacrids represent to some extent the crow-berry of the British mountains in habit. The mountain gentians, with their handsome yellow or purplish flowers, are amongst the most attractive of the genus. *Myosotis* comprises several species of similar habit to the British *M. alpestris*, with others, having terminal, solitary flowers, and hoary leaves. Numerous shrubby veronicas and a few herbaceous forms occur as sub-alpines; amongst the former is a group of singular forms, usually with closely appressed or imbricated leaves, but occasionally developing others of various forms, which are spreading and pinnatifid. Showy species of *Euphrasia* are frequent, and moss-like patches of the genera *Pygmea* and *Forstera* are not uncommon.

The alpine section of the British Flora exhibits no such striking plants as the above, either with regard to form or beauty; in many parts a compacted growth of *Salix herbacea*, *Carex rigida*, and *Lycopodium alpinum* is found on the highest peaks. *Silene acaulis*, *Gnaphalium supinum*, *Saxifraga stellaris*, *Viola palustris*, a few hawkweeds, alpine *Cerastia*, willow herbs, *Alchemilla alpina*, *Empetrum nigrum*, four or five grasses and rushes, *Saxifraga oppositifolia*, *S. nivalis*, *Sedum Rhodiola*, *Lomaria spicant*, *Lycopodium Selago*, *Polygonum viviparum*, *Cochlearia officinalis*, *Thalictrum alpinum*, and *Oxyria reniformis*, form the bulk of the sparse vegetation at and above 4,000 feet. About one-fifth of the British phænogamic plants and ferns occur between 2,000 feet and 4,330 feet; many of these, however, descend much lower.

The rarity of flowers with blue corollas in the alpine plants of New Zealand, and in its Flora generally, is noteworthy. There is no plant in any way resembling the charming *Gentiana verna*, so abundant in certain localities in the west of Ireland and in the north of England, or *Veronica alpina*, *V. saxatilis*, and other species. The British veronicas, however, are without exception herbaceous,* and are closely represented by several New Zealand species, one of which is identical.

In closing this very imperfect sketch, I will simply add that although more than one hundred British species have become naturalized in New Zealand, only one (*Cotula coronopifolia*, L.) of our indigenous plants has become in any way established in Britain, and even that may prove to have been introduced from Australia or from Southern Europe.

Art. XLIV.—*Notes on the Local Distribution of Certain Plants common to the British Islands and New Zealand.* By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 28th August,* 1871.]

Ranunculaceæ.

Ranunculus parviflorus, L., var. *australis*. North of Waikato. Differs from the typical form in the hooked style only.

Cruciferæ.

Nasturtium palustre, DC.

Cardamine hirsuta, L.

Of general distribution in both countries. The last exhibits a much greater amount of variation in New Zealand than in Britain.

Barbarea vulgaris, L. North of Auckland; local.

Caryophylleæ.

Spergularia rubra, Pers., var. *marina*. Often local in the north of New Zealand; general in the south.

Portulaceæ.

Montia fontana, L. Not found north of Waikato; usually a mountain plant. Common in Britain.

Geraniaceæ.

Geranium dissectum, L., var. *caroliniarum*. Sometimes difficult to distinguish from the typical form. The root is often annual. Distribution—general.

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* *Veronica fruticulosa*, L., has no claim to be considered a British plant.

G. molle, L. Distribution—general.

Oxalis corniculata, L. Distribution—general. South-west of England.

ROSACEÆ.

Potentilla anserina, L. Distribution—South of Auckland Isthmus. In Britain general.

HALORAGEÆ.

Callitriche verna, L. I have not seen specimens of the typical form. Our plant is *C. Muelleri*, which resembles the British *C. platycarpa*, Kuetz., but is not identical with any European form. It is probably common throughout the islands.

ONAGRARIEÆ.

Epilobium tetragonum, L. Our plant differs considerably from either of the British forms referred to this species; from *E. tetragonum*, Curt., in its elongated stolons, and from *E. obscurum*, Schreb., in its remarkably stout erect habit, closely appressed leaves, and erect capsules. Distribution—general.

E. pallidiflorum, Sol., has the stolons and habit of *E. obscurum*, Schreb., differing only in the large white flowers.

COMPOSITÆ.

Gnaphalium luteo-album, L. Common on sandy coasts and in light soils. Alien in Britain.

Taraxacum Dens-leonis, Desf. All the New Zealand specimens I have seen belong to var. *palustre*, the montane form in Britain. Distribution—frequent south of Waikato; rare in the north.

Picris hieracioides, L. Distribution—chiefly north of Auckland. England.

Sonchus oleraceus, L., var. *aspera*. Distribution—general.

CONVOLVULACEÆ.

Convolvulus sepium, L.

„ *Soldanella*, L.

Distribution—general; the latter confined to the coast.

SOLANEÆ.

Solanum nigrum, L. Distribution—general. England.

SCROPHULARINEÆ.

Limosella aquatica, L., var. *tenuifolia*. Distribution—general, but often absent from extensive districts. Resembles the mountain form of Britain.

Veronica Anagallis, L. Distribution—East Coast, *Colenso*. General in Britain.

Chenopodiaceæ.

Chenopodium urbicum, L. Distribution—North and South Islands; extremely local.

Chenopodium glaucum, L., var. *ambiguum*. Distribution—common on the coasts.

Suæda maritima, Dumort. Distribution—general on the coasts.

Atriplex patula, L. Distribution—East Coast, *Colenso*. In Britain general.

Polygoneæ.

Polygonum minus, Huds., var. *decipiens*. Distribution—general.

P. aviculare, L. Distribution—general. The var. *Dryandri*, which is local in the North Island, occurs in immense abundance in Canterbury and Otago.

Urticeæ.

Parietaria debilis, Forst. Distribution—general.

Typhaceæ.

Typha latifolia, L. Distribution—general. The male and female catkins are often separated.

T. angustifolia, L., has not been found in the colony.

Sparganium simplex, L. Distribution—North Island. Britain general.

Naiadeæ.

Lemna minor, L. Distribution—North and South Islands, but local. In Britain general.

L. gibba, L. Distribution—North Island, East Coast, *Colenso*. England.

Potamogeton natans, L. Distribution—general. Two forms are confused under this name—the ordinary *P. natans*, in which submerged leaves are wanting, and a form with large submerged leaves, which is the more common of the two, and respecting which full information is desirable. Young states of this have been mistaken by myself and others for *P. heterophyllus*, Schreb., which has not been found in New Zealand.

P. polygonifolius, Pourrett. Distribution—North Island, Great Omaha, and Papakura.

P. gramineus, L. *P. ochreatus*, Raoul, which is equally distinct from *P. compressus*, Sm., and *P. gramineus*, "L.," has been mistaken for this; it is found at the Bay of Islands (*Colenso*), Waikato, Thames (*T.K.*), and Banks Peninsula (*Raoul*).

P. pectinatus, L. Distribution—North Island, Hawkes Bay, and Waikato. In Britain general.

Ruppia maritima, L. Distribution—Frequent on the coast; in fresh water lakes in Waikato.

Zannichellia palustris, L. Distribution—North Island, Waikato, East Coast.

Zostera marina, L. Distribution—All round the coast. Flowers and fruit not seen.

JUNCEÆ.

Juncus maritimus, Lam. Distribution—On all the coasts.

J. cummunis, E. Meyer.

J. bufonius, L.

Distribution general.

Luzula campestris, DC. Distribution—general; local in the north.

CYPERACEÆ.

Scirpus maritimus, L. Distribution—On all the coasts, and in fresh water lakes Waikato.

S. lacustris, L. Distribution—general.

S. triqueter, L. Distribution—North Island, local. South Island, frequent. In England confined to the south, and local.

S. fluitans, L. Distribution—North Island, Waikato. In Britain general.

Carex stellulata, Good. Distribution—North and South Islands, but extremely rare. General in Britain.

C. teretiuscula, Good. Distribution—North and South Islands, local. Generally distributed in Britain, but less frequent than the preceding.

GRAMINEÆ.

Alopecurus geniculatus, L. Distribution—General south of Waikato.

Agrostis canina, L. Distribution—Sub-alpine. In Britain general.

Phragmites communis, Fries. Distribution—Said to have been found in the province of Nelson. General in Britain.

Deschampsia cæspitosa, Pal. Distribution—Southwards from the East Cape. Sub-alpine in the South Island. General in Britain.

Kœleria cristata, Pers. Distribution—South Island. Local in England.

Festuca duriuscula, L. Distribution—General from the East Cape southwards. General in Britain.

FILICES.

Hymenophyllum Tunbridgense, Sm. Distribution—general. In Britain local.

H. unilaterale, Willd. Distribution—North and South Islands; local and sub-alpine. Local in Britain, but more frequent than the preceding, and ascending to a much greater altitude.

Cystopteris fragilis, Bernh. Distribution—North and South Islands, but local and sub-alpine. In Britain general.

Pteris aquilina, L., var. *esculenta*. Distribution—general. Of more rigid habit than the typical form.

Asplenium Trichomanes, L. Distribution—North and South Islands; local and sub-alpine. General in Britain.

Aspidium aculeatum, Swartz. Distribution—General from the Thames southward. Our plant is often non-indusiate, and differs from any of the British forms.

Nephrodium thelypteris, Schl., var. *squamulosum*. Distribution—North Island; extremely local. Differs from the typical form in the bullate scales only.

Ophioglossum vulgatum, L., var. *lusitanicum*. Distribution—general. *O. lusitanicum* is not found in Britain *proper*, confined to one of the Channel islands.

LYCOPODIACEÆ.

Lycopodium Selago, L. Distribution—South Island; sub-alpine.

L. clavatum, L., var. *magellanicum*. Distribution—North and South Islands; sub-alpine. Differs from the British form in the slender habit and spreading leaves, which are never hair-pointed.

ART. XLV.—*On the New Zealand Species of* Pittosporum, *with Descriptions of New Species*. By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 2nd October*, 1871.]

AMONGST the genera of New Zealand plants which occupy a prominent position in the Flora, alike from their wide range of distribution, relative abundance, and number of species, the genus *Pittosporum* takes an important place. Although rarely of social character, its members form a considerable portion of the woodland Flora, and from their great variety in habit, stature, and inflorescence, present special features of interest.

In the "Flora Novæ Zelandiæ" ten species are described; in the "Handbook of the New Zealand Flora" the number is increased to thirteen, one of the additional forms having been described as a variety in the first-named work. Since the publication of the "Handbook" the number of species or sub-species has been increased by more than one-half, and the doubts expressed by its author as to the specific validity of some of the forms originally described have been confirmed. It is, therefore, of some importance that our present knowledge of the genus should be arranged in a connected form, and made available for further research.

It must, however, be pointed out that the present information is not sufficiently complete to admit of the preparation of a permanent revision of the genus, chiefly owing to the absence of any knowledge of the limits of variation in the southern forms.

The New Zealand species vary from small shrubs one foot in height, to trees of forty feet and upwards; they usually occur on the margins of forests, or in low-growing bush, particularly affecting the sloping sides and spurs of open gullies. *P. crassifolium* and *P. umbellatum* are invariably confined to littoral habitats, although often found at a considerable height on the cliffs, *P. cornifolium* usually, and *P. Kirkii* occasionally are epiphytic. *P. pimeleoides*, a remarkably local species, is restricted to clay hills near the Bay of Islands, and from the undiscriminating manner in which the open country has been cleared by fire has become very rare in its limited area. The seeds of all the species are imbedded in a viscid pulp, and a resin is exuded from the bark of *P. crassifolium*, *P. eugenioides*, and others.

The genus exhibits a pre-eminently northern distribution in the colony, although a few species have a remarkably restricted range; only two species are known to occur from the North Cape to Invercargill; three species are common to both islands; two are peculiar to the South Island; eleven are confined to the North Island. Of these last eight are not known to occur south of the province of Auckland, and of these, again, four are restricted to the district north of the Auckland Isthmus.

The altitudinal range of the New Zealand species is, with one or two exceptions, extremely limited, as might fairly be expected from its horizontal distribution. *P. rigidum* and *P. Kirkii* are known to occur up to 2,000 feet, and will probably be found at greater altitudes in the central ranges of the North Island. *P. patulum*, a remarkably local species, occurs at 5,000 feet in the province of Nelson.

The absence of any member of the genus from the Auckland Islands and the Chathams is significant, although there is reason to believe that at least one of the forms of *P. tenuifolium* is found in the latter group. On the other hand, the islands of the east coast of the province of Auckland exhibit a profusion of species—seven are found on the small island of Kawau, and nine on the Great Barrier.

The trunk of *P. eugenioides* attains a diameter of nearly two feet, and is occasionally rivalled by *P. crassifolium*, which is usually much smaller. The wood is perishable and of little use, even for firewood; from its whiteness and density it might prove of value to the inlayer and wood-turner. The only economic purposes to which any part of the plant has been adapted, so far as I am aware, is the use of the gummy matter, in which the seeds are imbedded, to mix with the juice of the sow-thistle as a masticatory by the natives, who are also said to have mixed the bruised leaves of *P. eugenioides* with fat, for the sake of the perfume.

P. tenuifolium is the "turpentine tree" of the Otago settlers, who plant it for hedges, as it bears clipping freely.

P. Buchanani and *P. eugenioides* appear to be constantly diœcious. Other species exhibit a strong tendency in this direction, as well as towards a whorled arrangement of branches and leaves; this is constant in *P. cornifolium*, frequent in *P. reflexum* and *P. Kirkii*, and less developed in *P. umbellatum*, *P. eugenioides*, and *P. virgatum*.

A few species exhibit considerable variation in foliage. *P. rigidum* and *P. patulum*, in certain states, can with difficulty be distinguished from such widely different plants as *Melicytus micranthus*, *Melicope simplex*, *Panax anomalum*, and *Elæocarpus Hookerianus*.

The following arrangement is proposed for the New Zealand species:—

A. Flowers axillary (rarely terminal in *P. fasciculatum* and *P. rigidum*).

1. *P. tenuifolium*
   sub-species *Colensoi*
   „ *fasciculatum*
2. *Buchanani*
3. *Huttonianum*
4. *rigidum*
5. *obcordatum*
6. *pimeleoides*
   sub-species *reflexum*
7. *cornifolium*
8. *P. Kirkii*
9. *umbellatum*
10. *virgatum*
11. *patulum*
12. *Ralphii*
13. *crassifolium*
14. *intermedium*
15. *ellipticum*
   sub-species *ovatum*
16. *eugenioides*

1. *P. tenuifolium*, Banks and Sol.—Sub-species *Colensoi.*—Sub-species *fasciculatum.*

Throughout the islands, not confined to the east coast; the sub-species rare and local.

Flowers in October.

These forms vary considerably in all their parts, so that it would not be difficult to obtain a connected series of specimens, which should include the whole. I fully agree with Dr. Hooker in considering them much too closely allied to admit of their taking specific rank, although, perhaps, the differences are too highly developed to allow of their being treated as mere varieties. *P. Colensoi* is said by Buchanan to be frequent in the north. I never met with it north of the Auckland Isthmus, and consider it a form of comparatively rare occurrence. Small forms of the typical *P. tenuifolium* are often referred to *P. Colensoi* by collectors.

2. *P. Buchanani*, Hook. f. North Island, Mongonui, *J. Buchanan*; near Mount Egmont. Dr. Hector informed me this species had not been found at Tongariro, as stated in the "Handbook."

3. *P. Huttonianum*, Kirk, *Trans.* N.Z. Inst., Vol. II., p. 92. Varying in habit and station from a laxly-branched shrub to a small tree 12–25 feet in height with strict branches; bark black, or dark brown; branches slender, and with the young leaves and petioles clothed with white floccose tomentum; leaves alternate, oblong or ovate, obtuse or acute, 3–5 inches long, slightly coriaceous; petioles slender, $\frac{1}{2}$–$\frac{3}{4}$ inch long. Flowers axillary, solitary, or rarely in twos on a common pedicel; peduncles downy, $\frac{1}{2}$–$\frac{3}{4}$ inch long; sepals lanceolate, acute, bullate at the base, downy; petals ligulate, sharply recurved at about two-thirds their length, the corolla never presenting the rotate appearance of *P. tenuifolium*; anthers very long, ovary pubescent, bracts at the base of the peduncle deciduous; capsules erect, pyriform, downy, 2–3-valved, larger than in *P. tenuifolium*.

North Island, Whangarei, *J. Buchanan*; Great Barrier Island, Thames Goldfield.

4. *P. rigidum*, Hook. f. The flowers are both axillary and terminal.

North and South Islands; in mountain districts rare.

I have received small flowerless branches of sinuate-dentate leaves, collected by Major Mair in the Uriwera country, which may be identical with this plant, and I have collected similar forms on the Cape Colville ranges and in the Kaipara district.

5. *P. obcordatum*, Raoul. South Island, Banks Peninsula.

I am informed by Mr. Potts that the capsule is small, globose, 2-valved.

6. *P. pimeleoides*, R. Cunn. A weak, much-branched shrub, 1–8 feet high; young shoots and leaves silky pubescent, linear-oblong, scattered or whorled, patent or appressed, acute or obtuse, entire. Flowers terminal in clusters of 3–6; peduncles 1-flowered, slender, silky, $\frac{1}{4}$–1 inch long; petals subulate, recurved, yellow, with a purple stripe; capsules erect, ovate-acuminate or conical, downy, 2-valved; valves membranous at length, deciduous, the nuts retaining their position on the peduncle long after the valves have fallen.

Sub-species *pimeleoides*, proper. Much and repeatedly branched, the branches and leaves usually whorled, 1–1$\frac{1}{4}$ inches long, $\frac{1}{4}$ inch wide, flowers clustered, valves of capsule with tips recurved.

Sub-species *reflexum*, R. Cunn. Leaves scattered, rarely whorled, linear, lanceolate acuminate, $\frac{1}{16}$ inch wide, crowded. Flowers terminal, solitary or clustered; capsule ovoid-acuminate; tips of valves recurved. Var. *Gilliesianum*—very slender, leaves crowded, linear-lanceolate, acute, capsule conical, tips of valves straight. *P. Gilliesianum*, Kirk, *Trans.* N.Z. Inst., Vol. I., p. 143.

North Island, rare, Mongonui, Bay of Islands, and Whangaroa.

Flowers in April.

In size and habit there is a wide difference between the sub-species, but the fruit is closely alike in both. I have seen no specimens of *P. reflexum* with axillary flowers.

7. *P. cornifolium*, A. Cunn. Usually epiphytic, rarely terrestrial; branches often scarred with the marks of fallen leaves.

North Island, Spirits Bay to Cook Straits.

Flowers from August to November.

8. *P. Kirkii*, Hook. f., *Trans.* N.Z. Inst., Vol. II., p. 92. A laxly branched shrub, 3 to 15 feet high; branchlets stout, ascending; bark reddish purple; leaves erect, alternate, crowded or whorled, glabrous, linear-obovate, acute or obtuse, 2–5 inches long, narrowed into rather broad purple petioles, excessively coriaceous, pale green above, lighter below, midrib stout, prominent and curiously flattened beneath. Flowers terminal in 3–7 flowered umbels; peduncles slightly decurved; sepals broadly lanceolate, with membranous margin; petals ligulate, recurved, bright yellow; filaments short; ovary with a few long hairs, and narrowed into the short style; stigma 2-lobed; capsules erect, clustered, glabrous, elliptic, $1\frac{1}{2}$ inches long, obtuse, 2–3-valved, remarkably compressed.

North Island, rocky woods, Whangarei, *J. Buchanan*; Great Barrier Island and Omaha, *T.K.*; Titirangi, *T. F. Cheeseman*; Cape Colville and Thames, *T.K.* Altitudinal range 1,000 to 2,300 feet.

Flowers in December. Often epiphytic.

9. *P. umbellatum*, Banks and Sol. Var. *cordatum*. Leaves linear spathulate, narrowed into the petioles, capsules cordate, valves not lobed.

North Island; always near the sea, from the North Cape to Poverty Bay. Var. *cordatum*, Great Barrier Island.

Flowers in October.

Comparatively rare on the west coast. This species and *P. crassifolium* have the same range, and evince the same preference for a littoral habitat. Probably both will be found to extend to the East Cape or still further south.

10. *P. virgatum*, n. s. A slender twiggy tree, 20–25 feet high; young shoots, leaves, and pedicels clothed with pale ferruginous pubescence; leaves linear-lanceolate or ovate, or obovate, entire or variously lobed and

toothed. Flowers terminal, in 2–3-flowered umbels, or solitary; pedicels short, decurved; flowers small; sepals linear, silky; petals recurved at the tips; ovary conical, hirsute; stigma 2-lobed; capsules erect, globose, woody, 2-valved; valves 2-lobed, granulated on both surfaces.

Var. *cratægifolia*—leaves linear-lanceolate, irregularly lobed and toothed.

Var. *serratum*—leaves ovate, acute, crenate-serrate or dentate. In the young state of all the varieties the leaves are deeply incised and lobed.

North Island, Whangaroa North, Great Barrier Island.

Flowers in October.

11. *P. patulum*, Hook. f. Branches stout, glabrous; young leaves narrow linear, lobed or pinnatifid, 2 inches long; mature leaves spreading 1–1½ inches long, ⅓ broad, linear-oblong, narrowed at the base into a short broad petiole, obtuse, entire or crenate-serrate, very coriaceous and shining. Flowers in terminal 4–6-flowered umbels; pedicels patent, 1″ long, with scattered pubescence; sepals and petals not seen; ovary glabrous; style elongated; capsule nearly globose, compressed, broader than long; valves somewhat woody, brown, 2-lobed.

South Island, Wairau Mountains, altitude 5,000 feet, "Handbook New Zealand Flora."

The description in the "Handbook" is avowedly drawn from "a single fruiting specimen," and the fruit is said to be axillary. The valuable specimens for which I am indebted to Mr. W. T. L. Travers show both flower and fruit strictly terminal; by the time the fruit has arrived at maturity the peduncle has contracted to half its original length, and has become rigid and erect. The latter characteristic is manifested in *P. Kirkii* and *P. virgatum*, etc.

12 *P. Ralphii*, Kirk, *Trans.* N.Z. Inst., Vol. III., p. 161. A laxly branched shrub, 8 to 12 feet high in cultivation, with dark brown bark; branches spreading, young branches tomentose; leaves oblong or obovate, on long slender petioles, acute or obtuse, 3″–5″ long, 1″–2″ wide, coriaceous, clothed beneath with buff tomentum. Flowers in terminal 3–8-flowered umbels; peduncles ½″–⅝″ long, tomentose, decurved in fruit; sepals linear, obtuse, tomentose; petals narrow, recurved; capsules rounded, 3-lobed and valved.

North Island, Patea, *Dr. Ralph*; cultivated at Wellington, *J. Buchanan*; Great Barrier Island, *W. J. Palmer*.

Easily distinguished from *P. crassifolium* and *P. umbellatum* by its slender spreading branches and oblong leaves; from *P. crassifolium* it differs in addition in the larger leaves, which are never narrowed into the petiole or have the margins recurved, and are less coriaceous and tomentose, and in the capsules being less than one-half the size of that species. From *P. umbellatum* it further differs in the tomentose leaves, woody 3-valved capsules, and large seeds.

13. *P. crassifolium*, Banks and Sol. An erect shrub or tree, 10 to 30 feet high, with black bark, branches stout, young shoots, leaves, and peduncles clothed with white tomentum; leaves alternate, narrow-obovate or linear-obovate, narrowed into the stout peduncle, acute or obtuse, excessively coriaceous, densely tomentose below, margins recurved. Flowers terminal, solitary or in 2–4-flowered umbels; bracts ovate, ciliate; pedicels decurved; sepals linear-oblong, tomentose; petals recurved, large; capsules terminal, $\frac{3}{4}''$–$1\frac{1}{4}''$ in diameter, 3-valved and lobed, on stout decurved pedicels 1″ long or more, usually solitary when mature; valves excessively stout and woody, downy.

Var. *strictum*—umbels terminal; capsules 3–5; pedicels strict.

North Island, by the sea, Spirits Bay to Poverty Bay.

Flowers in September.

As some confusion appears to exist amongst collectors respecting this very distinct species, I have ventured to add a few characters omitted from its diagnosis in the "Handbook."

14. *P. intermedium*, n. s. A small tree with black bark, in habit and foliage resembling large specimens of *P. tenuifolium*; young leaves and shoots pubescent; leaves $1\frac{1}{2}''$–2″ long, obovate, acuminate, narrowed at the base, flat, midrib pubescent, slightly coriaceous, erect. Flowers not seen; capsules terminal, on stout curved pedicels, solitary or in 2–3-flowered umbels, ovate-acuminate, $\frac{3}{4}''$ in diameter, 3-valved, downy.

North Island, Kawau Island.

I give this well-marked form specific rank with some hesitation; in foliage it resembles large forms of *P. tenuifolium*, while the capsule partakes of the characters of *P. crassifolium* and *P. ellipticum*. Dr. Hooker and Mr. Colenso consider it a new species, still it is possible that further observation may show the wisdom of uniting it with one or other of the above. I have been tempted to attribute its peculiarities to hybridization.

15. *P. ellipticum*, n. s. A small tree, with black bark; branches erect or spreading, puberulous; leaves ovate-lanceolate, or elliptic, or obovate, obtuse or acute, coriaceous, partially clothed with ferruginous pubescence beneath. Flowers in terminal 2–5-flowered umbels; pedicels short, decurved, tomentose; capsules globose, flattened, 2-valved, downy, stout.

Sub-species *ellipticum*, proper. Leaves ovate-lanceolate or elliptic; in the young state densely clothed on both surfaces with rusty coloured pubescence. Flowers terminal, in 3–5-flowered umbels; sepals broad, ovate, pubescent; petals recurved, reddish brown or chocolate coloured; ovary hirsute; style slender; stigma 2-lobed; capsules ovate, acuminate at both ends, with slightly flattened sides; valves faintly 2-lobed.

Sub-species *ovatum.* Leaves obovate or ovate-acuminate, spreading, $1\frac{1}{2}''$–$2''$ long, pubescent beneath. Flowers not seen; capsules 2–4, in terminal clusters; peduncles stout, $\frac{1}{2}'$–$\frac{3}{4}''$ long, globose, downy, 2-valved.

North Island. *P. ellipticum*—Manaia Hills; *ovatum*—Whangaroa North, Manaia Hills, *T.K.*; western part of the Titirangi district, *T.K.*

Flowers in October.

The dense ferruginous pubescence covering the young twigs, leaves, and inflorescence, give this species a singular appearance in the spring months.

16. *P. eugenioides*, A. Cunn. In forests throughout the islands.

Flowers in August.

I am informed by Dr. Hooker that several of the New Zealand species produce self-sown hybrid forms freely under cultivation in the south of France.

ART. XLVI.—*On the Habit of the Rata* (Metrosideros robusta).

By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 6th November,* 1871.]

THE occurrence of several climbing species of *Metrosideros* in New Zealand, coupled perhaps with the native application of the name "Rata" to the majority of species both scandent and erect, has led to a singular error in connection with the form now under consideration, affording a marked instance of the readiness with which erroneous statements relative to natural phenomema are accepted and repeated, although the exercise of a small amount of observation would suffice to detect the fallacy.

Few persons can have travelled amongst settlers in a forest district in the north without having their attention attracted by distorted giant Ratas, and hearing the commonly received opinion that these immense trees were originally weak climbing plants, the stems of which increased in bulk until they killed the fostering tree which had supported them, and ultimately united to form a solid trunk, perhaps some sixty or seventy feet in length, and with the branches perchance attaining a total height of 100 feet. The frequent repetition of these statements has led to the error being reproduced by many superficial writers on New Zealand, although in the original "Flora Novæ Zelandiæ," published twenty years ago, the plant is correctly described as never climbing. I copy, almost at random, the following extract respecting the Rata from Wakefield's "Handbook for New Zealand":—"Rata (*Metrosideros robusta*). There are several varieties of this tree—one grows at first as a parasite, creeping in numerous stem-like ropes up the trunks of the other forest trees, gradually enclosing them till they perish, and then uniting to form a noble tree, taller than that which it has destroyed, with an enormous trunk, but hollow within."

It is, however, noteworthy that this opinion is not expressed by Dr. Hochstetter and the writers of other standard works on New Zealand, who simply speak of the Rata as a large tree with showy blossoms.

The general resemblance which the foliage and inflorescence of one of the scandent species exhibits to our plant has doubtless contributed to the perpetuity of the mistake. *M. florida*, which is also called Rata, is a climber in all stages of its existence, but may readily be distinguished by its larger leaves and flowers, its weak stems, and above all by the capsule being included within the calyx tube. More than half the capsule of *M. robusta* is not included in the calyx tube.

There can be no question that *M. robusta* is often found destroying trees by which it is supported, and these instances are adduced by the bushman as decisive proof of the climbing habit of the plant, and he attempts to confirm his view by calling the species just mentioned (*M. florida*) the young state of the destroyer—totally ignorant of the fact that he is confusing two widely separate plants. In reality, however, our plant is exactly the reverse of a climber—the so-called trunks or stems being truly aerial roots, sent down from an epiphytic plant in search of nourishment! The seeds of *M. robusta* are conveyed by birds, or blown by the wind, amongst the epiphytic masses of Asteliads, Lycopods, and Ferns, so abundant in the trees of the northern forests. In this situation the plant takes root and forms a small bush, for a time obtaining sufficient nourishment from the decaying vegetation in which it is growing, until the limited supply proving insufficient for the increasing demand, its roots stretch boldly down the trunk of the supporting tree in search of that full supply which can only be obtained from the earth. Sometimes only a single root is given off, at others one main root with one or two weaker roots are to be seen, and again several roots of about equal dimensions are to be found, but in nearly all cases the different roots or stems are bound together by smaller roots, which are given off at right angles to the trunk of the supporting tree, and become united with the adjacent main roots by inosculation; not unfrequently masses of fibrous roots are developed, which perish with the increase of the main root, after serving their purpose of deriving temporary nourishment from the atmosphere. In course of time the various stems become inosculated, to a greater or lesser extent, along their course, and the supporting tree is literally strangled by their iron embrace. Notwithstanding the common belief that the stems ultimately become homogeneous, I have never met with an instance where they have united into a solid trunk; it is certainly true that straight stems of great bulk, sometimes twelve feet in diameter, are to be seen; but this is only the case when a single root stem has been formed, or when the specimen is entirely of terrestrial growth. This may be verified by examining the position of the pith. It is, however, to be noted that when several stems are given off, the pith in each will be found much closer to the side on which the root has been in contact with the supporting tree; this, however, arises chiefly from the unequal pressure to which the root has been subjected during growth. The roots or stems may be met with of all heights up to seventy feet, and from one to twelve feet in diameter.

That the habit of the plant is erect, and not scandent, is demonstrated by the young plants in cultivation in our gardens, and this leads me to mention another peculiarity of this species.* The young cultivated plants are always rigid, erect, and bushy, exactly resembling epiphytic specimens of similar size, or specimens growing on rocks. There is no tendency to a scandent habit, and not until the young plant attains a considerable size does it afford any decided indication of a true arboreal stem. It usually produces a few much-branched stems. This has led to the belief that the plant is naturally a shrub, and only becomes a tree when placed in a position to develop aerial roots. But the opinion cannot be maintained in presence of the occurrence of large terrestrial specimens in many localities. I am fully prepared to admit their rarity when compared with the abundance of specimens of epiphytic origin, still the fact remains that in some localities they are frequent enough to attract the special attention of the bushman, who calls this form the "inland pohutukawa," a designation he also bestows upon symmetrical specimens of true pohutukawa sometimes found in the forest. These terrestrial specimens of the Rata are usually found in comparatively open places in the forest, while the distorted giants which started in life as epiphytes are usually most abundant, and attain their greatest development in the denser parts, a condition which of itself goes far to account for the comparative rarity of terrestrial specimens. Occasionally dwarf specimens exactly resembling the *young* cultivated plants, except that they produce flowers, are found on elevated rocky places, but the cause of their stunted maturity is self-evident. It is uncertain if the aerial root of the Rata should be considered simply adventitious or as a special development of the original epiphytic root, although I am inclined to believe the latter. In any case the Rata stands alone amongst New Zealand trees in developing stems of large bulk and affording valuable timber from aerial roots.

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* A characteristic specimen, which has been under cultivation for at least fifteen years without producing flowers, may be seen in the grounds of the Honourable James Williamson, Remuera.

The pohutukawa (*Metrosideros tomentosa*) sometimes produces aerial roots from the main trunk, but these are usually small and appressed. Our President has informed me of a remarkable instance on the west coast of the Great Barrier Island; the plant grows on the summit of a cliff and has given off a root, now become an immense stem, which has travelled down the face of the cliff some sixty or seventy feet to seek its nourishment in the soil at the base. The example is so striking as to have received a special name from the Maoris.

The only tree which the Rata seems powerless to injure is the puriri (*Vitex littoralis*); a fine example, surrounded by three or four large stems, which it has forced outwards at the base, is to be seen on land belonging to Mr. W. C. Daldy, by the Hotea River, Kaipara; similar instances are rare.

While on this subject I may be allowed to remark that our plant (*M. robusta*) has been largely used of late years in the place of the pohutukawa for shipbuilding; it is therefore desirable that the attention of shipbuilders and marine insurance companies should be drawn to the fact that for durability it is inferior to the pohutukawa, or even to the rawiri or tea-tree. Should its use be persisted in, considerable discredit will in a few years be brought on our ship yards.* The Rata of the south (*M. lucida*) is not more durable, and has the additional disadvantage of splitting with the slightest blow. It is remarkable that the pohutukawa and the kauri, the timbers best adapted for shipbuilding in the colony, are practically confined to the province of Auckland, the former only having a single outlying habitat at Waitara in the province of Taranaki.

M. robusta appears to have its centre of distribution in the Kaipara district, where it is abundant, and attains a large size. It occurs from the North Cape to Cook Straits, and has, I believe, been found in the province of Nelson. It is, however, comparatively rare from the Waikato southwards.

I am informed by Sir George Grey that only a single specimen is known on the island of Kawau, although it is abundant on the Great and Little Barriers, Waiheke, and other wooded islands in the Hauraki Gulf.

Art. XLVII.—*On the Botany of the Titirangi District of the Province of Auckland.* By Thomas F. Cheeseman.

[*Read before the Auckland Institute, 31st July,* 1871.]

The Titirangi district may be defined as the tract of country bounded on the north by a line drawn from the head of the Waitemata to the mouth of the Muriwai River, on the west by the sea, and on the south and east by the

* Since the above was written I have been informed by a well-known shipbuilder that although *M. robusta* is not durable when grown on low land or in gullies, yet when grown on hill sides it is equally durable with the pohutukawa.

Manukau Harbour, the Whau portage and creek, and the Waitemata River. Its greatest length, from the Muriwai River to the North Head of the Manukau, is about twenty-two miles ; the extreme breadth hardly fourteen. The area may be roughly estimated at 100,000 acres.

The eastern portion of the district is composed of low undulating clay hills, intersected with numerous gullies, and supports a somewhat scanty and very uniform vegetation. The hills are almost invariably covered with a stunted growth of *Leptospermum scoparium,* intermingled with patches of *Pomaderris phylicifolia,* and *Pteris aquilina,* with a more or less dense undergrowth of sedges. Occasionally *Leucopogon fasciculatus, Dracophyllum Urvilleanum,* and *Epacris pauciflora* appear; while amongst the whole are found a few herbaceous plants, as *Geranium microphyllum, Acæna Sanguisorbæ Lagenophora Forsteri, Gnaphalium involucratum,* a few grasses, and some naturalized plants. The banks of the smaller streams, and the bottoms of many of the valleys, are occupied with a close growth of various species of sedges and other uliginal plants. In these localities such forms as *Cladium glomeratum, C. teretifolium, Eleocharis gracillima, Typha latifolia, Drosera binata, Isachne australis, Gleichenia hecistophylla* and *Lycopodium laterale,* are especially common.

The extensive mud-flats bordering the Whau and Waitemata Rivers afford a suitable habitat to the mangrove (*Avicennia officinalis*), which in many places forms large swamps. Nearer the shore, *Juncus maritimus, Cladium junceum, Leptocarpus simplex,* and *Dichelachne stipoides,* make a continuous fringe for miles ; while among many other littoral plants, *Ranunculus acaulis, Salicornia indica, Samolus littoralis, and Plagianthus divaricatus* are most abundant.

There can be no doubt that the scanty flora and barren appearance of this portion of the Titirangi district is, in a great measure, owing to the pernicious practice of burning off the vegetation every summer. By the agency of fire the patches of bush found by the sides of the larger streams are yearly diminishing, while in the open country many plants, once probably not uncommon, have now become local, or almost extinct. Extensive areas have even become denuded of nearly all vegetation, except a dwarfed covering of *Leptospermum,* only a few inches high, with occasional patches of *Schœnus tenax.* As an illustration of the rapidity with which species are extirpated under a continuance of this practice, I may mention that I well remember seeing, four years ago, the hill sides yellow from the abundance of the blossoms of the kumarahou (*Pomaderris elliptica*), in a locality where now hardly a single plant can be found, and that only by the closest search.

The central part of the district, or what is generally known as the Titirangi Ranges, exhibits a very different vegetation to that just described, being entirely covered with luxuriant forest. As to its physical features, it consists of two parallel chains of hills, trending nearly north and south, and separated by an intervening valley. The Nihotopu stream flows through the southern portion of this valley, discharging itself into the Manukau Harbour, while the northern part is occupied by the Waitakere River. Both these streams flow for a considerable distance at an altitude of 800 to 1,000 feet above the sea-level, and descend very abruptly towards the coast; in the case of the Waitakere, by a waterfall upwards of 200 feet high. The greatest elevation in the district, 1,500 feet, is attained by Te Anatuku mountain, immediately above the source of the Waitakere, but for several miles the range maintains an altitude of 1,100 to 1,300 feet.

The prevailing tree is the tawa (*Nesodaphne Tawa*), which probably forms three-fifths of the forest. Other common species are the hinau (*Elæocarpus dentatus*), rata (*Metrosideros robusta*), tangeao (*Tetranthera calicaris*), *Myrsine Urvillei*, *Pittosporum tenuifolium*, the rewa-rewa (*Knightia excelsa*), kauri (*Dammara australis*), and rimu (*Dacrydium cupressinum*). The greatest altitude reached in the district is not sufficient to exercise any marked influence on the vegetation, a few species are, however, chiefly found on or towards the summit of the range, and among them the following are prominent—*Pittosporum Kirkii*, *Drimys axillaris*, *Ixerba brexioides*, *Metrosideros lucida*, *Olea montana*, and *Dacrydium Colensoi*. Generally speaking, the undergrowth is dense, and principally composed of various species of *Gahnia* and *Astelia*, supplejack (*Rhipogonum scandens*), *Freycinetia Banksii*, the arborescent ferns, several species of *Coprosma*, *Senecio glastifolius*, *Myrtus bullata*, and, above all, *Alseuosmia macrophylla*, which occurs in profusion from the sea-level to the crest of the hills. Ferns are abundant, especially in the deep and narrow gullies, where the *Hymenophylleæ* are particularly well represented, and often of most luxuriant growth, while in many places, although chiefly in the higher central valleys, the ground is carpeted with mosses and *Hepaticæ*, principally of the genera *Hypnum*, *Isothecium*, *Hypopterygium*, *Plagiochila*, and *Gottschea*.

The great abundance of kauri early attracted the notice of sawyers, and I am informed that the first saw-mill worked by machinery in this province was erected in the Titirangi district. After twenty-five years' sawing, few timber trees remain on the eastern side, but extensive forests, almost untouched, exist by the Waitakere River, and a considerable quantity is still to be seen between the Huia Bay and the Manukau Heads. Besides the kauri, the kahikatea (*Podocarpus dacrydioides*) and the rimu (*Dacrydium cupressinum*) are extensively sawn, as also in a smaller degree is the totara (*Podocarpus Totara*) and matai (*P. spicata*). The tanekaha (*Phyllocladus trichomanoides*) does not appear to have been cut for its timber, although it is both excellent and durable, while the kawaka (*Libocedrus Doniana*), and the manoao (*Dacrydium Colensoi*) are too local to be ever of any use for economical purposes.

The western coast is extremely rugged and broken throughout its whole length, and presents a bold front to the sea, the cliffs generally being from 200 to 300 feet high, and in one locality at least, near the rocky islet of Parera, they attain a perpendicular height of over 500 feet. Near the Manukau Head, and extending about five miles northwards, a narrow belt of low sand hills may be seen on the seaward side of the cliffs, whilst further north the sea beats against the foot of a rocky coast line, except in a few isolated sandy bays.

The vegetation is principally composed of bush, but there is a considerable extent of open grassy land near the sea. In the forest the species appear to be nearly identical with those in the central part of the district, the principal difference being in the great abundance of *Pittosporum ovatum*, and the presence of *Ozothamnus glomeratus*, *Myrtus Ralphii*, and some others, together with the occurrence near the sea of *Sapota costata*. The sea cliffs and rocky slopes abound with interesting herbaceous plants, and would probably repay a more careful investigation than I have been able to give them. Among many other species, *Celmisia longifolia*, *Angelica rosæfolia*, *Cotula dioica*, *Spergularia rubra*, *Tetragonia trigyna*, and *Myosotis australis* are abundant. On the sand dunes the common arenarian plants occur, while by the margins of the lagoons and at the mouths of the streams such forms as *Triglochin triandrum*, *Crantzia lineata, and Myriophyllum pedunculatum* are plentifully found.

Owing to the small area of land brought under cultivation, naturalized plants are not so common as in many other districts, and have exercised comparatively little influence on the indigenous vegetation. Still many species are found by road sides and near the sawing stations, and with the progress of settlement their numbers are yearly increasing. At present *Hypochœris radicata* is the species most generally diffused, unless *Cyperus tenellus* be considered of foreign origin. The various species of docks, *Prunella vulgaris*, *Veronica serpyllifolia*, *Trifolium minus*, *Erigeron canadensis*, together with the commoner pasture and forage plants, are also very generally distributed throughout the district.

The subjoined catalogues include about 460 phænogamic plants and ferns, together with nearly 110 naturalized plants. Although the number of indigenous plants noted is considerably larger than has hitherto been recorded from any district of like area, yet it will be materially increased when the central and western subdivisions have been more thoroughly examined.

Lepidium oleraceum, Forst. Two very distinct varieties are found in this district ; one, which also appears to be the common form near Auckland, is a procumbent plant, with linear, deeply pinnatifid radical leaves, linear-spathulate toothed cauline ones, small flowers and pods. The other is a stouter, *erect* plant, with oblong-spathulate simply serrate radical leaves, 2–4 inches long; cauline leaves obovate-cuneate, serrate at the tips; flowers and pods larger.

Viola filicaulis, Hook. f. This curious little plant is not uncommon by the side of streams, above 800 feet of elevation. I am not acquainted with a more northern habitat.

Melicytus macrophyllus, A. Cunn.? A handsome shrub or small tree, with large deep green leaves 5–9 inches long, and fascicles of rather large campanulate flowers, that are most abundantly produced; is common in many places, and is probably referable to a state of this species. It is, I think, the *Melicytus*, n. sp., mentioned by Mr. Kirk in the *Trans.* N.Z. Inst., Vol. I., p. 142.

Pittosporum ovatum, Kirk. A most abundant tree on the western coast, often forming a considerable proportion of the bush.

Pittosporum Kirkii, Hook. f. This fine species is also frequently met with on the higher portions of the ranges, generally epiphytic on *Metrosideros robusta.* Capsules often 3-valved.

Myriophyllum pedunculatum, Hook. f. Now recorded for the first time as an inhabitant of the North Island. It is of common occurrence on the western coast, generally fringing the brackish water lagoons.

Gunnera prorepens, Hook. f.? A stout, excessively branched, prostrate plant; is found on the west coast, often forming large matted patches in damp sandy places, and is doubtfully referred to this species until better specimens can be obtained. Peduncles very stout and fleshy, covered with numerous bright red pendulous drupes.

Myrtus pedunculata, Hook. f. Rare, and apparently confined to a single locality.

Apium leptophyllum, F. Muell. In February, 1871, I observed a solitary plant of this species near Henderson's Creek, probably accidentally introduced.

Loranthus, n. sp.? A very distinct looking species of this genus has been collected at an altitude of 1,400 feet; parasitic on *Metrosideros robusta,* but neither flowers nor fruit have been obtained. It is probably identical with *Loranthus decussatus,* described by Mr. Kirk in *Trans.* N.Z. Inst., Vol. III., p. 162.

Sapota costata, A.DC. Not uncommon near the Manukau Head. I am not aware that it has been previously found on the western coast of the island.

Myosotis australis, Br. Abundant on the cliffs of the western coast. A most handsome plant, covered, when in blossom, with racemes of large white flowers.

Myosotis Forsteri, Ram. and Sch. Very local, the most northern habitat known to me.

Veronica elongata, Benth. Also local, and apparently restricted to the vicinity of the Huia River.

Dacrydium Colensoi, Hook. Some confusion appears to exist about the variety of this species found in the Titirangi district, and also in several other localities. Dr. Hooker considers it to be the typical form of *D. Colensoi*, but I am informed that Parlatore, in his monograph of the *Coniferæ*, describes it as a new species, under the name of *Dacrydium Kirkii.*

Corsysanthes Cheesemanii, Hook. f. As yet I have only noted this in a single locality, but it is probably not uncommon, and overlooked from its small size. One of the earliest of our Orchids, generally seen in flower towards the close of May, and continuing in bloom until the commencement of August.

Chiloglottis cornuta, Hook. f. Local. This plant seems to differ from the *C. cornuta* of the "Handbook" in the more numerous glands on the lip, but is referred to that species by Dr. Hooker.

Gahnia, n. sp. Allied to *G. setifolia*, but differing in the smaller size, much more slender panicles, with much fewer shorter branches, and by the larger spikelets and nuts. Originally discovered by Mr. Kirk.

Gleichenia flabellata, Br. Only seen by the Nihotopu stream. I am not aware that it has been found further south.

Trichomanes strictum, Menz. Confined to the highest summits of the range, 1,200 to 1,500 feet.

Hymenophyllum, n. sp. Minute, forming patches on the trunks of trees. Rhizome long, wiry; fronds $\frac{1}{6}$–1 inch high, simple, dichotomous, or sparingly irregularly digitately divided; segments linear-oblong, obtuse, with a stout costa and ciliate-toothed margins; involucres terminal, free, ovate; valves quite entire, not spinulose on the back. Easily distinguished from its nearest ally, *H. minimum*, by its smaller size, less divided, often quite simple fronds, and by the entire valves of the involucres.

LIST OF PHÆNOGAMIC PLANTS AND FERNS,

OBSERVED IN THE TITIRANGI DISTRICT.

Clematis
- indivisa, *Willd.*
- fœtida, *Raoul.*
- parviflora, *A. Cunn.*

Ranunculus
- plebeius, *Br.*
- rivularis, *Banks and Sol.*
  - *var.* subfluitans
- acaulis, *Banks and Sol.*

Drimys
- axillaris, *Forst.*

Nasturtium
- palustre, *DC.*

Cardamine
- hirsuta, *Linn.*
- stylosa, *DC.*

Lepidium
- oleraceum, *Forst.*

Viola
- filicaulis, *Hook. f.*

Melicytus
- ramiflorus, *Forst.*
- macrophyllus, *A. Cunn. var.*

Pittosporum
tenuifolium, *Banks and Sol.*
crassifolium, *Banks and Sol.*
ovatum, *Kirk*
eugenioides, *A. Cunn.*
cornifolium, *A. Cunn.*
Kirkii, *Hook. f.*
Stellaria
parviflora, *Banks and Sol.*
Spergularia
rubra, *Pers.*,
var. marina
Elatine
americana, *Arn.*
Hypericum
japonicum, *Thunb.*
Plagianthus
divaricatus, *Forst.*
Hoheria
populnea, *A. Cunn.*
Entelea
arborescens, *Br.*
Aristotelia
racemosa, *Hook. f.*
Elæocarpus
dentatus, *Vahl.*
Hookerianus, *Raoul*
Linum
monogynum, *Forst.*
marginale, *A. Cunn.*
Geranium
dissectum, *Linn.*
var. carolinianum
microphyllum, *Hook. f.*
molle, *Linn.*
Pelargonium
australe, *Willd.*
var. clandestinum
Oxalis
corniculata, *Linn.*
Phebalium
nudum, *Hook.*
Melicope
ternata, *Forst.*
Mantellii, *Buch.*
simplex, *A. Cunn.*
Dysoxylum
spectabile, *Hook. f.*
Pomaderris
elliptica, *Lab.*
phylicifolia, *Lodd.*
Dodonæa
viscosa, *Forst.*
Alectryon
excelsum, *DC.*
Corynocarpus
lævigata, *Forst.*
Coriaria
ruscifolia, *Linn.*
Carmichælia
australis, *Br.*
Sophora
tetraptera, *Ait.*
Rubus
australis, *Forst.*
b. schmidelioides
c. cissoides
Acæna
Sanguisorbæ, *Vahl*
Novæ Zelandiæ, *Kirk*
Quintinia
serrata, *A. Cunn.*
Ixerba
brexioides, *A. Cunn.*
Carpodetus
serratus, *Forst.*
Weinmannia
silvicola, *Banks and Sol.*
Tillæa
verticillaris, *DC.*
Drosera
binata, *Lab.*
auriculata, *Backh.*
Haloragis
alata, *Jacq.*
tetragyna, *Lab.*
var. diffusa
depressa, *Hook. f.*
micrantha, *Br.*
Myriophyllum
variæfolium, *Hook. f.*
pedunculatum, *Hook. f.*
Gunnera
monoica, *Raoul*
prorepens, *Hook. f. ?*
Callitriche
Muelleri, *Sond.*
Leptospermum
scoparium, *Forst.*
ericoides, *A. Rich.*
Metrosideros
florida, *Sm.*
lucida, *Menz.*
albiflora, *Banks and Sol.*
diffusa, *Sm.*
hypericifolia, *A. Cunn.*

Metrosideros—*continued.*
- robusta, *A. Cunn.*
- tomentosa, *A. Cunn.*
- scandens, *Banks and Sol.*

Myrtus
- bullata, *Banks and Sol.*
- Ralphii, *Hook. f.*
- pedunculata, *Hook. f.*

Eugenia
- Maire, *A. Cunn.*

Fuchsia
- excorticata, *Linn. f.*

Epilobium
- nummularifolium, *A. Cunn.*
- rotundifolium, *Forst.*
- glabellum, *Forst.*
- tetragonum, *Linn.*
- junceum, *Forst.*
- pubens, *A. Rich.*
- Billardierianum, *Seringe*
- pallidiflorum, *Sol.*

Passiflora
- tetrandra, *Banks and Sol.*

Mesembryanthemum
- australe, *Sol.*

Tetragonia
- expansa, *Murr.*
- trigyna, *Banks and Sol.*

Hydrocotyle
- elongata, *A. Cunn.*
- americana, *Linn.*
- asiatica, *Linn.*
- pterocarpa, *F. Muell.*
- Novæ Zelandiæ, *DC.*
- moschata, *Forst.*

Crantzia
- lineata, *Nutt.*

Apium
- australe, *Thouars*
- filiforme, *Hook.*
- leptophyllum, *F. Muell.*

Angelica
- rosæfolia, *Hook.*

Daucus
- brachiatus, *Sieb.*

Panax
- Edgerleyi, *Hook. f.*
- crassifolium, *Dcne. and Planch.*
- Lessonii, *DC.*
- arboreum, *Forst.*

Schefflera
- digitata, *Forst.*

Griselinia
- lucida, *Forst.*

Corokia
- buddleoides, *A. Cunn.*
- Cotoneaster, *Raoul*

Loranthus
- decussatus ? *Kirk*
- micranthus, *Hook.*

Tupeia
- antarctica, *Cham. and Schl.*

Alseuosmia
- macrophylla, *A. Cunn.*
- linariifolia, *A. Cunn.*

Coprosma
- lucida, *Forst.*
- grandifolia, *Hook. f.*
- Baueriana, *Endl.*
- robusta, *Raoul*
- Cunninghamii, *Hook. f.*
- n. sp.
- spathulata, *A. Cunn.*
- tenuicaulis, *Hook. f.*
- rhamnoides, *A. Cunn.*
- divaricata, *A. Cunn.*
- propinqua, *A. Cunn.*
- acerosa, *A. Cunn.*

Nertera
- Cunninghamii, *Hook. f.*
- dichondræfolia, *Hook. f.*

Galium
- umbrosum, *Forst.*

Olearia
- furfuracea, *Hook. f.*
- Cunninghamii, *Hook. f.*
- albida, *Hook. f.*
- Solandri, *Hook. f.*

Celmisia
- longifolia, *Cass.*

Vittadinia
- australis, *A. Rich.*

Lagenophora
- Forsteri, *DC.*
- petiolata, *Hook. f.*
- sp.

Bidens
- pilosa, *Linn.*

Cotula
- coronopifolia, *Linn.*
- australis, *Hook. f.*
- minor, *Hook. f.*
- dioica, *Hook. f.*
- minuta, *Forst.*

Cassinia
- leptophylla, *Br.*

Ozothamnus
- glomeratus, *Hook. f.*

Gnaphalium
Keriense, *A. Cunn.*
luteo-album, *Linn.*
involucratum, *Forst.*
collinum, *Labill.*
Erechtites
arguta, *DC.*
scaberula, *Hook. f.*
quadridentata, *DC.*
Senecio
lautus, *Forst.*
glastifolius, *Hook. f.*
Brachyglottis
repanda, *Forst.*
Sonchus
oleraceus, *Linn.*
Wahlenbergia
gracilis, *A. Rich.*
Lobelia
anceps, *Thunb.*
Pratia
angulata, *Hook. f.*
Selliera
radicans, *Cav.*
Gaultheria
antipoda, *Forst.*
Cyathodes
acerosa, *Br.*
Leucopogon
fasciculatus, *A. Rich.*
Frazeri, *A. Cunn.*
Epacris
pauciflora, *A. Rich.*
Dracophyllum
latifolium, *A. Cunn.*
squarrosum, *Hook. f.*
Urvilleanum, *A. Rich.*
Myrsine
salicina, *Heu.*
Urvillei, *A. DC.*
Samolus
littoralis, *Br.*
Sapota
costata, *A. DC.*
Olea
Cunninghamii, *Hook f.*
lanceolata, *Hook. f.*
montana, *Hook. f.*
sp. ?
Parsonsia
albiflora, *Raoul*
rosea, *Raoul*
Geniostoma
ligustrifolium, *A. Cunn.*
Myosotis
australis, *Br.*
Forsteri, *Rœm. and Sch.*
Convolvulus
sepium, *Linn.*
Tuguriorum, *Forst.*
Soldanella, *Linn.*
Dichondra
repens, *Forst.*
Solanum
aviculare, *Forst.*
nigrum, *Linn.*
Gratiola
latifolia, *R. Br.*
sexdentata, *A. Cunn.*
Glossostigma
elatinoides, *Benth.*
Limosella
aquatica, *Linn.*
var. tenuifolia
Veronica
salicifolia, *Forst.*
macrocarpa, *Vahl*
elongata, *Benth.*
Rhabdothamnus
Solandri, *A. Cunn.*
Vitex
littoralis, *A. Cunn.*
Avicennia
officinalis, *Linn.*
Myoporum
lætum, *Forst.*
Mentha
Cunninghamii, *Benth.*
Plantago
Raoulii, *Dcne.*
Chenopodium
glaucum, *Linn.*
var. ambiguum
Suæda
maritima, *Dum.*
Salicornia
indica, *Willd.*
Scleranthus
biflorus, *Hook. f.*
Polygonum
minus, *Huds.*
var. decipiens
aviculare, *Linn.*

Muhlenbeckia
 adpressa, *Lab.*
 complexa, *Meisn.*
Rumex
 flexuosus, *Forst.*
Tetranthera
 calicaris, *Hook f.*
Nesodaphne
 Tarairi, *Hook. f.*
 Tawa, *Hook. f.*
Atherosperma
 Novæ Zelandiæ, *Hook. f.*
Hedycarya
 dentata, *Forst.*
Knightia
 excelsa, *Br.*
Persoonia
 Toro, *A. Cunn.*
Pimelea
 longifolia, *Banks and Sol.*
 virgata, *Vahl*
 arenaria, *A. Cunn.*
 prostrata, *Vahl*
Santalum
 Cunninghamii, *Hook. f.*
Euphorbia
 glauca, *Forst.*
Epicarpurus
 microphyllus, *Raoul*
Parietaria
 debilis, *Forst.*
Elatostemma
 rugosum, *A. Cunn.*
Peperomia
 Urvilleana, *A. Rich.*
Piper
 excelsum, *Forst.*
Dammara
 australis, *Lamb.*
Libocedrus
 Doniana, *Endl.*
Podocarpus
 ferruginea, *Don*
 Totara, *A. Cunn.*
 spicata, *Br.*
 dacrydioides, *A. Rich.*
Dacrydium
 cupressinum, *Sol.*
 Colensoi, *Hook.*
Phyllocladus
 trichomanoides, *Don*
Earina
 mucronata, *Lindl.*

Earina—*continued.*
 autumnalis, *Hook. f.*
Dendrobium
 Cunninghamii, *Lindl.*
Bolbophyllum
 pygmæum, *Lindl.*
Sarcochilus
 adversus, *Hook. f.*
Acianthus
 Sinclairii, *Hook. f.*
Cyrtostylis
 oblonga, *Hook. f.*
 rotundifolia, *Hook. f.*
Corysanthes
 triloba, *Hook. f.*
 oblonga, *Hook. f.*
 rotundifolia? *Hook. f.*
 rivularis, *Hook. f.*
 macrantha, *Hook. f.*
 Cheesemanii, *Hook. f.*
Microtis
 porrifolia, *Spreng.*
Caladenia
 minor, *Hook. f.*
Pterostylis
 Banksii, *Br.*
 graminea, *Hook. f.*
 trullifolia, *Hook. f.*
 puberula, *Hook. f.*
Chiloglottis
 cornuta, *Hook. f.*
Thelymitra
 longifolia, *Forst.*
 pulchella, *Hook. f.*
 imberbis, *Hook f.*
Prasophyllum
 pumilum, *Hook. f.*
Orthoceras
 Solandri, *Lindl.*
Libertia
 ixioides, *Spreng.*
 grandiflora, *Sweet.*
 micrantha, *A. Cunn.*
Freycinetia
 Banksii, *A. Cunn.*
Typha
 latifolia, *Linn.*
Sparganium
 simplex, *Huds.*
Lemna
 minor, *Linn.*
Triglochin
 triandrum, *Mchx.*

Potamogeton
natans, *Linn.*
Zostera
marina, *Linn.*
Rhipogonum
scandens, *Forst.*
Cordyline
australis, *Hook. f.*
Banksii, *Hook. f.*
Pumilio, *Hook. f.*
Dianella
intermedia, *Endl.*
Astelia
Cunninghamii, *Forst.*
grandis, *Hook. f.*
Solandri, *A. Cunn.*
Banksii, *A. Cunn.*
n. sp.
Arthropodium
cirrhatum, *Br.*
Phormium
tenax, *Forst.*
Colensoi, *Hook. f.*
Areca
sapida, *Sol.*
Juncus
maritimus, *Lam.*
communis, *E. Mey.*
planifolius, *Br.*
bufonius, *Linn.*
Luzula
campestris, *DC.*
Leptocarpus
simplex, *A. Rich.*
Cyperus
ustulatus, *A. Rich.*
tenellus, *Linn.*
Schœnus
axillaris, *Hook. f.*
tenax, *Hook. f.*
Tendo, *Banks and Sol.*
tenuis, *Kirk*
Scirpus
maritimus, *Linn.*
lacustris, *Linn.*
Eleocharis
sphacelata, *Br.*
acuta, *Br.*
var. platylepis
gracillima, *Hook. f.*
Isolepis
nodosa, *Br.*
prolifer, *Br.*
riparia, *Br.*
Desmoschœnus
spiralis, *Hook. f.*
Cladium
glomeratum, *Br.*
teretifolium, *Br.*
articulatum, *Br.*
Gunnii, *Hook. f.*
junceum, *Br.*
Sinclairii, *Hook. f.*
Gahnia
setifolia, *Hook. f.*
n. sp.
lacera, *Steud.*
xanthocarpa, *Hook. f.*
arenaria, *Hook. f.*
Lepidosperma
tetragona, *Lab.*
concava, *Br.*
Uncinia
australis, *Pers.*
Banksii, *Boott*
Carex
virgata, *Sol.*
b. secta
subdola, *Boott*
ternaria, *Forst.*
Raoulii, *Boott*
lucida, *Boott*
pumila, *Thunb.*
Forsteri, *Wahl.*
sp.
breviculmis, *Br.*
Neesiana, *Endl.*
dissita, *Sol.*
Lambertiana, *Boott*
vacillans, *Sol.*
Microlœna
stipoides, *Br.*
avenacea, *Hook. f.*
Hierochloe
redolens, *Br.*
Spinifex
hirsutus, *Lab.*
Paspalum
scrobiculatum, *Linn.*
distichum, *Bur.*
Panicum
imbecille, *Trin.*
Isachne
australis, *Br.*
Zoysia
pungens, *Willd.*
Echinopogon
ovatus, *Pal.*

Dichelachne
 stipoides, *Hook. f.*
 crinita, *Hook. f.*
 sciurea, *Hook. f.*
Sporobolus
 elongatus, *Br.*
Agrostis
 æmula, *Br.*
 Billardieri, *Br.*
 quadriseta, *Br.*
Arundo
 conspicua, *Forst.*
Danthonia
 semi-annularis, *Br.*
Trisetum
 antarcticum, *Trin.*
Glyceria
 stricta, *Hook. f.*
Poa
 anceps, *Forst.*
Festuca
 littoralis, *Br.*
Bromus
 arenarius, *Lab.*
Triticum
 multiflorum, *Banks and Sol.*
 scabrum, *Br.*
Gleichenia
 circinata, *Swartz*
 var. hecistophylla
 Cunninghamii, *Hew.*
 flabellata, *Br.*
Cyathea
 dealbata, *Swartz*
 medullaris, *Swartz*
 Smithii, *Hook. f.*
Dicksonia
 squarrosa, *Swartz*
Hymenophyllum
 Tunbridgense, *Sm.*
 n. sp.
 multifidum, *Swartz*
 rarum, *Br.*
 dilatatum, *Swartz*
 Javannicum, *Spreng.*
 polyanthos, *Swartz*
 var. sanguinolentum
 demissum, *Swartz*
 scabrum, *A. Rich.*
 æruginosum, *Carm.*
 Lyallii, *Hook. f.*
 flabellatum, *Lab.*
Trichomanes
 reniforme, *Forst.*

Trichomanes—*continued.*
 strictum, *Menz.*
 elongatum, *A. Cunn.*
 humile, *Forst.*
 venosum, *Br.*
Davallia
 Novæ Zelandiæ, *Col.*
Lindsæa
 linearis, *Swartz*
 Lessoni, *Bory*
 trichomanoides, *Dryand.*
Adiantum
 hispidulum, *Swartz*
 affine, *Willd.*
 æthiopicum, *Linn.*
 Cunninghamii, *Hook.*
 fulvum, *Raoul*
Hypolepis
 tenuifolia, *Bernh.*
 distans, *Hook.*
Cheilanthes
 tenuifolia, *Swartz*
 var. Sieberi
Pellæa
 rotundifolia, *Forst.*
Pteris
 aquilina, *Linn.*
 var. esculenta
 tremula, *Br.*
 scaberula, *A. Rich.*
 incisa, *Thunb.*
 macilenta, *A. Rich.*
 Endlicheriana, *Agardh.*
Lomaria
 filiformis, *A. Cunn.*
 procera, *Spreng.*
 fluviatilis, *Spreng.*
 membranacea, *Col.*
 vulcanica, *Blume*
 lanceolata, *Spreng.*
 discolor, *Willd.*
 nigra, *Col.*
 Frazeri, *A. Cunn.*
Doodia
 media, *Br.*
Asplenium
 obtusatum, *Forst.*
 lucidum, *Forst.*
 flabellifolium, *Cav.*
 falcatum, *Lam.*
 Hookerianum, *Col.*
 bulbiferum, *Forst.*
 flaccidum, *Forst.*

Aspidium
- Richardi, *Hook.*
- coriaceum, *Swartz*

Nephrodium
- velutinum, *Hook. f.*
- decompositum, *Br.*
- hispidum, *Hook.*

Polypodium
- australe, *Mett.*
- Grammitidis, *Br.*
- tenellum, *Forst.*
- rugulosum, *Lab.*
- pennigerum, *Forst.*
- rupestre, *Br.*
- Cunninghami, *Hook.*
- pustulatum, *Forst.*
- Billardieri, *Br.*

Nothochlæna
- distans, *Br.*

Leptopteris
- hymenophylloides, *Presl.*

Lygodium
- articulatum, *A. Rich.*

Schizæa
- dichotoma, *Swartz*
- bifida, *Swartz*
- fistulosa, *Lab.*

Ophioglossum
- vulgatum, *Linn.*

Botrychium
- cicutarium, *Swartz*

Phylloglossum
- Drummondii, *Kunze*

Lycopodium
- Billardieri, *Spring.*
- densum, *Lab.*
- laterale, *Br.*
- cernuum, *Linn.*
- scariosum, *Forst.*
- volubile, *Forst.*

Tmesipteris
- Forsteri, *Endl.*

Azolla
- rubra, *Br.*

NATURALIZED PLANTS.

Ranunculus
- repens, *Linn.*

Nasturtium
- officinale, *Br.*

Barbarea
- præcox, *Br.*

Senebiera
- pinnatifida, *DC.*

Capsella
- bursa-pastoris, *Linn.*

Lepidium
- ruderale, *Linn.*

Sinapis
- arvensis, *Linn.*

Brassica
- rapa, *Linn.*
- napus, *Linn.*
- oleracea, *Linn.*

Raphanus
- sativus, *Linn.*

Vitis
- vinifera, *Linn.*

Silene
- quinquevulnera, *Linn.*

Stellaria
- media, *With.*

Cerastium
- vulgatum, *Linn.*
- viscosum, *Linn.*

Malva
- rotundifolia, *Linn.*

Lavatera
- arborea, *Linn.*

Pelargonium
- quercifolium, *Linn.*

Erodium
- cicutarium, *Linn.*

Ulex
- europæus, *Linn.*

Trifolium
- pratense, *Linn.*
- medium, *Linn.*
- repens, *Linn.*
- procumbens, *Linn.*
- minus, *Linn.*

Medicago
- lupulina, *Linn.*
- maculata, *Linn.*
- denticulata, *Willd.*

Vicia
- sativa, *Linn.*

Acacia
lophantha, *Willd.*
Amygdalus
pessica, *Linn.*
Rubus
fruticosus, *Linn.*
Fragaria
vesca, *Linn.*
Rosa
rubiginosa, *Linn.*
canina, *Linn.*
multiflora, *Thunb.*
Lythrum
hyssopifolium, *Linn.*
Petroselinum
sativum, *Linn.*
Daucus
carota, *Linn.*
Sherardia
arvensis, *Linn.*
Erigeron
canadense, *Linn.*
Bellis
perennis, *Linn.*
Matricaria
Chamomilla, *Linn.*
Chrysanthemum
leucanthemum, *Linn.*
Senecio
vulgaris, *Linn.*
scandens, *Linn.*
Osteospermum
moniliferum, *Willd.*
Carduus
lanceolatus, *Linn.*
Lapsana
communis, *Willd.*
Hypochæris
radicata, *Linn.*
Cichorium
Intybus, *Linn.*
Helminthia
echioides, *Gært.*
Sonchus
oleraceus, *Linn.*
Taraxacum
dens-leonis, *Desf.*
Anagallis
arvensis, *Linn*
Vinca
major, *Linn.*
Erythræa
centaurium, *Pers.*
Solanum
tuberosum, *Linn.*
Physalis
peruvianum, *Linn.*
Veronica
arvensis, *Linn.*
agrestis, *Linn.*
serpyllifolia, *Linn.*
Mentha
piperita, *Linn.*
viridis, *Linn.*
Stachys
arvensis, *Linn.*
Prunella
vulgaris, *Linn.*
Plantago
major, *Linn.*
lanceolata, *Linn.*
Rumex
viridis, *Sibth.*
obtusifolius, *Linn.*
crispus, *Linn.*
acetosa, *Linn.*
acetosella, *Linn.*
Euphorbia
peplus, *Linn.*
Ficus
Carica, *Linn.*
Iris
germanica, *Linn.*
Agave
americana, *Linn.*
Colocasia
antiquorum, *Scholl.*
Richardia
africana, *Kunth.*
Phleum
pratense, *Linn.*
Phalaris
canariensis, *Linn.*
Holcus
lanatus, *Linn.*
mollis, *Linn.*
Agrostis
vulgaris, *With.*
Cynodon
dactylon, *Linn.*
Digitaria
sanguinalis, *Scop.*
Anthoxanthum
odoratum, *Linn.*
Aira
caryophyllea, *Linn.*

Avena
  sativa, *Linn.*
Poa
  annua, *Linn.*
  pratensis, *Linn.*
Briza
  minor, *Linn.*
Dactylis
  glomerata, *Linn.*
Bromus
  erectus, *Hud.*

Bromus—*continued.*
  sterilis, *Linn.*
  mollis, *Linn.*
  racemosus, *Linn.*
Lolium
  perenne, *Linn.*
  temulentum, *Linn.*
Triticum
  sativum, *Linn.*
Hordeum
  sativum, *Linn.*

Art. XLVIII.—*On the Naturalized Plants of the Province of Canterbury.* By John F. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 4th October,* 1871.]

The question of the introduction and naturalization of European and other plants in New Zealand having become a very important one, I have been induced to draw up a list of those to be found in the neighbourhood of Christchurch, and to make a few remarks on the subject, more especially as no list of Middle Island naturalized plants has yet appeared, though an excellent paper on the introduced plants of the Auckland province, by Mr. Kirk, was published in the *Transactions* for 1869.*

Though my list is by no means to be considered a complete one, it yet contains 171 species, being nearly one-fourth of the total number of flowering plants (naturalized and native) found in the province.

This is certainly very remarkable when we consider that twenty years ago few or none of these plants were to be found in the province. At that time the district consisted of low swampy country, covered with coarse sedges, grasses, large masses of *Phormium tenax*, or such shrubs as *Coriaria*, *Carmichælia*, *Cordyline*, *Leptospermum*, etc.; here and there grew a small patch of forest, generally composed of *Podocarpus dacrydioides* and *P. spicata*, with a dense undergrowth of *Coprosma*, *Pittosporum*, *Panax*, and similar plants. Now, however, through the colonization of the country by European settlers, the scene has been entirely changed; the sedgy plains have been turned into well cultivated farms; the patches of forest and masses of *Phormium tenax* have almost disappeared, and in their stead we have rich pastures of European and other grasses, and gardens containing almost every plant to be found in those of England.

So completely have these introduced plants established themselves in the neighbourhood of Christchurch, that they nearly equal the native plants in

* See *Trans.* N.Z. Inst., Vol. II., p. 131.

the number of species, and by far outnumber them in the abundance of each kind. The rapidity with which foreign plants become naturalized in New Zealand is indeed a most surprising and extraordinary circumstance, and of great interest to every colonist, as it must be quite evident to every observer that the introduction of these European plants will certainly result in the extermination of the indigenous flora, and that at no very distant period of time.

The indigenous Flora seems to have arrived at a period of its existence, when it has no longer strength to maintain its own against the invading races; indeed, every person who has attempted the cultivation of native plants knows how difficult it is to cultivate the most of them, on account of their weakness of constitution. Again the hand of man is busily employed in their extermination—everywhere the forests are being cut down or burnt, the swamps drained, and the grassy plains and valleys broken up and cultivated. Under these combined influences it is evidently utterly impossible that the native plants can survive. Already a few of the rarer species are nearly extinct, and nothing can save our fine forests from destruction but the most rigid preservation by the Government.

It will be seen from the list of species that most of the plants enumerated are natives of Europe; in fact, most of them are common British weeds. Along the roadsides, for miles from the city of Christchurch, are to be seen such plants as *Polygonum aviculare*, *Stellaria media*, *Capsella Bursa-pastoris*, *Sinapis arvensis*, and an abundant growth of grasses, the most common of which are *Hordeum murinum*, *Poa annua*, *Bromus Schraderii*, *B. racemosus*, *B. mollis*, *Lolium* (several species), etc. On the hills and waste ground may be found *Hypochœris radicata*, *Carduus lanceolatus*, *Erodium cicutarium*, *Anthemis nobilis*, *Marrubium vulgare*, *Trifolium repens*, which is, perhaps, the commonest plant in Canterbury, *Conium maculatum*, *Daucus Carota*, *Pastinaca sativum*, etc. In wet places we find an abundant growth of the large English docks, *Rumex obtusifolius* and *R. crispus*, with the sorrel, *R. Acetosella*, *Ranunculus repens*, *Galium Aparine*, etc.

In the river Avon two plants are found which require more than a passing notice—these are the watercress, *Nasturtium officinale*, Linn., and *Anacharis Alsinastrum*. The former was introduced about twenty years ago, and has proved a great nuisance, blocking up the river and adjacent water-courses, impeding drainage so much that the Provincial Government have had to spend large sums of money to keep it down; it grows to an immense size, far exceeding anything ever seen in England. I may here mention that the water cress is very much infested with the cabbage blight, *Aphis brassica*.

The *Anacharis Alsinastrum*, a well known and remarkable American aquatic, is now to be found in abundance in the river Avon, where two years ago it did not exist. It was introduced in the year 1868, and planted in one of the ponds of the Acclimatization Society as shelter for the young trout; unfortunately the plant was by some means conveyed into the river, where it is spreading with astonishing rapidity. Although pistiliferous plants only have been found in the province, the latter fact is, perhaps, of little importance, as every joint will form roots when separated from the parent plant. As it is sure to prove a far greater nuisance than the water-cress, its introduction is much to be regretted, seeing that the Avon and other small streams must be kept clear for drainage purposes. The spread of this plant over Britain during the last twenty years is one of the most curious and interesting problems that has come under the notice of living botanists. About the year 1850 it was found in a pond in the centre of England, and was then supposed to be indigenous; shortly afterwards it was found in many distant localities, and was proved to be naturalized, the mode of its migration being still a mystery. It is now common all over Britain, and has, in many instances, impeded navigation in rivers and canals, and interfered with the working of water-mills. In most of those places efforts have been made to eradicate it, but with very little success. The *Anacharis* is greedily eaten by swans, ducks, and other water birds, but this circumstance, instead of being advantageous, is quite the contrary, as small portions of the plant are carried away by these birds and transplanted to other rivers. It will, indeed, be an extraordinary circumstance if this remarkable plant should become as common in New Zealand as it is in Britain.

Conium maculatum, Linn., the hemlock of England, is to be found in considerable quantities in the neighbourhood of Christchurch, where it was sown in the year 1865 by an herbalist, who, unfortunately, cannot be punished for the injury he has done the province by the introduction of this very poisonous plant.

I see that *Polygonum aviculare* is considered by Mr. Kirk to be indigenous to New Zealand, but, after nine years' study of the native Flora, I feel compelled to differ from him in this matter. The plant is spreading very rapidly in this province, more especially along the roadsides, where the seeds are carried in the mud on cart wheels, etc.

In conclusion, I beg to remind the botanists in the Middle Island that now is the time to determine the date of introduction of foreign plants into the country.

The following abbreviations are used in the list of species :—a. for Agrestal, plants of cultivated land; aq. for Aquatic, plants growing in rivers, etc.; p. for Palustral, plants of swamps, etc.; s. for Sylvestral, plants growing in woods; v. for Viatical, plants of waysides and waste places.

The following numerals are used to indicate the order of abundance in which the species are found :—1, 2, 4, 6.

1—Is used to intimate that of the species so marked only occasional individuals are found.

2—That the species is found in greater abundance than 1, but still not common.

4—That the species is common in some localities, but does not interfere to any great extent with the native Flora.

6—That the species are very abundant, and rapidly taking the place of native plants.

The date of introduction is also given when known.

The derivation of the plants is Europe, unless otherwise stated.

LIST OF SPECIES.

Ranunculus
- acris, *L.*, v., 4
- repens, *L.*, v., 4
- bulbosus, *L.*, a., v., 2

Nasturtium
- officinale, *L.*, aq., 6

Barbarea
- præcox, *Br.*, a., v., 4

Capsella
- Bursa-pastoris, *L.*, a., v., 6

Lepidium
- sativum, *L.*, a., 2

Alyssum
- maritimum, *Willd.*, v., 2

Cochlearia
- armoracia, *L.*, a., 1

Sinapis
- arvensis, *L.*, v., a., 6

Brassica
- Napus, *L.*, v., a., 2
- Rapa, *L.*, a., 1
- oleracea, *L.*, v., a., 2
- campestris, *L.*, a., 1

Raphanus
- sativus, *L.*, a., v., 1

Viola
- tricolor, *L.*, v., a., 6

Gypsophila
- tubulosa, *Boiss.*, v., 4

Silene
- quinquevulnera, *L.*, Asia, a., v., 6
- noctiflora, *L.*, a., 4

Stellaria
- holostea, *L.*, v., 4
- media, v., etc., 6

Cerastium
- vulgatum, *L.*, v., a., 6

Spergula
- arvensis, *L.*, a., 2

Githago
- segetum, *Lam.*, v., a., 4

Dianthus
- barbatus, Asia, s., 1

Malva
- rotundifolia, *L.*, a., 2

Lavatera
- arborea, *L.*, a., 2

Erodium
- cicutarium, *L.*, v. 6
- moschatum, *L.*, v., 4

Linum
- usitatissimum, *L.*, v., a., 2

Ulex
- europæus, *L.*, v., a., 6

Cytisus
- scoparius, *Lk.*, v., a., 6
- capensis, Africa, v., a., 4

Trifolium
- repens, *L.*, v., a., 6
- pratense, *L.*, v., a., 4
- minus, *Sm.*, v., 6
- medium, *L.*, a., 4
- procumbens, *L.*, a., 2

Melilotus
leucantha, Asia, a., v., 4
Medicago
lupulina, *L.*, a., 2
maculata, *L.*, v., a., 1
Onobrychis
sativa, *Lam.*, a., 1
Lotus
corniculatus, *L.*, a., v., 6
major, *Scop.*, v., 2
Vicia
hirsuta, *L.*, v., a., 4
sativa, *L.*, v., a., 4
Lathyrus
latifolius, *L.*, a., 4
Rubus
fruticosus, *L.*, v., 1
rudis, *Wehe.*, v., 1
Idæus, *L.*, v., 2
Rosa
rubiginosa, *L.*, v., 4
Prunus
avium, *L.*, s., 1
cerasus, *L.*, s., 2
Pyrus
malus, *L.*, s., 1
Geum
urbanum, *L.*, a., v., 4
Potentilla
anserina, *L.*, v., a., 6
fragariastrum, *Ehr.*, a., 1
Fragaria
vesca, *L.*, s., 4
elatior, *Ehr.*, s., 2
Amygdalus
persica, *L.*, Asia, s., 2
Œnothera
stricta, *L.*, v., a., 4
Ribes
grossularia, *L.*, s., 4
Petroselinum
sativum, *L.*, a., 4
Apium
graveolens, *L.*, a., v., 2
Daucus
Carota, *L.*, a., v., 4
Pastinaca
sativum, a., v., 4
Conium
maculatum, *L.*, v., a., 4
Sambucus
nigra, *L.*, s., 2
Galium
aparine, *L.*, v., a., 4
Helianthus
tuberosus, *L.*, America, v., 2
Erigeron
canadense, *L.*, America, etc., v., 4
Bellis
perennis, *L.*, a., v., 4
Bidens
pilosa, *L.* ? Asia, etc., a., 1
Anthemis
nobilis, *L.*, v., a., 4
Achillea
millefolium, *L.*, v., 4
rubra, 1866, v., 4
Chrysanthemum
leucanthemum, *L.*, a., 4
segetum, *L.*, v., 1
Senecio
vulgaris, *L.*, v., 6
Carduus
lanceolatus, *L.*, a., v., 6
benedictus, *L.*, a., 2
marianus, 1869, v., 2
Matricaria
Chamomilla, *L.*, a., 4
Artemisia
Absinthium, L., a., v., 4
Tragopogon
porrifolius, L., v., 2
minor, *Fries.*, v., 2
Centaurea
solstitialis, L., v., a., 4
Lapsana
communis, L., a., 4
Hypochæris
radicata, L., v., etc., 6
glabra, L., 1865, v., etc., 6
Sonchus
oleraceus, L., v., etc., 6
Taraxacum
dens-leonis, *Desf.*, v., 6
Gnaphalium
luteo-album, L., v., 4
Erythræa
centaurium, *Pers.*, a., 2
Ligustrum
vulgare, L., v., 4
Echium
vulgare, L., v., a., 4
Myosotis
arvensis, *Hoff.*, v., 4
Solanum
nigrum, L., v., etc., 6
tuberosum, L., v., 4

Verbascum
Thapsus, L., v., 4
Veronica
arvensis, L., v., 4
officinalis, L., v., 2
saxatilis, L., v., 2
Verbena
officinalis, L., v., a., 4
Lamium
album, L., s., 1
Mentha
viridis, L., p., v., 4
piperita, L., v., 4
Marrubium
vulgare, L., a., 6
Anagallis
arvensis, L., a., 4
Prunella
vulgaris, L., a., 4
Plantago
lanceolata, L., v., 6
major, L., v., 6
media, L., v., 4
Polygonum
aviculare, L., v., etc., 6
convolvulus, L., a., 1
fagopyrum, *Sm.*, 1866, a., 2
Rumex
obtusifolius, L., p., 6
crispus, L., p., 6
acetosa, L., a., 6
acetosella, L., v., 6
Chenopodium
urbicum, L., v., 6
album, L., v., 6
Bonus-Henricus, L., v., 2
Euphorbia
peplus, L., a., 4
helioscopia, L., a., 4
Urtica
urens, L., v., 4
dioica, L., v., 2
Humulus
Lupulus, L., 1865, a., 4
Anacharis
alsinastrum, 1870, America, aq., 4
Asparagus
officinalis, L., a., 2
Phleum
pratense, L., v., a., 6
Alopecurus
pratensis, L., v., a., 4
agrestis, L., v., a., 4
Phalaris
canariensis, L., v., 6
Holcus
lanatus, L., v., 6
mollis, L., v., 4
Anthoxanthum
odoratum, L., v., 6
Panicum
glaucum, L., Asia, v., 2
colonum, L., Asia, v., 2
sanguinale, L., v., 4
Agrostis
vulgaris, *With.*, a., 4
alba, L., a., 2
Avena
sativa, L., Asia, a., 4
fatua, L., a., 1
Arrhenatherum
avenaceum, *Beauv*, a., 4
bulbosum, *Lind.*, a., 4
Poa
trivialis, L., a., 4
annua, L., v., 6
nemoralis, L., a., v., 4
pratensis, L., v., 6
var. angustifolia, a., 4
Briza
minor, L., v., 4
maxima, L., v., 2
Cynosurus
cristatus, L., a., 4
Dactylis
glomerata, L., v., 6
Festuca
duriuscula, L., v., etc., 6
bromoides, L., a., 6
ovina, L., a., 4
pratensis, L., a., 2
rubra, L., v., 2
Bromus
sterilis, L., v., 4
erectus, *Huds.*, v., 4
mollis, L., v., 6
racemosus, L., v., 6
asper, L., v., 4
madritensis, L., 1864, v., 4
unioloides, *Kth.*, 1866, America, v., 6
Schrœderi, *Kth.*, 1866, America, v., 6
Lolium
perenne, L., v., 6
temulentum, L., v., 4

Lolium—*continued.*
- arvense, L., v., 4
- multiflorum, *Lam.*, v., 4
- italicum, L., v., 4

Triticum
- repens, L., v., etc., 4

Hordeum
- murinum, L., v., 6
- sativum, L., a., 2
- maritimum, L., v., 4
- distichum, L., v., 1

Art.—XLIX.—*On some New Species of New Zealand Plants.* By John F. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 4th October,* 1871.]

Aciphylla montana, Armstrong. n. s.

Small, 8–10 inches high, smooth and shining. Radical leaves numerous, spreading, 4–5 inches long, pinnate. Leaflets jointed, 2–3 inches long, $\frac{1}{5}$–$\frac{1}{8}$ broad, linear or sword-shaped, pungent, striate, midrib rather obscure; sheath 1–1½ inches long, $\frac{1}{3}$–$\frac{1}{2}$ inch broad, with one small subulate leaflet on top of each side. Flowering stem about 8 inches high, as thick as a goose quill, deeply grooved, shining, with one leaf about halfway up; umbels few, fascicled, in a contracted panicle 2 inches long; peduncles very short; bracts numerous, 1–2½ inches long, with one to three spreading leaflets, and two small subulate ones at the top of the sheath. Fruit small, about $\frac{1}{6}$ of an inch long, closely packed on very short pedicels; carpels with five rather narrow wings. Flowers not seen.

Hab.—On rocky ledges 4,000 feet altitude, Rangitata District, 1869; Collected by *W. Gray* and *John F. Armstrong.*

A curious little species approaching some states of *A. Monroi*, Hook. f., but sufficiently distinct in the fascicled umbels and very large bracts.

Senecio Pottsii, Armstrong. n. s.

A small suffruticose, decumbent, very slender species; branches ascending 3–6 inches long, flexuose, grooved, covered with white loose cottony tomentum. Leaves petioled, alternate, ovate or spathulate, $\frac{1}{2}$–1 inch long, crenate, glabrous above or nearly so; covered below with appressed cottony tomentum. The veins almost parallel with the midrib; head solitary, on slender bracteate peduncles, turbinate $\frac{1}{3}$ inch long; involucral scales 15–20, linear spreading, obtuse, cottony.

Hab.—Mount Jollie, Rangitata District, altitude 4,500 feet, *W. Gray* and *John F. Armstrong.*

My specimens are very imperfect, but the species seems very distinct from any other New Zealand one, differing chiefly in the suffruticose habit and solitary heads. I have named this distinct and curious species in compliment to Mr. T. H. Potts, of Governor Bay, who has paid much attention to the cultivation of New Zealand plants.

Trichomanes Armstrongii, Baker.

(*Hymenophyllum Armstrongii*, Hook. f.)

A very small species, forming dense dark green coloured masses beneath water-falls; rhizome creeping, very slender; fronds about $\frac{1}{2}$ inch long, usually pinnate, but frequently flabellate; pinnules few, 2–4 lines wide, with no veins but the midrib, and a peculiar purple ciliated margin, which distinguishes the species from any other New Zealand form; sori 1–2 or 4 to a frond at the tips of the pinnules, obconic and ciliated.

Hab.—Waterfalls near the sources of the Waimakiriri, altitude 3,800 feet, *Dr. Haast* and *J. B. Armstrong*, 1867.

Veronica anomala, Armstrong. n. s.

A slender, erect, quite glabrous shrub, 2–3 feet high, with long weak purplish branches. Leaves patent, shortly petioled, glabrous, $\frac{1}{2}$–1 inch long, $\frac{1}{4}$ inch broad, coriaceous, linear-oblong, concave, entire, polished on the upper surface; midrib obscure. Flowers crowded together at the points of the branches; sessile in the axils of the uppermost leaves; sepals $\frac{1}{6}$ inch long, linear-oblong, acute; corolla white, tube $\frac{1}{4}$ inch long; limb $\frac{1}{4}$–$\frac{1}{2}$ inch broad; lobes 3 nearly equal, or 2 unequal, with the longer one forked at the tip; capsule not seen. Flowers in winter.

A curious plant, differing from all other Veronicas in the number of corolla lobes. In foliage it much resembles *V. vernicosa*, and in the corolla has some distant resemblance to *V. Colensoi*. It may prove to be an hybrid between these two species.

Hab.—Head waters of the River Rakaia.

Gentiana Novæ Zelandiæ, Armstrong. n. s.

Root slender, annual; stems numerous from the root, ascending, about 6 inches high, very slender, rather leafy, many-flowered, black when dry. Leaves linear-spathulate, linear-oblong, or spathulate-oblong, $\frac{1}{4}$ to $\frac{1}{2}$ inch long. Flowers about $\frac{1}{2}$ inch long, pale yellow, on slender pedicels; calyx rather deeply divided; lobes shorter than the corolla, linear-acute; corolla-lobes, ovate-oblong, acute.

Hab.—Sources of Rangitata River, *Armstrong*.

Art. L.—*Report of a Committee of the Canterbury Philosophical Institute on Native and Introduced Grasses.*

[*Submitted to the Philosophical Institute of Canterbury, 5th April,* 1871.]

In presenting to this Society their report, your Committee have to express regret that in some respects their labours have not been crowned with the success they anticipated, more especially as regards native grasses.

As a first step in the prosecution of the task allotted to them, your Committee resolved on taking in hand the subject of native grasses, as being, besides its intrinsic importance, that on which information was most deficient. To facilitate the collection of such information, they prepared a printed list of such native grasses as appeared to them most valuable (33 in number), with a series of questions in a shape conveniently arranged for the insertion of the required answers. These questions referred mainly to the locality, altitude, and peculiarities of soil in which each grass is found. Its season of flowering or seeding, its feeding value in different seasons of the year, the special circumstances affecting its growth, its power of resisting drought and frost, its comparative feeding properties, and how it is relished by different kinds of stock, its increase or the reverse since the settlement of the country and the cause thereof, and generally any other information that could be furnished.

A large number of these papers, accompanied by a printed circular, setting forth the objects your Committee had in view, were distributed amongst gentlemen who were thought likely to take an interest in the subject, both in this and the other provinces of New Zealand.

One serious obstacle in the way of acquiring the desired information did not fail to present itself to your Committee, namely, their inability, save in a very few cases, to give any but the botanical names of the native grasses. This they feared would prove an insurmountable difficulty to many persons who would otherwise willingly respond to their inquiries. Their anticipations on this head have proved but too correct.

To lessen this impediment so far as lay in their power, your Committee in some instances, therefore, where from the presumed pursuits and studies of the persons addressed they believed it advisable, added a special communication, of which the following is an extract:—

"The Committee in preparing a list of grasses have had a difficulty in giving the common names, and as many observers of grasses may not be able to recognise them under their scientific nomenclature, it is desirable that the English and Maori names should be added where practicable. Believing that you will be able to assist them in this object, the Committee will feel obliged by your attaching the common names to the inclosed list, and returning it at your earliest convenience."

In short, your Committee asked generally for the assistance of all persons interested in the furtherance of the important subject they had undertaken.

The answers to the appeal of your Committee were but very few, and those contained (with one important exception to be afterwards referred to) only expressions of regret at being unable to furnish the information asked for. The only information received as to the common names, either English or Maori, was from Mr. Colenso, of Hawkes Bay, who states that, "As to the Maori names of grasses (in the printed list), the smaller ones are all known as Patiti; No. 3, *Hierochloe redolens*, has a separate name, and is called Karetu."

Your Committee, in expressing themselves as above, do not wish to be understood as implying censure on any of the gentlemen to whom they addressed themselves, for apathy in the matter, for they have reason to believe that in most cases the cause why the circulars were not returned was, that the settlers to whom they were sent were unable to identify the grasses by their technical names; and as the Committee, as before stated, were unable to give the common names in the circular, there thus arose almost a deadlock between the parties.

The above general statement of the course adopted and its results will, your Committee are convinced, go far towards indicating the causes of the imperfect success attained in that branch of the inquiry to which the Society attached peculiar interest, viz., the acquiring a more perfect knowledge of the properties of, and the best means of utilising, the indigenous grasses of the colony.

Before leaving this part of their report, your Committee wish, in connection with their native grass circulars, to advert particularly to the one exception before alluded to. That exception is a valuable contribution from Mr. Thomas Kirk, of Auckland. Besides returning the tabulated form with the desired replies as to the grasses therein named which are natives of Auckland, and giving additional information on other native grasses of that province not mentioned in your Committee's list, and some of which are probably peculiar to the North Island, Mr. Kirk accompanied his reply with some interesting specimens of indigenous grasses, and also a comprehensive and valuable paper on the progress and condition of exotic grasses in the province of Auckland. (Appendix A. to this Report.)

The dried specimens above mentioned consist of *Microlæna stipoides*, *Zoysia pungens*, *Isachne australis*, and *Sporobolus elongatus*, and came to hand in a good state of preservation.

In his letter accompanying these contributions, and addressed to the chairman of your Committee, Mr. Kirk, after many kindly expressions of interest in the work on hand, and apologies for delay arising from severe illness, goes on to remark: "I have filled up the form as well as I could; for, as to the indigenous grasses of the province, you will observe that the most valuable kinds with you take but a secondary place here, whilst those of most service to us do not come so far south as Canterbury. I have added rough notes on the chief cultivated and naturalised grasses in this province (Auckland), as it is evident that good permanent pasture can not be made by native grasses alone, although several species are of great value when mixed with the rye-grasses, fescues, and meadow grasses of Europe." Again: "Severe frosts are unknown north of the Auckland isthmus, and we have no hills so high as 3,000 feet even, except on the south and south-eastern extremity of the province, so that little can be said of the effects of frost on altitude." Mr. Kirk concludes by courteously volunteering his further services in any way that can advance the work on hand, and asking your Committee to kindly send him in return specimens of any indigenous grasses of Canterbury—"especially," he says, "those marked on your list, so as to ascertain any divergence in nomenclature."

Your Committee, sensible of Mr. Kirk's ready kindness, desired their chairman to convey to that gentleman their thanks for, and great appreciation of, his valuable contributions. In addition to which, Mr. Armstrong (a member of your Committee), in comformity with his request, forwarded to him a selection of such specimens (35 in number) of the native grasses of Canterbury as he thought most desirable and acceptable, and has now an additional number in course of preparation.

The information given by Mr. Kirk your Committee strongly recommend should be printed *in extenso*, both on account of its intrinsic value, and because it chiefly refers to the province of Auckland, which is so far distant from Canterbury, that it is quite possible the same grasses may occupy different positions relatively in the two places.

Finally, Messrs. J. F. and J. B. Armstrong have furnished your Committee with a series of notes on 42 grasses indigenous to the province of Canterbury, which your Committee are persuaded will prove of great value and interest. (Appendix B. to this Report.)

At the commencement of this season, your Committee sent out a few circulars (with tabulated lists as before), requesting information upon 21 exotic grasses, and they are glad to be able to report that three of these have been returned, with much valuable information filled in. The Committee is indebted for these to Messrs. S.D. Glyde, M. Dixon, and J. C. Boys, three gentlemen who have had considerable experience in grasses.

To facilitate comparison, the replies and remarks furnished by the above-named gentlemen in the returned circulars have been thrown into a synoptical form, and are presented in an Appendix, together with a series of observations by Mr. A. Duncan, one of the Committee, which your Committee anticipate will prove of much interest to the practical cultivator. (Appendix C. to this Report.)

During the season your Committee have collected, chiefly through the instrumentality of Mr. Armstrong, a large number of specimens of native and exotic grasses. These have all been named; and the native grasses, properly classified in frames, will be exhibited in the Museum, the Director having kindly made room for them in a position where they may be easily seen, and will thus afford a ready means to all who may take an interest in the subject, to familiarise themselves with the appearance and names of the indigenous grasses, and much facilitate future inquiries.

The specimens of exotic grasses are being arranged in books, which will be placed in cases, and, on application to the custodian, given out to any person who may be desirous of inspecting them; a list of these several grasses is submitted with the report.

In addition to these Mr. Armstrong has furnished a list of the naturalized grasses of Canterbury, which will be found in Appendix D. to this Report.

In conclusion, your Committee confidently hope that, although, from the limited amount of information they have been able to obtain, more particularly as regards the indigenous grasses, the result of their labours may seem but slight, it will, nevertheless, materially facilitate further inquiries should the Society, now or at any future time, determine on further prosecuting investigations, the object of which is the "adding to the wealth of the permanent pastures of the colony."

Robert Wilkin, Chairman.

Appendix A. (Part. I.)

Notes on Introduced Grasses in the Province of Auckland.—By T. Kirk, F.L.S.

Alopecurus pratensis, L. Meadow Fox-tail grass.—A grass of high value, yielding a large return of herbage of the first quality; very early, but continuous. Sparingly cultivated, although often found in grass paddocks, and naturalized in many places.

Phalaris Canariensis, L. Canary grass.—Occasionally cultivated for seed, but is naturalized from the North Cape to Upper Waikato, and in some places occurs so abundantly as to be cut or pulled for fodder early in the season. Grows quickly.

Phleum pratense, L. Timothy grass.—A valuable grass, attaining its greatest luxuriance in the autumn, but affording a continuous yield; prefers moist soils, but has considerable power of adaptation.

Gastridium lendigerum, Beauv. Nit-grass.—Has been introduced with seeds of other grasses, and has become naturalized in many places. Yields a large quantity of seed, but comparatively little herbage.

Agrostis vulgaris, L. Common Bent.—Naturalized in many places, often found amongst cultivated grasses. Yields a large quantity of herbage, which attains its maximum before flowering. A valuable and hardy grass, although not affording such heavy yields as the Fiorin grass, *A. alba* b. *stolonifera*.

Holcus mollis, L.

" *lanatus*, L.

Soft Bent grasses.—Of no value to the cultivator, but, unhappily, having acquired the name of *Soft Fescue* in this province, the seed is collected and sown by inexperienced settlers, to their certain loss and disappointment.

Setaria italica, P. de Beauv.—A strong growing grass, affording an immense yield of coarse herbage and seed, has become naturalized in waste places, roadsides, etc., and is always eaten by cattle; prefers moist places.

Poa pratensis, L. Common Meadow grass. — If I were instructed to select the one most valuable grass as yet introduced into this province, my choice would fall upon this. It adapts itself to every variety of soil and situation—in shade in the Domain grounds it makes a dense sward, and gives a remarkably large yield—in the adjoining pasture it is of equal value—it grows freely on stiff clays, and may be seen "clearing-out" other grasses in scoria paddocks—affords a large yield of nutritious herbage—resists frost and drought. It is naturalized in many places in the province, is spreading freely, and would come into more general cultivation but for the difficulty experienced in obtaining clean seed.

P. annua, L.—Abundantly naturalized, yields a short but dense crop of rather watery herbage, which soon dies off. Of no value to the cultivator.

P. trivialis, L. Rough Meadow grass.—A valuable grass alike for pasturage and hay; flowers early, and is most nutritious when the seed is ripe. Very serviceable on shaded land and open forest. I have never seen it in cultivation in Auckland, although it is sparingly naturalized, but being closely cropped by cattle does not increase.

Briza minor, L. Small Quaking-grass.—An annual grass of little value, abundantly naturalized here, and yields a considerable quantity of light herbage in the early spring.

Dactylis glomerata, L. Cock's foot grass.—A rather coarse but nutritious grass, yielding a large return, and perhaps better than any other kind commonly sown in the north for resisting the attacks of caterpillar. It has the disadvantage, however, from its coarse growth, of killing off rye-grass, and other weak growing kinds which may be sown with it. In the North it is usually relied upon for the staple, especially on bush paddocks.

Cynosurus cristatus, L. Crested Dog's-tail.—A valuable grass, especially for rather dry soils, and ought to be generally grown. Makes with *Poa pratensis* and *Lolium perenne* first-class pasturage on the scoria land about Auckland, and on ordinary soils in the Waikato.

Festuca bromoides, L.—An annual grass, and abundantly naturalized, but of little value.

Festuca ovina, L. Sheep's Fescue.

„ *rubra*, L. Reddish Sheep's Fescue.

Valuable grasses, especially on sheep-runs, but so rarely cultivated here as to form no appreciable portion of the pasturage.

Bromus erectus, Hud.

„ *commutatus*, Schrad.

„ *mollis*, L.

„ *racemosus*, L.

Brome grasses.—Not cultivated here so far as I am aware, but naturalized to a greater or lesser degree, and eaten by cattle. *B. commutatus* is perhaps the most valuable. *B. mollis* is (on Dr. Schomburgh's authority) cultivated with advantage in South Australia, both for green fodder and hay.

Avena sativa, L. Oat.—Abundantly cultivated for green fodder, hay, and grain; naturalized in many parts of the province.

Lolium perenne, L. Rye-grass.—A well known and valuable grass, adapted to a wide range of soil and situation, but in the North apt to be destroyed by caterpillar. Commonly naturalized.

L. Italicum, A. Braun.—Occasionally cultivated with clover, etc., and sparingly naturalized. A valuable grass, but less capable of resisting drought and caterpillar than the last.

Cynodon Dactylon, Pers. Dog's-tooth.—Abundantly naturalized from the North Cape to Cambridge, and without question the best grass we have for resisting drought. Makes a compact sward, and is much eaten by cattle.

Anthoxanthum odoratum, L. Sweet Vernal grass.—Everywhere, both naturalized and cultivated. Grows quickly, affording a short but very dense crop; of most value early in the season. As is well known, imparts the peculiar fragrance to newly mown hay.

Eragrostis Brownii, Kunth.—An abundant naturalized grass at Kerikeri, Bay of Islands, producing a large quantity of slender herbage, which is greedily eaten by cattle. Chiefly grows amongst tea-tree, etc., and found also near Auckland, but not plentiful. I am inclined to think highly of this grass for cultivation in the North, but am doubtful as to its capability of resisting frost. Appears to prefer poor stiff clays, on which it attains great luxuriance.

Ceratochloa unioloides, P. de Beauv. Prairie grass.—Not cultivated in this province to any extent, but has become largely naturalized. Affords a very heavy yield, but on the whole appears better adapted for fodder than pasturage. When young it is eaten by cattle with avidity, but is usually passed over when old. Would probably possess greater value in Canterbury than in this province, as it roots deeply, and is able to endure a considerable amount of drought.

Stenotaphrum glabrum. Buffalo grass.—A smooth, stout-growing, procumbent grass; a great favourite with sheep, horses, and cattle, even when associated with rye-grasses and other ordinary cultivated kinds. It is rare here at present, but will, I anticipate, prove of great value, especially for *planting* on our clay tea-tree hills. At present it has not seeded *freely*, but may be expected to do so.

I regret my inability to give either native or settler's names of the native grasses, as requested. Very few indeed of our northern natives have any knowledge of the old native names, and my residence in the colony has been but short. *Hierochloe redolens,* and the more valuable *Isachne australis,* are alike called "Swamp-grass" by the settlers. *Sporobolus elongatus* is generally known as "Rat's-tail grass" as far south as Lake Taupo; but at Port Waikato it is called "Chilian-grass," as it is erroneously supposed to have been introduced with the so-called "Chilian groundsel" *Erigeron canadensis,* a plant which appears to have been brought to this colony with grass seed from South America. I am not aware that other native grasses have received special names in this province, The common names for introduced grasses are applied in a somewhat arbitrary manner, which has occasionally proved a source of loss and vexation.

Several of the native-grasses, as *Microlœna stipoides, Danthonia semi-annularis, Agrostis œmula,* etc., maintain their ground against, and unite with, several of the introduced kinds in the formation of natural pasture in many places in this province. The kinds just mentioned may often be seen mixed with *Agrostis vulgaris, Anthoxanthum odoratum,* etc., and especially with the little Yellow Suckling, *Trifolium minus,* forming large patches of gradually extending herbage amongst the tea-tree about Auckland. Some paddocks on the west side of the city appear to have been spontaneously formed in this way, although they have been improved by the depasturing of cattle.

The common red and white clovers, and the various medicks, with other forage plants, are largely naturalized in the province, and yield a large quantity of grateful food. On the volcanic hills about Auckland the toothed and spotted medicks, *Medicago denticulata* and *M. maculata,* yield largely in winter and early spring; the yarrow (*Achillea Millefolium*) is occasionally met with, both as a naturalized and cultivated plant, and is closely cropped by sheep and cattle. The same may be said of the melilot, bird's-foot trefoil, wild-carrot, rib-grass, and several vetches.

It is probable that in the province of Canterbury native species of *Ligusticum*, *Angelica*, and other aromatic plants are sought after by cattle and sheep. In the northern part of this province we have no *Ligusticum*, and only one species of *Angelica*, *A. rosæfolia*, which is found in rocky places by the sea, rarely within reach of cattle; but *Apium leptophyllum*, *Mentha Cunninghamii*, *Lepidium oleraceum*, *Daucus brachiatus*, and other pungent and aromatic kinds are usually eaten with avidity. This suggests the advisability of improving permanent pasture by the addition of some of the well-known condimental plants, as parsley, caraway, burnet, burnet-saxifrage, yarrow, black-medick, etc. The common parsley is abundantly naturalized in many places in Auckland, and everywhere greedily eaten. Attention is being more generally directed to these plants in England as supplying a felt want, and parsley, yarrow, fenugreek, etc., are regularly advertised by agricultural seedsmen.

Many valuable grasses, as the meadow fescues—*Festuca pratensis*, *F. loliacea*, *F. elatior*—some of the larger growing meadow grasses, as *Poa sudetica* and *P. serotina* (the *P. fertilis* of seed-dealers), have not been introduced into this province at present. It is probable that *Festuca pratensis* and *F. loliacea* would largely supersede the rye-grass so commonly sown, as the yield both for pasturage and hay is fully equal, while the quality is more nutritious.

Appendix A (Part II.)

Synopsis of Tabular Circular returned, with Information and Observations on sundry Indigenous Grasses named therein, and also on certain others not mentioned in the Circular. By T. Kirk, F.L.S., Auckland.

Gymnostichum gracile.—Found at Kaipara, etc., at sea-level; flowers in November; apparently local, and in comparatively small quantity.

* *Hierochloe redolens.* Tall sweet scented Holy-grass.—Found at sea-level on swampy ground; is useful as a spring and summer grass; not eaten when better kinds can be had.

* *Panicum imbecille.*—Found at sea-level to 1,500 feet in woodlands; continuously useful; like the last, not eaten when better kinds can be had.

* *Echinopogon ovatus.*—Found in waste lands and neglected cultivations; is useful in spring to autumn; flourishes in disturbed soil; useless for cattle.

* The species thus marked are amongst the commonest plants in the Province of Auckland.

* *Dichelachne crinita.*—Found in waste lands and neglected cultivations; useful in spring and autumn; flourishes in disturbed soil; a good grass for waste places, but inferior to many others.

Agrostis canina. Brown Bent grass.—Prefers moist soil; useful in summer and autumn; is affected by drought; a valuable grass for stock, and is increasing; only found in the Auckland district as a cultivated plant.

* *Agrostis æmula.*—Common at sea-level to 2,000 feet; flowers October to January; useful in spring and summer; affected by drought; is a serviceable grass, but less valuable than *A. canina.*

**Agrostis quadriseta.*—Common at sea-level to 1,500 feet on rich land; flowers November to February; useful in spring and summer; affected by drought; is a serviceable grass, but also less valuable than *A. canina*, and produces less herbage.

Danthonia Cunninghamii. Snow-grass.—A local grass, found at sea-level to 1,200 feet on moist land; affected by drought.

* *Danthonia semi-annularis.*—Abundant at sea-level to 2,000 feet; flowers continuously, and prefers disturbed soil; is a valuable grass, and is increasing. The variety formerly known as *D. cingula*, is a useful grass, and appears to deserve the attention of the cultivator.

Trisetum antarticum. Oat-grass. — A local grass, widely distributed; found from sea-level to 1,500 feet in dry soil; flowers October to January; useful in spring and summer; is affected by drought; a valuable grass.

Poa breviglumis.— Found in many localities at sea-level, on sandy soil; flowers October to January; useful spring to autumn; resists drought; is a valuable grass; ought to be generally cultivated on sandy soils.

Poa anceps. Soft Meadow grass.—Abundant from sea-level to 2,000 feet; found on moist soil; flowers November to February; useful spring to autumn; resists drought; a valuable grass, but not equal to *P. pratensis.*

Poa australis. Soft Meadow grass.—A local grass; highly nutritious; ought to be generally cultivated.

Triticum multiflorum.

,, *scabrum.* Rough wheat grass.

Found at sea-level; flower from October to January: useful in spring and summer; useful grasses; increasing slowly.

The above grasses are contained in the list circulated by the Committee. The following are not named therein :—

Microlæna stipoides, Br.—Is found from North Cape to Upper Waikato, at low elevations; a highly valuable grass, much and greedily sought after by sheep, horses, and cattle; one of the most valuable we have; is becoming mixed up with cultivated grasses, and is increasing; resists drought, but would probably not resist frost.

Microlæna avenacea, Br. — A coarse grass, often eaten by cattle, and valuable for sowing in open forests, etc.

Isachne australis, Br.—One of the best grasses for mainlands and swamps; greedily eaten by horses, cattle, and sheep; produces a large yield of slender but nutritious herbage, but would probably not resist frost; found from North Cape to Upper Waikato; a valuable grass from spring to autumn.

Zoysia pungens, Willd.—A low growing grass, rarely more than 2 to 3 inches high, producing a compact sward of short but succulent and nutritious herbage; chiefly on land or mud by the sea. Abundant in central and upper Waikato, where it doubtless marks the site of an ancient sea-basin. Closely cropped by sheep, horses, and cattle. From Spirits Bay to Upper Waikato, and probably further south.*

Sporobolus elongatus, Br.—A grass of remarkable toughness and hardiness of endurance. In Lower Waikato and other places it forms extensive pastures, and is kept as closely cropped by cattle as if frequently mown; still it is not a favourite grass where other kinds can be had. From North Cape to Upper Waikato and Lake Taupo; and, like some other plants, is increasing from the spread of agricultural operations.

Agrostis Billardieri, Br.—A rather coarse grass; not uncommon on poor soils, but not much eaten by cattle.

Appendix B.

Notes on grasses indigenous to the Province of Canterbury.

By J. F. and J. B. Armstrong.

1. *Microlæna avenacea,* Br.—A large coarse grass, common in woods and warm gullies, not hardy in the Government Domain; eaten by cattle; of no use to the farmer. Flowers in December.

2. *Alopecurus geniculatus,* L.—The common fox-tail grass; found in various swampy localities, also found in Europe and America; of no use to the cultivator. Flowers in December, January, and February.

3. *Hierochloe redolens,* Br.—Karetu, swamp grass; abundant in swamps and wet places; eaten by stock, but far too coarse for general cultivation. November and December.

4. *Hierochloe alpina,* R. and S.—Somewhat like *H. redolens,* but smaller, and a much superior grass; it is alpine and not common.

5. *Spinifex hirsutus,* Lab.—A curious grass, of no agricultural importance; the burr grass of the settlers.

6. *Panicum imbecille,* Trin.—This is said to be found in the province, but we have never observed it; it is probably worthless.

* See "Handbook N.Z. Flora."

7. *Zoysia pungens*, Willd.—A small matted grass; growing on sand-hills in the neighbourhood of the sea; would be useful for fixing loose sand. Flowers in November.

8. *Echinopogon ovatus*, Pal.—A tall slender grass of no agricultural importance; common in woods on Banks Peninsula. Flowers in November.

9. *Dichelachne crinita*, Hook. f.—A valuable grass, much eaten by horses, cattle, and sheep, forming good pasture and producing abundance of food. Flowers in December.

10. *Apera arundinacea* Hook. f.—A tall, reed-like, very beautiful grass; its agricultural qualities are quite unknown; found by the Hon. J. Hall on an island in the Rakaia.

11. *Agrostis æmula.*
12. „ *pilosa.*
13. „ *canina.*
14. „ *avenoides.*

Are abundantly distributed on the plains and on the Alps; they are much alike in character, being valuable cattle and sheep grasses.

15. *Agrostis Billardieri*, Br.—A dwarf broad-leaved grass, found on sand-hills and rocks near the sea; much eaten by cattle and horses. Flowers in December.

16. *Agrostis setifolia*, Hook. f.—A very small tufted species, found on the Alps; value unknown; produce small.

17. *Agrostis parviflora*, Br.
18. „ *quadriseta.*

Are both common on the Alps and some parts of the plains, and are of little value.

19. *Agrostis Youngii*, Hook. f.—Found on the Alps by Dr. Haast; somewhat like *A. avenoides*, and probably similar in quality.

20. *Arundo conspicua*, Forst.—A very beautiful species; it is the largest New Zealand grass, and is grown in British gardens for ornamental purposes.

21. *Danthonia Cunninghamii*, Hook. f.
22. „ *flavescens*, Hook. f.
23. „ *Raoulii*, Steud.

These are large coarse grasses, called snow-grasses. They are eaten by horses, and are used for thatching.

24. *Danthonia semi-annularis*, Br.—Common throughout the province, and so closely cropped by cattle and horses that we had considerable difficulty in obtaining specimens.

25. *Deschampsia cæspitosa*, Pal.—A tall grass, very common on the banks of the Avon below Christchurch; of no value. Flowers in December and January.

26. *Kœleria cristata*, Pers.—A beautiful grass, common on the plains and Malvern Hills; one of our best pasture grasses, eaten by sheep, cattle, and horses.

27. *Trisetum antarcticum*, Trin.—A first-rate grass, slender, tufted, and very beautiful; Banks Peninsula; not common. Flowers in November and December.

28. *Trisetum subspicatum*, Pal.—A small alpine grass, rare in Canterbury, but more common in Otago; eaten by sheep and cattle; found in all quarters of the globe.

29. *Trisetum Youngii*, Hook. f.—A tall slender grass, found by Dr. Haast in the Macaulay Valley; probably good.

30. *Glyceria stricta*, Hook. f.—Common near the Sumner estuary; perhaps a good spring grass. The British *G. fluitans* is abundant in the Avon, and is perhaps indigenous. It is an excellent grass for cattle and aquatic birds.

31. *Poa imbecilla*, Forst.—Common in the open bush on Banks Peninsula, where it forms a dense green sward, producing a large quantity of good herbage, eaten by cattle and sheep.

32. *Poa breviglumis*, Hook. f.—A small tufted grass, producing a large quantity of food; common in several places near Christchurch. Flowers in November and December.

33. *Poa foliosa*, Hook. f.

34. „ *australis*, Br., var. *lævis*.

These two species are common in the Alps and low hills. They are both tufted, and are very good pasture grasses.

35. *Poa anceps*, Forst.—This is the common tussock-grass of the Plains and Port Hills.

36. *Poa Colensoi*, Hook. f.

37. „ *Lindsayi*, Hook. f.

Are alpine pasture grasses, of considerable merit for sheep feeding.

38. *Festuca duriuscula*, Linn.—The hard fescue; a small and valuable grass found all over the world in alpine pastures. November and December.

39. *Triticum multiflorum*, Banks and Sol.—A tall coarse-looking perennial grass, very nearly allied to, if not the same as, the British *T. repens*, L.; it is of no agricultural value, and is common everywhere. Flowers in December.

40. *Triticum scabrum*, Br.—The blue-grass of settlers; a valuable grass found in many countries; in Canterbury it grows at an elevation of five to six thousand feet, and is certainly one of the best native grasses.

41. *Triticum Youngii*, Hook. f.—This was found by Dr. Haast, and is described as a remarkable species, with few spikelets and very long rigid awns; if it is perennial it will probably prove a useful cattle grass.

42. *Gymnostichum gracile*, Hook. f.—This was found by Raoul at Akaroa; it is described as a curious grass, three or four feet high, growing in woods; probably of no value for feeding purposes.

Appendix C. (Part I.)

Synopsis of Three Returned Tabular Circulars, with Information on certain Introduced Grasses, in answer to the Committee's Inquiries. By J. C. Boys, M. Dixon, and S. D. Glyde.

The localities reported from are all in the province of Canterbury—viz., Eyrewell, altitude 500 feet, by Mr. Dixon; Prebbleton, altitude 60 feet, by Mr. Glyde; Rangiora, altitude 80 feet, and Christchurch, altitude 15 feet, by Mr. Boys.

1. *Lolium perenne.* Common Rye-grass.—Altitude 80 feet; thrives in moist rich clay; flowers from November to March; good all the year round; resists drought badly; most valuable of grasses for general purposes; resists frost very fairly when the ground is well drained, not otherwise; is increasing; does not contain so much nutritive matter as many of those following.—*Boys.*

Altitude 500 feet; flowers three weeks in December; useful from spring to autumn; will not stand drought; is valuable as a mixture; will diminish with heavy stocking.—*Dixon.*

Altitude 60 feet; thrives in dry soil; flowers in December; good spring grass; resists drought badly; is diminishing.—*Glyde.*

2. *Lolium italicum.* Italian Rye-grass.—Altitude 500 feet; will diminish; serious damage is apt to be caused by the seed being sold in quantities for permanent pasture instead of permanent grasses.—*Dixon.*

Altitude 60 feet; thrives in dry soil; flowers in December; a summer grass; resists drought well; stock like it better than common rye-grass; is increasing.—*Glyde.*

3. *Dactylis glomerata.* Cock's-foot.—Altitude 80 feet; thrives in moist rich clay; flowers from middle of December to end of February; useful spring, summer, and autumn; resists drought better than rye-grass; stock fond of it when not too old, but should be kept fed down; second grass in value; resists frost badly; is increasing; no pasture land should be without it.—*Boys.*

Altitude 500 feet; flowers two or three weeks in January; is useful early and late; resists drought well; valuable early grass; resists frost well; requires sowing on dry pastures.—*Dixon.*

Altitude 60 feet; thrives in dry soil; flowers in January; useful summer grass; resists drought well, but frost badly; should be kept fed close or it grows tufty.—*Glyde.*

4. *Phleum pratense.* Timothy.—Altitude 80 feet; thrives in moist rich clay; flowers from beginning of January to March; useful spring, summer, and autumn; resists drought badly, but will stand any amount of wet; everything ravenous after it; the finest grass in the world and the most nutritive; most valuable in consequence of not spreading; is decreasing; no pasture land should be without it, although everything from the sheep to the caterpillar is so fond of it, which is why I place it fourth as to value.—*Boys.*

Altitude 500 feet; very good on wet, good in all soils; flowers three weeks in February; very good summer grass; likes moisture and good land; very valuable feeding grass; does not resist frost well; will increase in suitable localities.—*Dixon.*

5. *Cynosurus cristatus.* Crested Dog's-tail.—Altitude 80 feet; thrives in moist rich clay; flowers from middle of December to middle of February; useful summer and autumn; resists drought well; third grass in value; resists frost well; is increasing; forms a nice sward, and thrives on the wet as well as on the dry banks.—*Boys.*

Altitude 500 feet; good in all soils, very good in dry; flowers second week in January; good all the year round; resists drought well; is increasing; will increase on the native grasses; forms a valuable mixture.—*Dixon.*

6. *Anthoxanthum odoratum.* Sweet-scented Vernal.—Altitude 80 feet; thrives in moist rich clay; flowers in middle of October, and seed is all shed by middle of December; useful spring grass; I should place it about twentieth on the list as to value; increasing in the paddock in which it was sown, but does not seem to spread over the farm; not a good grass, throws scarcely any feed, but gives the hay a sweet scent, and is very early.—*Boys.*

Altitude 500 feet; thrives in all soils; flowers first week in November; useful winter and spring; resists drought very well; valuable as a mixture; resists frost very well; is increasing; will increase on the native grasses. —*Dixon.*

7. *Festuca pratensis.* Meadow Fescue.—Altitude 80 feet; thrives in moist rich clay; a useful summer grass; fifth in value on the list; resists frost pretty well; is increasing; it is one of the best grasses for permanent pasture, and forms a good sward.—*Boys.*

Altitude 500 feet; thrives in all soils; flowers second week in January; useful spring, summer, and autumn; resists drought very well; valuable mixture; is increasing; should not think it would increase with heavy stocking.—*Dixon.*

8. *Festuca ovina.* Sheep's Fescue.—Altitude 500 feet; thrives as sheep pasture in all soils; flowers first week in January; useful in winter and all the year round; resists drought very well; valuable mixture; resists frost very well; is increasing, and forms close undergrowth.—*Dixon.*

9. *Festuca heterophylla.* Various leaved Fescue.—Altitude 500 feet; thrives in dry sheep pastures; flowers first week in January; resists drought very well; valuable mixture; resists frost very well; is increasing, and forms close undergrowth.—*Dixon.*

10. *Festuca duriuscula.* Hard Fescue.

11. „ *rubra.* Red Fescue.

12. „ *tenuifolia.* Fine leaved Fescue.

Altitude 500 feet; all thrive on dry sheep pastures; flower first week in January; useful all the year round; resist drought very well; are valuable as mixtures; stand frost very well; are increasing. The special variety will adapt itself to any particular soil where it is sown, and will become *duriuscula, ovina,* or *rubra,* according to the poverty of the land or otherwise. —*Dixon.*

13. *Poa pratensis.* Smooth-stalked Meadow grass.—Is found about the side walks, Christchurch; altitude 15 feet; thrives in dry rich sandy loam; flowers from 15th November to end of December; useful in early summer; resists drought and frost well; valuable on dry soil, but useless in a stiff wet soil; increasing about Christchurch; forms a close bottom, but patchy; value on list No. 7 or 8.—*Boys.*

Altitude 500 feet; thrives in dry soil, but good in all; flowers second week in January; useful all the year round; resists drought and frost very well; valuable mixture; stock very fond of it; is increasing; will grow anywhere.—*Dixon.*

14. *Poa trivialis.* Rough-stalked Meadow grass.—Altitude 500 feet; thrives on strong soil; flowers third week in January; useful all the summer; resists drought well, and frost very well; stock are *not* fond of it; cannot speak as to its increase or decrease; stock would eat it *after every other.*—*Dixon.*

15. *Poa nemoralis.* Wood Meadow grass.

16. „ *nemoralis sempervirens.* Hudson Bay Meadow grass.

"I have not been able to distinguish the particular varieties."—*Dixon.*

17. *Alopecurus pratensis.* Meadow Fox-tail.—Altitude 80 feet; thrives on moist rich clay; flowers in November; useful spring grass; stock like it; it is a most valuable meadow grass; is increasing; is absolutely necessary for good permanent pasture ground.—*Boys.*

Altitude 500 feet; it likes good land, but has done well on medium; flowers early in November; useful spring and summer; forms a valuable mixture; stock very fond of it; stands frost very well; is increasing; will be a very useful grass on the best pastures in New Zealand; resists drought as well as most grasses.—*Dixon.*

18. *Holcus lanatus.* Yorkshire Fog.—Altitude 80 feet; thrives on wet peaty land; flowers in November; useful winter grass; is only valuable as

affording winter feed when all the other grasses have been cut off by frost; increasing a great deal too fast unless the ground be well drained.—*Boys.*

Altitude 500 feet; thrives everywhere; flowers second week in December; useful in spring, etc.; do not think it stands drought quite so well as some others; stock do not prefer it; resists frost very well; is increasing, and easy of production.—*Dixon.*

19. *Avena flavescens.* Golden Bristle grass.—Altitude 60 feet; thrives on dry soil; flowers in December; is a useful autumn grass, and resists drought well, but stock do not like it; is on the increase; it appears to kill other grasses; paddocks that have been sown down any time almost invariably get overrun with it.—*Glyde.*

20. *Avena elatior.* Large Oat-grass.—It is a great weed.—*Dixon.*

21. *Ceratochloa unioloides.* Prairie grass.—Altitude 500 feet; do not think it will be permanent; stock like it very much, and it resists frost very well, but is decreasing.—*Dixon.*

Altitude 60 feet; it thrives on dry soil; flowers in December; is a useful autumn grass, and resists drought well; stock very fond of it; stands frost well; is on the increase. There is great difference of opinion with regard to this grass. I had a field of it; it did well first year, second year nothing; ploughed it up and put in wheat, the grass came up in the stubble better than ever.—*Glyde.*

Note by Mr. Dixon.—I take it for granted that a paddock intended for permanent pasture must be laid down with permanent pasture grasses, and must not on any account be broken up again, as it requires a great number of years to get these grasses established; light stocking should be a rule. My replies must be taken relatively.

Remarks on Appendix C. By A. Duncan.

As will be seen in the tabulated reports furnished by Messrs. Dixon, Boys, and Glyde, the great majority of grasses, of which information was asked for, have been tried in this province, and all have been more or less favourably spoken of with the exception of the two *Avenas*, and the *Poa nemoralis* and *P. nemoralis sempervirens.* Respecting the *Avenas*, it is probable that these grasses have been confounded with others that are to a certain extent like them, if observed casually.

Mr. Glyde evidently confounds the *Avena flavescens* with the *Bromus mollis*, or else the *Bromus secalinus*, commonly termed Goose or Brome grasses. Mr. Dixon, on the other hand, names the same grass *Trisetum flavescens* (which is the name it goes under in commerce), but says he has been "unable to make it out in the plot." Mr. Dixon, however, says the *Avena elatior* is "a great weed," evidently confounding it with the *Bromi.*

The natural habitat of the *Poa nemoralis* is shady woods, particularly alpine situations, and these conditions were probably wanting in the respective situations on which the experiments were conducted. The latter of the *Poas* has been extensively experimented upon during the last two years in different parts of the province, as well as in the Amuri district of the province of Nelson, and casual information has reached the committee of its likelihood to prove a very valuable addition to our exotic grasses, particularly in hilly districts, where its remarkable stoloniferous habit and grazing capabilities will be of advantage in occupying tracts of hill country.

This grass was introduced in considerable quantities by the Messrs. G. and J. Tinline and Mr. Caverhill, from the United States of America, and is there termed Virginia-grass.

I am aware that there are other sorts of exotic grasses that are useful for special purposes, such as water meadows. The committee, however, were of opinion that no information was to be had bearing upon this particular part of the subject, and therefore did not place several grasses used for such purposes in the catalogue of sorts for which information was asked.

It is much to be regretted that fuller information was not supplied respecting the soil, with sub-soil, on which the different sorts of grasses were growing, as the influence of soils on vegetation rules to a great extent the sorts of grasses that are suitable; and it may be that some sorts which have to a certain extent been unfavourably spoken of, were growing on soils wholly unsuited for favourable comparison.

The following instances will make my meaning clear :—

Cynosurus cristatus (Crested Dogs'-tail) does not thrive well on fertile clay soils, nor on alluvial bottoms, but for poor clay, high lying clay, light chalk, brashy limestone, or sandy soils, it is eminently adapted.

Poa trivialis (Rough-stalked Meadow grass) does not do well on fertile clay soils, nor on loams derived from the old or new red sandstones, but on all other medium soils is one of the most important grasses.

Festuca pratensis (Meadow Fescue) is one of the best grasses on alluvial or clay soils of all descriptions, but on limestone, chalk, or other soils of a light character, it is not found to thrive.

These instances prove the necessity for the character of the soils being thoroughly understood before a judicious selection of grasses can be made for different localities, and it is in this respect that the Committee feel that the information at their command has not been so specific and full, considering the magnitude of the subject in its relation to the province, as would warrant them in arriving at a definite conclusion in respect to certain exotic grasses.

Appendix D.

List of Naturalized Grasses found in Canterbury. By J. F. Armstrong.

1. Phleum pratense, *Linn.* Timothy grass. Widely distributed.
2. Alopecurus agrestis, *Linn.* Annual. Fox-tail grass. Rare.
3. ,, pratensis, *Linn.* Meadow Fox-tail grass.
4. Phalaris canariensis, *Linn.* Annual. Canary grass. Rare.
5. Holcus mollis, *Linn.* Creeping Fog grass. Rare.
6. ,, lanatus, *Linn.* Yorkshire Fog grass. Common.
7. Anthoxanthum odoratum, *Linn.* Sweet Vernal. Common.
8. Panicum colonum, *Linn.* Annual. Rare.
9. ,, glaucum, *Linn.?* Annual. Rare.
10. ,, sanguinale, *Linn.* Annual. Rather common.
11. Agrostis vulgaris, *With.* Bent grass.
12. Avena sativa, *Linn.* Common Oat. Annual. Common.
13. ,, fatua, *Linn.* Wild Oat. Annual. Rare.
14. Poa trivialis, *Linn.* Rough Meadow grass. Rare.
15. ,, annua, *Linn.* Annual. Very common.
16. ,, nemoralis, *Linn.* Wood Meadow grass. Rare.
17. ,, pratensis, *Linn.* Meadow grass. Common.
18. ,, pratensis, *var.* angustifolia. Common.
19. Briza minor, *Linn.* Annual. Quaking grass. Rare.
20. Cynosurus cristatus, *Linn.* Crested Dog's-tail grass.
21. Dactylis glomerata, *Linn.* Cock's-foot grass. Common.
22. Bromus mollis, *Linn.* Annual. Soft Brome grass.
23. ,, racemosus, *Linn.* Annual. Goose grass. Common.
24. ,, madritensis, *Linn.* Annual. Italian Brome.
25. ,, asper, *Linn.* Annual. Rough Brome grass.
26. ,, unioloides, *Kth.* Annual.? Spreading fast.
27. ,, schraderii, *Kth.* Prairie grass. Common.
28. Lolium perenne, *Linn.* Ray grass. Common.
29. ,, italicum, *Linn.* Italian Rye grass. Common.
30. ,, multiflorum, *Lam.* Rare.
31. ,, temulentum, *Linn.* Darnel. Common.
32. ,, temulentum, *var.* ramosum. Rare.
33. Triticum vulgare, *Linn.* Common Wheat. Rare.
34. Hordeum sativum, *Linn.* Barley. Annual. Rare.
35. ,, murinum, *Linn.* Wall Barley. Annual. Common.
36. ,, maritimum, *Linn.* Sea-side Barley. Common.

37. Festuca ovina, *Linn.* Sheep's Fescue. Rare.
38. „ pratensis, *Linn.* Meadow Fescue. Very rare.
39. „ rubra, *Linn.* Red Fescue. Not common.
40. Arrhenatherum avenaceum, *Beauv.* Oat grass. Rare.
41. „ bulbosum, *Lind.* Bulbous Oat grass. Very rare.
42. Triticum repens, *Linn.* Creeping Wheat or Twitch.
43. Hordeum distichum, *L.* Two-rowed Barley. Rare.

IV.—CHEMISTRY.

ART. LI.—*On the Conducting Power of various Metallic Sulphides and Oxides for Electricity, as compared with that of Acids and Saline Solutions.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.*

[*Read before the Wellington Philosophical Society, 29th January,* 1871.]

IN papers read before this Society last year,† I showed that the metallic sulphides and arsenides generally were capable of exhibiting strong electro-motive power when paired either among themselves or with metals electrically negative to them, from which circumstance it appears that their capacity to conduct electricity is greater and more general than is at present contemplated for them.

It therefore became a matter of some interest to ascertain what are the exceptions to this general electric conductivity on the part of these minerals, and also to compare those which do conduct electricity with our best conducting solutions of acids or salts; the very low electric conductivity asssigned to even the best conductors among these ores in our most recent works on electricity, and the fact that they are all placed in these works (under one head ing, that of "ores") below the feeblest liquid saline conductors, when coupled with that of their general conductivity, made it especially desirable that a strict comparison should be instituted between the minerals and saline solutions referred to, in respect to their relative conducting power for electricity; and I have therefore attempted this in the manner below described.

I had hoped to furnish absolute results, but the time at my disposal, and my inability to possess myself of a sufficiently delicate resistance coil, has limited me for the present to seeking only after relative results.

The following is the method I employed:—

A voltaic cell of constant power was connected with a galvanometer, and this with platina wire electrodes of equal diameter, the free ends of which were ground plane, and fixed at a determinate distance from each other. In the case of testing liquids the wires were immersed in them to a uniform depth, and the indications, when they had attained constancy, were read off upon the galvanometer. In the case of solids the ends of the wires were firmly

* [This and the following Chemical Papers have been revised for the press by the Author.—ED.]

† See *Trans.* N. Z. Inst., Vol. III., p.p. 222 and 232.

placed on a flat surface of them, at the same distance from each other as before used.

When a solid had to be compared with a liquid the ends of the wires were allowed to be well under the surface of the latter, the same distance being maintained between the wires as before. It was afterwards found, however, that their immersion to a considerable depth did not materially affect the reading of the instrument.

In the annexed table the results of these experiments are embodied; those substances which have proved the best conductors by this process being placed superiorly. All the ores were selected for compactness and purity, and were mostly crystallized.

Mispickel	Binoxide of manganese
Galena	Iron pyrites
Sub-sulphide of copper	Nitric acid (concentrated)
Ferro-sulphide of copper	Per-chloride of iron (concentrated)
Proto-sulphide of iron	Sulphuric acid (concentrated)
Tin pyrites	Sulphuric acid (weak)
Nickel pyrites	Sea water
Sulphide of bismuth	Titanic iron
Magnetic iron ore	Boulangerite
Oxide of zinc	Hematite (impure)
Graphic tellurium	

The following minerals were proved to be non-conductors or comparative non-conductors :—Sulphides of molybdenum, zinc, antimony and manganese; cinnabar (red variety, cryst.), orpiment, bournonite (cryst.), proustite, pyrargyrite, silver glance, carbonate of iron (black variety, cryst.), chrome ore (cryst.), wolfram (cryst.), specular iron ore (cryst.), rutile, braunite, tin ore (cryst), leverite (cryst.), sub-oxide, and protoxide of copper, iserine, oxychloride of copper.

The table above given discloses the fact that a great number of our ores are superior in conducting power for electricity to the best liquid non-metallic conductors we are at present acquainted with; indeed, most of the minerals which fall in this class are by approximate admeasurements very far superior in this respect to such liquids.

I should state that all the minerals cited here are native ores.

All the ores of silver named above were found to be more or less antimonial, from which circumstance their refusal to conduct electricity may be due, as the pure sulphide, chemically prepared and fused, conducts very well. The effect of antimony in impairing conductive power is well exemplified in the case of bournonite and boulangerite, as compared with the non-antimonial lead ore, galena.

In the case of the silver ore, however, this variation may be due to a difference in molecular arrangement, as sulphide of mercury, though a non-conductor in the state of cinnabar (red variety), conducts freely when its precipitate is simply dried or sublimed, so long as it retains its dark colour.

Several other interesting questions are started by the knowledge of some of the facts above disclosed; for instance, the conducting power of native oxide of zinc for electricity is remarkable; the specimen tested, I may state, being nearly pure, and of a reddish colour. Possibly this circumstance (that of its conductivity) tends to show that it is rather a mixture of a higher oxide with the protoxide than a simple protoxide as now supposed.

Why some sulphides conduct so readily, and others do not conduct to any notable extent, is another most important question in physics, and one which the results above stated are too few in number and not sufficiently varied in kind to enable us to solve. I firmly believe, however, that when they are checked and largely added to by results of experiments upon larger mineralogical collections than the one to which I have had access, and especially upon minerals prepared chemically pure, and in different allotropic states, the question raised above, and others allied thereto, will receive their proper answers, and electrical science be enlarged.

I may state in conclusion that I have frequently found the testing of unknown ores in regard to their electric conductivity a very useful preliminary to their chemical investigation or analysis. It is a test easy of application, and does not of course necessitate breaking up or damaging them in any way.

ART. LII.—*On the Electro-motive and Electrolytic Phenomena developed by Gold and Platina in Solutions of the Alkaline Sulphides.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th January,* 1871.]

IN some former papers upon the absorption of sulphur by gold and platinum* I adduced evidence to show that this absorption was a chemical act; that a true chemical combination had been effected between the sulphur and the gold or platinum, as the case might be, the result being a sulphide of the metal used; and I stated that, so far as this evidence could be deemed worthy of acceptance, it impugned the correctness of the general belief that the absorption of certain gases by platinum was in every instance simply mechanical.

Irrespective, therefore, of the primary question raised, it became of some importance, upon general grounds, to obtain further and, if possible, decisive

* See *Trans. N. Z. Inst.*, Vol. III., pp. 216 and 221.

evidence of the precise character of this absorption, and for this object I have continued my investigations, and have varied their nature so as to secure such evidence, quite independent of all that has been already advanced.

It will perhaps be remembered that the whole of my evidence upon this point, as at present given, is based upon certain chemical reactions which my processes obtained. That which I now beg to lay before this Society rests upon certain electrical reactions or manifestations which have discovered themselves to me; and, in anticipation of what should perhaps be left for disclosure as a resultant of particular experiments, I will state now that these electrical reactions are all extremely favourable, if not conclusive, as to the correctness of the opinion which ascribes this absorption to chemical action. I may observe here that this was the direction I contemplated taking for my experiments at the time (one which they would indeed naturally have taken), but that I had not the necessary apparatus to aid me in such a course.

It is well known that the exercise of chemical force, or, as it is named chemism, is always accompanied by a development of electricity, and this varies in its intensity with that of the chemical forces brought into play.

In cognisance of these facts, therefore, it occurred to me to test whether electricity is developed at all during the sulphurization of either of these metals.

Taking two plates of gold prepared chemically pure, I placed one of them in a cell charged with sea water, and the other in a porous cell charged with sulphide of ammonium, which cell I partially immersed in the former. These plates I connected voltaically at points quite clear of the liquid, and inserted a delicate galvanometer in the circuit, when I found the needle of this instrument was vigorously deflected over an arc of 20° to 30°, indicating, of course, that a strong current of electricity was being generated. The direction of this current, as shown by the needle, was from the inner to the outer cell. The gold in the sulphide solution, therefore, was the positive element of the pair.

Electric currents of equal strength were also developed by charging both cells with sea water, or with solution of potash or ammonia, and administering sulphuretted hydrogen to the gold plate in either cell. The direction of these currents was constantly from the cell to which the gas was applied. By charging one of the cells with potash or ammonia, and the other with sea water, a current of electricity was also produced, but this was of very feeble intensity, and might well be owing to traces of sulphur in the alkaline solutions.

To avoid any errors which might be caused by films of air or other gases adhering to the plates, and so getting in contact with the sulphide solutions, these plates, prior to their immersion, were always raised to a red heat, and plunged while in this state into water or the solution about to be used, which liquids, moreover, had been previously boiled for many hours to expel the gases dissolved in them.

The same kind of electrical reactions were obtained by substituting platina for gold in these experiments.

It was further found that gold paired with platina in sulphide solutions is negative to it, but if paired with iron it is positive. It is necessary in order to obtain this latter result to use sulphide solutions quite clear from free alkalies, otherwise their electric order is reversed. For this purpose it is best to prepare such solutions by boiling the *carbonate* of the alkali with sulphur for some hours.

As appropriate to the subject, I will insert here a table of the electromotive order of the several metals I have tested in sulphide of sodium. The order observed is from negative to positive :—

Carbon	Mercury
Iron	Lead
Steel	Tin
Gold	Copper
Platinum	Zinc
Silver	

The currents thus developed by gold and platinum in sulphide solutions soon ceased, but they were so well marked, and had such an apparent intensity, that I was induced to try if they had any effect upon certain metallic solutions, and on trial I found that, in the case of that obtained by the use of gold plates in contiguous solutions of potash and sulphide of potassium, a degree of intensity was reached sufficient to decompose solutions of copper, silver, and gold, and to deposit these several metals in adherent films upon proper electrodes. The same results were afterwards obtained with platinum.

This capability of gold and platinum to generate electrical currents under these circumstances—currents of such intensity as to exhibit true electrolytic effects—when taken along with the results of my former experiments on this subject, appears conclusive evidence in favour of the sulphurization of these metals being, as has been already argued, the result of chemical action.

It is very difficult to suppose that the mere absorption or condensation of sulphur from these various solutions by gold or platinum could ever produce electric currents having so great an intensity, since the sulphur, being in a liquid form, must already be condensed almost to a maximum.

I must apologise if I have appeared to dwell too long upon the subject of the nature of this absorption, but the exceedingly close structure of the metals experimented with, and their very high atomic equivalents, restrict this absorption to one of the most superficial character, and thus preclude us from forming any opinion based upon those visible physical changes which are the usual concomitants of chemical action. Thus I am compelled to attack the subject by indirect methods, and these, being individually less decisive for the object in view, require a certain amount of variation to make up for their want of directness.

Judging from a variety of circumstances, which I need not here detail, I am inclined to believe a sub-sulphide of gold or platinum is produced in these experiments, and that in the case of the gold sulphide its colour is yellow, which, if true, would well account for the fact that no visible change is induced upon this metal by sulphurization.

It is very probable that were a bundle of light rays reflected from a series of gold plates in succession, and another from a series of sulphurized gold plates, a very manifest difference in the colour of the rays so reflected would be apparent.

It is only proper to state here that Professor Becquerel has just announced, in a series of papers, a certain electro-motive power of gold, platinum, etc., in pure water and also in neutral saline solutions, abstracts of which are given in the several numbers of the "Chemical News," which I have placed upon the table for the reference of members. This is exceedingly relative to the subject of this paper, but it will be observed on reading these abstracts that the results of the author's researches are quite distinct from those here described, since the electric phenomena which he describes "are very feeble," while those I have cited were strong enough to decompose metallic solutions. Moreover, these currents were produced by Professor Becquerel under such circumstances that he was driven to the conclusion "that capillary affinity plays a very important part in their production;" whereas the currents which I have described are so far superior to those producible by the exercise of capillary affinity that the influence of such affinities upon them would not be perceptible by aid of the instruments used. The sulphides do not appear, however, to have been experimented with by Professor Becquerel in the researches I have alluded to.

Art. LIII.—*Preliminary Notes on the Isolation of the Bitter Substance of the Nut of the Karaka Tree* (Corynocarpus lævigata). By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 1st July,* 1871.]

A very interesting as well as a most important investigation in any country, whether for toxological or for scientific purposes generally, is that which has for its object the identification and examination of the particular principle to which is due those poisonous or other marked effects which may have been observed on the administration of certain of its plants or herbs, or parts of them, to the animal system.

But especially is this the case in the country we are now settling, the character of its Flora being in certain respects peculiar, and in many cases greatly divergent from that of any other country we are yet acquainted with, any addition, therefore, from such a quarter to the number of active principles recognised can hardly fail to be of value, as enabling us to attain to a more comprehensive view of the whole subject of vegetable medicinals or poisons—the manner of their association with other principles or with particular orders or parts of plants—and lastly, the mode in which they operate in producing their individual effects; while there is besides the chance that any principle so isolated and identified may be more useful medicinally, and more readily administered when separated from the plant.

Altogether the subject appears to be one eminently worthy of careful attention, and I have therefore from time to time examined many of those plants which have come the more prominently under notice by reason of their acknowledged potency in respect of the characters stated.

The last subject of these investigations has been the kernel of the fruit of the Karaka tree, which, as is pretty well known, is extremely poisonous to man if taken in an unprepared state; and though I have not yet completed it, sufficient knowledge has I think been arrived at to render a statement of the results so far obtained interesting.

Not having personal acquaintance with the mode in which the karaka berry is prepared as food by the natives, nor of its action as a poison, I am indebted to Mr. W. Colenso, F.L.S., for the following accurate information:—

"1. Preparation as food.—The kernels were prepared for food thus:—In the autumn a large party would go to the karaka woods on the sea-coast, which were mostly rigidly preserved (tabooed), to gather the fruit; this was generally done by beating them down with a long pole (hence the term, "ka haere ki te ta karaka"—the verb *ta*, to hit, or strike, sharp, short, sudden blows with a stick; the same verb is used in speaking of the operation of tattooing), after which they gathered them up into baskets. In, or near, the adjoining beach large pits were dug for earth ovens, into which, when ready, the karakas were poured, and the earth banked up in the usual way. These ovens were left several hours before they were opened, generally till the next day, or even longer, when the karakas were taken out, put in baskets, laced up, and placed under water, often at the mouth of some neighbouring stream or quasi lagoon, where also they remained some time (I believe a day or two at least), for the double purpose of destroying all remains of the poisonous quality, and for the loosening and getting rid of the skin and flesh (sarcocarp) of the fruit. When they were washed clean by knocking them about pretty roughly to rid them of the outer skin, etc., taken out, spread in the sun on mats and stages, and carefully dried; and when quite dry again put up in new baskets for winter use, for feasts, for distinguished visitors, and for gifts to friendly chiefs and tribes residing inland.

"As the same karaka woods did not bear alike plentifully every year, the years of barrenness were to the tribe seasons of calamity and want, the karaka being one of their staple vegetable articles of food.

"2. The symptoms attending cases of poisoning through eating the raw kernel were—violent spasms and convulsions of the whole body, in which paroxysms the arms and legs were stretched violently and rigidly out, accompanied by great flushings of heat, protrusion of the eyes and tongue, and gnashing of the jaws, but unattended by vomiting (very different in appearance and result from the bite of the poisonous spider, katipo, of which I have also seen and attended several cases, which are of a much more mild type, and never fatal). I mention this as both were likely to be caused in the same locality (near the uninhabited sea-shore) and season, and at first by a tyro might be mistaken. Unless speedily attended to the poisoning by karaka quickly proved fatal; and even in those few cases in which I have known natives to recover very likely it was more owing to the small quantity of the poison received into the system, than to the means used as *internal* remedies. As the sufferers were invariably little children, they were more easily dealt with; and to prevent the limbs becoming distorted, or stretched and rigid, a pit was quickly dug, into which the child was placed in a standing posture, with its arms and legs bound in their natural position, and the mouth gagged with a bit of wood to prevent the sufferer biting its own tongue; and there the child was left, buried up to its chin, until the crisis had passed by; sometimes it was also plunged repeatedly into the sea before being pitted. Fortunately the cases of karaka poisoning were but few, owing, no doubt, to the hard texture and disagreeable taste of the karaka kernel in its raw state; very much fewer than those arising from the eating of the sweet fruit of the tutu *(Coriaria)*, which latter, however, were more easily managed by the natives.

"The writer well recollects having seen at Wangarei (Bream Bay), in the years 1836-9, a fine healthy youth of about 12 years of age, who had been recovered from poisoning by karaka kernels. He, however, had not been properly attended to, as to the tying of his limbs in their right position while under the influence of the poison, and he was therefore now a curious spectacle, reminding one of the instrument called a caltrops more than anything else. One leg was curved up behind to his loins, and the other bent up in front with the foot outwards; one arm inclined behind his shoulder, and the other slightly bent and extended forwards; and all, as to muscles, inflexibly rigid. He could do nothing, not even turn himself as he lay, nor drive off the sand-flies (which were there in legions) from feasting on his naked body, nor scratch himself when itching, nor put any food to his mouth. He was the only child of his parents, who, fortunately for him, were both alive and took great care of him, turning and shifting his position very often by day and night, as, from his body not evenly resting, he could not possibly remain long in one position. When not asleep he was laughing (if not eating), and greatly enjoyed his being so placed that he could see the children at play, in which he always encouraged them by his voice, often seeming the merriest of the village. I frequently sat by his side during my visits, to talk with him, and to drive away the tormenting sandflies, which he would beg me to do. His skin was remarkably fine and ruddy—I might call it pretty—being wholly without eruption, blemish, or scar; his teeth pearly white, and voice and laugh regularly strong, hearty, and ringing. His eyes were very brilliant and of an intelligent cast; but in conversing with him I always thought his intellect was not so sharp (or developed) as ordinarily that of Maori boys of his age."

This interesting account discloses the fearful nature of the poison of the karaka nut, and also that the Maoris employ two distinct processes—baking and washing—in their mode of preparation of this article for food; but it cannot be gathered therefrom whether both processes are necessary for the removal of the poison from the kernel, and if not which is the essential one.

It will be noticed that the kernel only is spoken of as being poisonous, the fruit which surrounds it in its natural and ripened state being, as is well known, wholesome and pleasant, though not powerfully flavoured.

In pursuance of my object, therefore, I gathered a quantity of the kernels from which the fruit had completely rotted off, and after removing the woody husk I bruised them very finely and put part to bake at a temperature of 212° for four hours, when it appeared their bitter flavour was destroyed.

The other part I steeped in successive quantities of cold water for two days. The steep-water separated from the bruised nut contained a great variety of substances, those positively identified therein being approximately in the order of their relative abundance, as follows:—vegetable albumen (emulsin), casein (legumin), grape sugar, gum, a bitter substance, and a tasteless essential oil, which latter floated in greater part on its surface. The solid insoluble part of the nut left after the successive additions and abstractions of water was nearly tasteless, and completely devoid of all *bitterness*, and showed a resemblance in chemical composition to the insoluble part of hazel nuts.

The competence of either of the processes used by the Maoris (baking or washing) in the preparation of the nut, for the decomposition or removal of the bitter part of it, being thus shown, it naturally occurred to me that this bitter might be the poisonous part of the nut. I therefore made the isolation of this principle for the present my first object.

The bitter part in question was soon found to be capable of absorption by animal charcoal, and of removal therefrom by hot alcohol. I therefore took advantage of this deportment to obtain it in a pure state for examination. The details of this process are as follows :—

The kernels are well crushed and triturated with successive quantities of water (cold) till their bitter taste is gone. The solutions thus obtained are rendered distinctly acid to the taste by acetic acid, by which the casein and emulsin present are precipitated, and the filtrate therefrom agitated with animal charcoal till the bitter substance is removed. The charcoal is then collected and mixed with boiling alcohol, and the pure alcoholic solution of the bitter substance thus obtained is allowed to remain for two or three days at common temperatures, when the bitter part crystallizes out in beautifully radiating acicular forms.

The characters of these crystals are as follows :—Intensely bitter; colour white; lustre pearly; feebly acid; at 212° Fahr. melts; gives a dark rose colouration with warm sulphuric acid; soluble in hot water, and feebly so in cold water; soluble in alcohol, also in hydrochloric and acetic acids; soluble in ammonia and potash; insoluble in ether and chloroform; does not give any precipitate with tannic acid, nor with potasso-iodide of mercury, nor potasso-sulpho-cyanide of zinc; does not contain nitrogen.

The evidence as submitted above shows that the principle is not of an alkaloidal nature.

Its deportment with sulphate of copper and potash is strikingly similar to that of digitaline to the same tests. Both give green precipitates of a tint very similar to arsenite of copper. This property of either of these vegetable principles to give green precipitates with copper under these circumstances seems characteristic of them, as, among the numerous substances the most likely of any I know to give this reaction, not one has, on experiment, been ascertained to deport itself in this manner. Thus either of these principles is readily distinguishable in this way from picrotoxia, resins generally (including common resin), soaps, gums, and the bitter principle of *Phormium tenax.*

The green precipitates formed in this way by the bitter of the karaka and digitaline respectively are, however, readily distinguished from each other by subjecting them to a rise of temperature (120° Fahr. to 212° Fahr.); that containing the digitaline is unaffected, while the other precipitate speedily changes its colour to yellow, the copper being reduced to the sub-oxide, as if grape sugar were present. Further, if the proportion of the karaka bitter to the copper and potash is not properly adjusted, reduction commences at once.

It appears, however, that if the solution of digitaline is boiled with acid prior to the mixing with copper and potash, a great reduction of the copper will take place on raising their temperature to 200° Fahr.

Taking all these facts into consideration, I am inclined to believe that the bitter of the karaka nut is a glucoside, and that digitaline falls into the same class, though I have not known this character imputed to it before.

An appropriate name for this bitter principle of the karaka will be, I think, *karakine*, and this name, therefore, I propose to give it.

Having failed, after a careful examination of the nut for vegetable alkaloids, to find any principle having the characters of these bodies, I conclude that the bitter substance here treated of (karakine) is the poisonous part of it; but not having sufficient of this principle separated to allow of a proper trial of its effects upon the animal system, I am unable to confirm or disprove the correctness of these surmises, but I hope at an early date to be able to supplement this paper by a statement of results of experiments undertaken to settle the question.

As being connected with this subject I may state, in conclusion, that the inner bark of the tree is also bitter, probably from the presence of karakine. The outer bark is not bitter, but astringent from the presence of tannin, while the sap, the wood, and the leaf (which is, I hear, wholesome to cattle) taste sweet (sugar), with not the least bitterness. These observations were taken in July.

Art. LIV.—*On a New and Rapid Process for the Generation of Sulphuretted Hydrogen Gas for use as a Re-agent in Laboratory Operations.*

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

[*Read before the Wellington Philosophical Society, 26th August,* 1871.]

Sulphuretted hydrogen gas is in such constant use in all laboratories, that I offer no excuse for submitting a new process for its generation, particularly as there appears to be a positive want for a better one than that at present in ordinary use. Indeed, owing to this want several processes have lately been published for its preparation especially having for their object a combination of evenness and constancy of delivery, but I have not learnt that the advantages promised by their several authors have been realised in actual practice. In consequence it occurred to me to try whether the reaction of metallic sulphides with zinc in acidified water, described in the third volume of our *Transactions*,* could not be turned to account for the production of this gas.

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* See *Trans.* N. Z. Inst., Vol. III., p. 222.

It will be remembered, perhaps, that in that paper I stated that an evolution of sulphuretted hydrogen occurred under the above circumstances, the gas being thrown off from the surface of the sulphide used, while the zinc was *oxidized* and the sulphur of the sulphide *hydrized*, a true voltaic pair forming, as further demonstrated in an ensuing article.*

This reaction, therefore, I applied in the following modified manner, and found it to answer so well that I am induced to make the process public for the benefit of practical chemists:—

Fragments of galena and granulated zinc, in proportions of about 1 to 1, are well mixed and put into a small apparatus of the kind generally in use for the preparation of this gas, and hydrochloric acid diluted with water (1 to 20 or so) poured upon them. Sulphuretted hydrogen is instantly given off, and its evolution is found to proceed energetically, regularly, and continuously for a great length of time—a length proportionate to that of the quantity of material used and its proper adjustment as to parts. A little hydrogen accompanies the gas named, and traces of hydrochloric acid. The acid is, however, easily removed, by allowing it to pass through a little carbonate of lime before use, while the presence of hydrogen can have no bad effect for all ordinary purposes.

After a sufficiency of the gas has been used it is best, in ordinary cases, simply to wash the galena and zinc with water, when the apparatus is ready for further use at a moment's notice; but when quantities are required in rapid succession a form of apparatus may be used which allows the separation of the acid liquid from the undecomposed substances, within itself, when the delivery tube is closed. But a still more excellent method may be had recourse to in such cases, and this is to make the necessary electric contact of the zinc with the sulphide dependent upon the juxtaposition of moveable wires carried outside the apparatus. For this it is only necessary to use them in mass instead of in fragments, connecting them electrically by means of wires, which are passed through the cork of the apparatus, and which are only allowed contact with each other by means of proper connecting screws.

If care is taken to keep the zinc and sulphide from direct contact, the evolution of gas instantly ceases on disconnecting the wires, and commences on making the connection.

For this last method it is necessary to amalgamate the zinc. I should state that any sulphide which is an electrical conductor may be substituted for galena, such as sulphide of iron or copper, but for cheapness and general convenience I recommend galena.

Having used this method during the last six months a great number of times, I have no hesitation in recommending it as a most simple, expeditious,

* See *Trans.* N. Z. Inst., Vol. III., p. 232.

and economical one, easy of control, and capable of delivering the gas equally, continuously, and vigorously; and I am authorized to state that Dr. Hector's experience of it in the Colonial Laboratory testifies to the correctness of these assertions.

Art. LV.—*Notes in Support of the Alleged Alkalinity of Carbonate of Lime.* By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 30th September*, 1871.]

In a paper which appeared in the second volume of the *Transactions* of this Society,* I asserted the alkalinity of carbonate of lime, but the correctness of this assertion having been disputed by Mr. Charles R. C. Tichborne, F.C.S., of the Laboratory, Apothecaries Hall, Ireland, in a communication to the Editor of the "London Chemical News,"† I have re-investigated this subject and extended my researches upon it, by which I have arrived at results corroborative of the correctness of my statement, and which show besides that a large number of salts hitherto maintained to be neutral, or about which nothing has been affirmed, are in reality alkaline.

The latter results I will communicate in a separate form at an early date,‡ limiting myself in this paper to an attempt to clear the ground already broken, as far as I can, from the objections above referred to.

Mr. Tichborne very courteously, and with a considerable amount of plausibility, intimates that as the reddened litmus has the acid used to colour it only weakly combined with the tinctural matter of the paper, the carbonate of lime acts merely by absorbing this acid, and thus the litmus is brought back to its normal colour, blue with a shade of violet; and that therefore this is not a reliable test in such a case.

In answer to this I would ask, does not this capacity of the lime salt to abstract the acid, whether acetic or carbonic (for I guarded against encumbering the process with a double decomposition by using the latter acid), argue most forcibly and sufficiently for its alkalinity?

If it does not demonstrate alkalinity in such a case, then reddened litmus in opposition to all received opinion is not a proper test, nor indeed one at all, for ascertaining this character for any substance.

I would ask what other condition or property is required for a substance besides that enabling it to act as an alkali upon litmus, wanting which it is neutral?

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* See *Trans.* N. Z. Inst., Vol. II., p. 150.

† See "Chemical News," No. 565, September 23rd, 1870.

‡ See Art. LVI.

However, I will not press this point further as I do not wish to rely upon one set of experiments, or upon any particular method I have adopted in them, for testing the truth of my allegation. I have therefore availed myself of the first test suggested by Mr. Tichborne for determining the question finally, and the results of this I will now describe.

Blue litmus paper after being well washed in distilled water free from ammonia till of a pale violet color, had its colour very distinctly changed to a deep blue on being pressed while moist upon a freshly fractured surface of calcspar. The failure of Mr. Tichborne to obtain a like result with this test I can only explain by supposing an omission on his part to insure a sufficiently large area of contact between the spar and the paper to render the chromatic change visible.

In regard to Mr. Tichborne's second test, I take exception to the employment of turmeric paper, as it only shows alkalinity in any substance in which it exists to a marked extent, and this is not a question of degree but one of condition—alkalinity or neutrality.

That turmeric paper cannot indicate alkalinity where this does not reach to a certain degree is manifest from the refusal of the organic base analine to affect it, although analine acts both upon reddened litmus and the juice of red cabbage as an alkali.

Again, I find pure strychnine, though it does not affect turmeric, behaves with reddened litmus just like an alkaline body, and this by the way may be a character of the alkaloids generally with such tests.

Lastly, to anticipate a little of the results of the investigation referred to, hydrous tribasic phosphate of lime does not colour turmeric, although we know, from the manner in which it may be produced and the circumstances attending its formation, that it must be alkaline, which character it plainly manifests to reddened litmus.

Thus we can mix alkaline solutions of chloride of calcium and tri-basic phosphate of soda, and the precipitate of phosphate of lime which falls leaves the supernatant solution distinctly *acid*. Now, as we have no reason for supposing that the phosphoric acid in changing bases has lost any portion of its combining or neutralizing power, we are constrained to hold that this precipitate is alkaline to an extent at least equally divergent from neutrality, as is the acid solution around it; and still turmeric paper does not indicate this alkalinity.

The turmeric paper test being therefore obviously unreliable for the detection of alkalinity in certain cases, I rely for the verification of the correctness of the statement in question upon the results of the first experiment suggested by Mr. Tichborne in the communication under review.

I have to apologise for allowing such a length of time to pass ere noticing this criticism, but I waited in the hopes that some one might have taken up the question with such authority and potency of argument as would have settled it one way or the other, and thus saved me further thought on this subject, as it is so much more pleasant and exhilarating, besides being more in accordance with our colonial instincts, to break up fresh ground or explore new country, than to turn back from this to tinkering about old work, or to protect it from hostile blasts, even though these be ever so courteously blown or kindly tempered.

I will only add that I shall be very glad to have the subject still further discussed, especially as it now appears likely that some general principle may soon be recognised, by the use of which we can easily and certainly classify into the three distinctive groups, *acidic*, *basic*, and *neutral*, those bodies whose re-action with test paper is difficult to observe by reason of their intense colour or their extreme insolubility in water.

ART.—LVI.—*On the Alkalinity or Acidity of certain Salts and Minerals, as indicated by their Reaction with Test Paper.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 28th October,* 1871.]

A KNOWLEDGE of the reaction of various substances with test paper is justly esteemed of considerable importance, since it enables us at once to refer them to one or other of three distinctive groups, each of which has strict regard to the molecular structure of those substances falling within it, as manifested by the chemical combinations they are most prone to form. These groups are, as is well known, the alkaline or basic, the acidic, and the neutral, and properly prepared test paper indicates the one to which any particular substance belongs by suffering certain colourations when brought in contact with it, these changes being the result of chemical ones, by which the combinations previously existing among the colouring matter of such paper are ruptured, and new ones superinduced.

The terms alkalinity and acidity, therefore, have a signification expressive of condition, and their real meaning is only this, that as applied to any substance they indicate a tendency in such to form combinations with acid or alkaline bodies, as the case may be. Neutrality, however, has a relation more to the breaking point (if I may so term it) of these combinations in the litmus paper, than to absolute condition of the substance tested; for it is easy to conceive that a substance may be acid or alkaline, and still, by reason of the feebleness of either these characters, be unable to overturn the combinations referred to, and so manifest either of these reactions.

I only point this out that I may not be misunderstood in the use I make of the term neutrality, and not for the sake of opening a question, as I do not attempt here to remove the neutral point thus arbitrarily located to a position nearer to the true one, preferring to take up ground less subject to criticism, and of more immediate interest, viz., that set forth in the heading of this paper, to which, after the above necessary explanations, I now address myself.

These reactions being in general so easy to obtain in the case of bodies capable of manifesting them, I may perhaps be deemed hypercritical when, in the course of this statement, it is found that my remarks tend to show that the condition of certain of these bodies, as demonstrated by such tests, has been mis-stated in our popular works on chemistry, and that this has tended inferentially to involve us in further errors relative to the numerous substances chemically allied thereto; at the risk of being thought so, however, I do not hesitate to make the following remarks, and the exact condition of such bodies shall be the principal subject of this paper.

The ores I particularly object to as having their true characters in these respects mis-stated, or inferentially liable to be misapprehended, belong to a class of salts insoluble, or nearly so, in water. They are the carbonates, borates, silicates, phosphates, and arseniates of the alkaline earths (lime, baryta, strontia), also of magnesia, silver, and lead. Theoretically they should be *alkaline*, from the following considerations.

Taking an equivalent of any of these bases and combining it with one of sulphuric or any of the stronger acids, we have a salt corresponding to those of the alkaline mono-sulphates in being *neutral*. Thus, under these conditions, the bases referred to are, equivalent for equivalent, equal in degree of alkalinity to that of the alkalies (potash, soda, etc.), and, therefore, the corresponding salts of these two classes throughout should possess one common character in respect to this particular reaction.

Now the alkaline carbonates, borates, and their common phosphates, etc., give a very decided alkaline reaction with litmus paper properly prepared; they are indisputably *alkaline*, but the corresponding salts of lime, strontia, etc., are, as a rule, accepted either from experimental results direct, or from inferences based on them, as being neutral, although, from the above considerations, they ought to be alkaline.

The importance of ascertaining which of these two assumptions is correct is obvious, for, if these salts are in reality neutral, we learn, and must take cognizance of, a radical difference existing either in the acids or the bases of which these salts are made up, according as the other portion of the salt is possessed of powerful or weak affinities. In such a case lime, for instance, would not retain the same degree of saturating power (quantivalence) through all its combinations with the acids, the degree of this in any case being determined by the strength of the acid employed; a strong one being thus necessary, as it were, to draw out its highest capabilities in this respect.

Our recently acquired knowledge of the mobility (if I may term it so) of the component molecules of bodies in respect to each other, even in the case of simple elements, and the great tendency many of them manifest to form *intercombinations* among themselves, dispose us favourably towards a belief which, by ascribing a variable potentiality of this nature to these bodies, explains away the apparent anomaly I have just referred to as pertaining to them in their present reputed condition, and make it very desirable to have experimental results, by which to enable us to decide between theory and our present belief. Results, therefore, having for their sole purpose this object I now relate, from which it will be seen, I think, that theory is in this case our safer guide.

The ground taken up by these results has been already just broken in upon, as will perhaps be remembered, in a communication to this Society, entitled "The Alkalinity of Carbonate of Lime,"* and while the criticism which it evoked has been already useful in stimulating me to this inquiry, it will be useful again, but in a different manner, by supplying us with a knowledge of the precise conditions deemed necessary, by a well-known chemist, to insure reliable indications when testing substances generally in respect to their behaviour with the test I am employing—litmus paper. Using the precautions recommended in this criticism, I prepared the test (litmus paper) for use by simply washing it in water free from ammonia till it acquired a pale violet colour, in which condition "it is a delicate test for either acids or alkalies."

Thus prepared, the test when pressed upon them in a moist state indicated the conditions of the following substances to be as stated below :—

Alkaline.	Acidic	Neutral.
Carbonate of magnesia (magnesite)	Phosphate of alumina (wavellite)	Quartz
" lime (calcareous spar)	Phosphate of zinc cryst. $(Zn\ O)_3 + PO$	Clay (purest-washed)
" strontia	Phosphate of iron, (proto- and sesqui-)	Clay slate
" baryta	Arsenite of zinc	
" lead		
" silver		
Borate of magnesia (datholite) crystallized		
Tribasic phosphate of lime cryst. $(Ca\ O)^2 + HO + PO$		
Tribasic phosphate of magnesia $(Mg\ O)^2$ PO		
Apatite $(Ca\ O)^3 + PO$		
Phosphate of silver $(A9\ O)^3 + PO$		
Silicate of magnesia (olivine)		
" " (serpentine)		
Mica		
Felspar		

* See Art. LV.

If the terms acidity and alkalinity have any meaning, or if the test here applied to discover these properties is trustworthy, we cannot refrain from classifying those substances specified in the first and second columns of the foregoing table as alkaline and acidic respectively.

That the test used is trustworthy, in the case of alkalinity at least, and these results consequently so far correct, is in the highest degree probable, from the fact that it has been approved of, and I may say recommended, for this latter object, by one who attempts to demonstrate the condition of neutrality in a case for which, as aforesaid, I have assigned alkalinity.

The correctness of this table being allowed, we may safely and largely add to it by filling in with those salts analagous in chemical composition to the ones stated, or we may at once deduce from it the following general conclusions :—

1. That those salts of the earthy oxides, as also those of the oxides of silver and lead, which contain single equivalents of carbonic, phosphoric, arsenic, or boracic acids, are alkaline.

2. That the common silicates of these oxides are also alkaline.

3. That the salts of the sesqui-oxides and the remaining metallic protoxides are acid when containing one equivalent or more of phosphoric or arsenic acid.

4. That the silicates of the sesqui-oxides are neutral.

The salts of the oxides, therefore, enumerated under the foregoing Nos. 1 and 2 appear to agree, in respect to the characters under investigation, with the corresponding salts of the alkalies ; the oxides themselves, as compared to those of the so-called alkalies, thus exhibiting an equal alkalinity through all their combinations, and therefore each oxide is, as far as we can judge, similar in molecular arrangement throughout all such combinations.

In the case of those salts comprised in section 3, it is seen that they compare with the sulphates and chlorides of the same or corresponding bases in being *acid*; but the degree of this acidity is, we know, dissimilar, and may be inferred from the character of alkaline salts with these acids respectively, which has been already described.

The facts above stated have a great significance in respect to the relative potency of the alkalies as compared with that of the alkaline earths ; thus, the perfect equality of the bases magnesia and lime as compared with potash (equivalent for equivalent) in respect to alkalinity (here shown) will, if fully recognised, oblige us to dispute the title which this base now holds—that of being the most powerful of any we are yet conversant with.

In reality lithia has far better claims upon this position, as having the lowest combining number, and being, equivalent for equivalent, undoubtedly equal to potash in basicity, it has, therefore, for similar weights, the greatest saturating power for acids.

Next to lithia is magnesia, then lime, soda, and *afterwards* potash. In this connection it is proper to remark that lithia is the only base which readily attacks platinum when fused upon it—a pretty good test of strength one would think, and proving, as far as a single result has weight, that the relative position I here assign to this base is correct.

Both potash and soda, however, have certainly an appearance of being far more powerfully alkaline than any of the bases just compared with them, but this is due simply to the fact that they dissolve in water to a larger extent and with far greater speed than these bases, whereby they are enabled to act with greater facility, and effect more, in a given time.

The fact is that in our use of the term alkalinity hitherto we have not expressed absolute potentiality, but rather energy or speed of action, and this speed being dependent (other circumstances being equal) upon the degree of solubility in water of the substance tested, we have thus unconsciously perverted the true meaning of the term (alkalinity), by making it denote a certain degree of solubility—a quality which we do not know is the least related to it.

It only remains to notice that in relation to rocks the terms basicity and acidity have, by the facts above stated, their significance enlarged and their appropriateness rendered still more apparent than before, while the term neutrality is now shown to be predicable of certain of them and to be equally significant.

The character of rock masses, or portions of them, in these respects may be discovered in a very direct and simple manner, by just pounding a portion of them upon litmus paper moistened and properly prepared, when, according to the results and manner of sampling, we know off-hand the true condition of the specimen as a whole, or of any particular portion of it; and, knowing this, we learn at once the general affinities of such rocks or portions of rocks, or to particularise whether they are absorbent of acid silicates or silica, or of basic silicates (as the earthy or alkaline ones), or whether, as in the case of clay or clay slate, they are negative to both these classes of bodies.

I may add, in conclusion, that the rationale of the new process for the retention of the fertilizing constituents of sewage by means of phosphate of alumina is readily explicable by the fact that this is an acid salt (see table); it is thus enabled to chemically absorb all the more basic organic portions of such sewage, these being generally the most valuable for manure, as they are, I believe, the most noxious to animal life.

Art. LVII.—*On a Form of Electro-Magnetic Seismograph adapted for Indicating or Registering Minute Shocks.*—By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 25th November,* 1871.]*

The author has prepared an instrument for this purpose in which an electric circuit is broken, instead of being (as in the system adopted by M. Palmieri) completed by an earthquake.

The following is a specification of this instrument :—A solid block of metal, having a fine platinum wire attached, which projects about half an inch from it horizontally, is connected with a vertical galvanometer, and this with a single pair or small battery of pretty constant power.

A very fine platinum wire depends from a point above in such a position that it presses slightly upon the wire just specified by its lower extremity, a small bob being attached thereto to steady it. A fine screw, or other proper adjusting apparatus, is employed to regulate the pressure (*i.e.* area of contact) of these wires upon each other ; the top of this long wire being connected with the other pole of the battery. This apparatus when properly set is capable of indicating very feeble shocks. A gentle wind of varying power playing upon the substantial building in which it was first used kept the indicator constantly in motion. When the shock receiving part of the instrument (a massive pile of wood bearing the metal block), in order to avoid effects of wind, was placed under ground, it was ascertained that the impact of two pounds weight of stone, falling from a height of five feet upon ground situated fifty feet from this part of the instrument, affected the indicator very determinately. The intervening ground was clay. In conclusion, the author describes the method in which he arranges a series of such shock-receivers, with batteries for denoting direction of shake, so as to secure economy with effectiveness, and by which constancy in battery power can be dispensed with.

Art. LVIII.—*New Process for the Manufacture of Sulpho-cyanide of Potassium.*

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

[*Read before the Wellington Philosophical Society, 25th November,* 1871.]

The methods by which this salt is now prepared for laboratory and other purposes necessitates several purifying processes, in order that the ultimate

* The original paper, of which this is an abstract, was sent to the Editor of the "Chemical News."

product may have the degree of purity required; thus we have first the formation of the crude article, by heating to tranquil fusion dry ferro-cyanide of potassium with sulphur, and this product has to be treated in various ways in order to remove sulpho-cyanide of iron, alkaline sulphides, etc., from the salt in request.

The processes, therefore, necessary to accomplish this purification must largely add to its cost. To save this expenditure in labour and material I have sought to effect the economical manufacture of this salt by the application of a process or reaction which I have taken advantage of in discriminating the state in which sulphur exists on the surfaces of sulphurized gold.* This process consists in applying cyanide of potassium to such compounds at common temperatures, when any sulphur present in a free state would combine with it to form a sulpho-cyanide, but if present as a sulphide would only be transformed into a soluble sulphide.

In my first experiments, however, for the purpose of preparing this salt direct from cyanide of potassium and common flour of sulphur, I found that unless the temperature of the mixture was raised considerably, only a very small portion of the sulphur was taken up, and the product was then contaminated with the impurities I designed to omit.

This refusal of sulphur to combine freely with the cyanide at common temperatures was, I found, entirely due to the presence of some gas, probably air, which substance may readily be got rid of, as will suggest itself, by pouring the sulphur into boiling water and keeping up ebullition for a few minutes. When the water and sulphur is quite cooled down the cyanide may be added to the sulphur in an equivalent proportion.

The quickest way to effect the combination is to suspend the wet sulphur in a porous bag near the top of the cyanide solution, when in a few days the combination will be complete, and a product obtained comparable in purity with that of the cyanide used. I need not state that the operation should be carried on in an air-tight vessel.

It is absolutely necessary that the cyanide used should be free from caustic alkali, otherwise sulphides would be generated; it is but rarely, however, that cyanide is thus contaminated.

If the precautions indicated are taken, the product is sufficiently pure for use in all the ordinary applications to which this salt is put in the laboratory.

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* See *Trans.* N.Z. Inst., Vol. III., p. 216.

Art. LIX.—*Absorption of Copper from its Ammoniacal Solution by Cellulose in presence of Caustic Potash.* By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 25th November,* 1871.]

When a weak ammoniacal solution of copper containing a little caustic potash is poured upon a filter of Swedish paper (cellulose) the liquid which passes through the paper is quite or nearly colourless, and the filter is found to have retained all, or nearly all, the copper of such solution.

The form in which the metal is retained appears to be that of a greenish blue hydrate, this being in weak chemical combination with the cellulose of the filter associated with a little ammonia.

A solution similar to the above, except that cobalt is substituted for copper, is unaffected by cellulose. A nickel solution could not well be applied, as the potash rapidly precipitates the metal unaided.

The presence of tartaric acid, sugar, or albuminous matters, does not interfere in any way with the absorption of copper instanced, nor are any of these substances adequate to supply the part of ammonia in the absorption stated.

In testing liquids, therefore, for diabetes, etc., we may, by the use of filter paper in the manner indicated, remove any ammonia that may happen to be present in such solutions, by which we are enabled to be certain that any blueness of colour they may possess after such treatment is not due to the presence of an ammoniacal compound of copper.

GEOLOGY.

Art. LXI.—*On the Alluvial Deposits of the Lower Waikato, and the Formation of Islands by the River.* By Captain F. W. Hutton, F.G.S.

[*Read before the Auckland Institute, 29th May,* 1871.]

The alluvial deposits of the Lower Waikato, between Taupiri and Mercer, consist of reddish-yellow loam, resting on pumice, gravel, and sand.

The pumice deposit is generally pretty regularly stratified, and can often be divided into three subordinate divisions. The lowest of these is composed of coarse white quartz sand without much pumice, and contains layers of magnetic iron sand. The middle one is pumice gravel, the stones often being of the size of peas or beans; while the upper deposit is similar to the lowest but with more pumice, and also with pieces of obsidian. The sand is for the most part formed of slightly rolled transparent crystals of quartz. All parts of this formation are sometimes bound together into a hard rock by a ferruginous cement. It is not found much below Rangiriri. It is quite evident that nearly the whole of the materials that form this deposit have been brought down from the volcanic region in the centre of the island, and it must therefore have been formed when the land south of Taupiri was above the level of the sea. The absence of fossils is easily accounted for by supposing it to be an old river bed, for no shells inhabit the centre of the river, and none are found on the present sand-banks; they only live at the margins of the river where the bottom is more muddy, and where alone vegetation grows. Above the pumice formation lies a fine reddish-yellow loam, with occasionally a few rounded stones of pumice, so much decomposed that they are easily cut through with a spade. I have never found any shells in it, but in places it passes into a whitish sand containing the following species of diatoms, viz.:—*Epithemia*, sp.; *Himantidium pectinale*, Kutz; *Amphicampa*, sp.; *Surirella craticula*, Ehr.; *Cyclotella*, sp.; *Orthosira punctata*, Sm.; *Stephanodiscus*, sp.; *Cocconema cymbiforme*, Ehr.? *Navicula affinis*, Ehr.; *Navicula*, sp.; *Pinnularia major*, Sm.; *P. viridis*, Sm.; *Pinnularia*, 2 sp.; *Pinnularia interrupta*, Sm.; *Stauroneis phœnicenteron*, Ehr.; and two others, the genera of which I have not been able to determine. These diatoms decidedly prove the fresh water origin of the loam.

This loam generally rests on a tolerably even surface of the pumice sand, but in places a good deal of contemporaneous erosion and filling up, and re-arrangement of the pumice sand, appears to have been going on during its deposition.

Above the loam a vegetable soil more or less darkly coloured by humus, and from 0 to 4 feet in thickness is generally found. This soil sometimes rests abruptly on the loam but more often passes gradually down into it. It contains in various places, and at various depths down to 18 inches from the surface, collections of marine pipi-shells (*Mesodesma chemnitzii*) and burnt wood, evidently the remains of Maori feasts, for they still occasionally bring up these shells from the mouth of the river. No trace of holes having been dug for Maori ovens can be seen, although if any digging or turning over of the soil had taken place it could not fail to be detected in the clean sections of the river bank. We must therefore conclude that these remains show the level of the river bank at the time when the shells were cooked. The ordinary floods of the Waikato seldom overflow the banks of the river, although they fill up large swamps beyond the banks; and even when they do flow over they seldom remain at that height more than three or four days, and they deposit very little mud during that time; but in August and September of last year a heavy flood occurred, which was the highest that had been known for 30 years, and it covered the banks for about three weeks. During this time a layer of fine yellow loam about three quarters of an inch thick was deposited, but the traffic on the bank destroyed a good deal of it again. Of course when the banks were lower the floods would be oftener, and perhaps remain longer, but I think that an inch of deposit in 20 years would be a very liberal allowance, and at this rate some of the Maori feasts would date back 360 years. The next series of beds, in descending order, is the clays and sands which form the greater part of the hills between Rangiriri and Mere-mere, and on the opposite side of the river; this also contains no fossil shells, but only plants and beds of lignite with wood, and it is probably of fresh water origin also. 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.

It is, I believe, the commonly received opinion that islands in a river have generally been caused by the stream gradually cutting through its bank at a sharp bend, and leaving what was before a point as an island. Without committing myself to the opinion that this is never the case, I may state that it is seldom, if ever, the way in which islands are formed. If it were so, we ought to see rivers running round a deep re-entering bend without a salient point projecting into it, and islands ought often to be shorter in the direction

* See *Trans.* N. Z. Inst., Vol. III., p. 147.

of the river than across it, and these cases are certainly rare, if indeed they exist at all. The river also should always swell out round an island, whereas islands are often seen in parts of a river where it is no broader than it is either above or below it; and it would also be difficult in this way to account for two islands lying parallel and abreast of one another—a case of common occurrence, especially near the mouths of rivers. Besides, the greatest strength of the current is never in the bends. A sharp bend blocks up the stream, and reduces its velocity; and it is at the point where the water is able to get away that the strongest current is found. Any one who has been used to paddling up a river in a canoe will, I am sure, bear me out in this. The wear on the bank therefore is greatest at the point and gets less and less towards the bend, and the river tends to wash away the point and not to detach it as an island. The great flood of last August, which has been already mentioned, has left behind it two sand-banks which bid fair to become permanent islands, and which well exemplify the usual way in which these islands are formed. The sand-banks of the Waikato are constantly shifting their places, and moving down the stream, on account of the sand being pushed along the bottom of the river. This only happens when they are covered by water, for when the river is low, and the banks are above it, the strength of the current is not sufficient to wash them away, and they retain their position until the next flood. The high flood of last spring raised two of these banks — one opposite to Rangiriri and the other about four miles above it, opposite to Armitage's farm—so high that no subsequent flood covered them until the beginning of April, 1871, so that they were about seven months in the spring and summer above water. During this time they became so covered with vegetation that the flood of last April, which covered them, had no further effect than to raise them still higher by depositing more sand and mud round the plants, and it is evident that if this is continued they will soon only be covered by the highest floods, and will thus resemble the ordinary islands of the river.

I visited the island opposite to Rangiriri on the 17th of last April, and collected on it the following plants:—*Nasturtium palustre*, abundant; *Pelargonium clandestinum*, common; *Geranium microphyllum*; *Trifolium pratense*; *T. minus*; *Coprosma robusta*, one seedling; *Cotula coronopifolia*, abundant; *Erigeron canadense*, abundant; *Gnaphalium luteo-album*; *G. involucratum*; *Sonchus oleraceus*; *Plantago major*, abundant; *Rumex obtusifolius*, abundant; *Juncus communis*; *Cyperus ustulatus*; *Isolepis setosus*; *Agrostis æmula*, common; *Arundo conspicua*, one old plant only which had been floated down the river, but was now standing upright and growing well; *Holcus mollis*; *Agrostis Billardieri*, and *Poa australis* v. *lævis*.

This island was then about 250 yards long by 50 broad, the highest point being the end pointing down the river, as is always the case with sand-banks.

On the east side the water deepened quickly, but on the west side it was shallow for a considerable distance. It is situated just opposite to the main entrance of the Waikari Lake.

The second new island is situated a little above Armitage's farm ; it is smaller now than the first, but has been much reduced in size by a large coal barge having been stranded on the upper part, and the disturbance caused by getting her off has washed a large part of it away.

It is evident that if these banks are prevented from moving by the roots of the plants growing on them, every flood must increase their height until ultimately they are rarely under water ; so that all that is wanted to form an island is that some unusually high flood should so raise a sand-bank that it is not covered for several months during the season that seeds can germinate, and so allow the plants to grow sufficiently large for their roots to hold the sand together the next time that it is submerged. Floods in spring might therefore often cause islands, while floods in autumn might fail to do so.

These remarks on the formation of islands by rivers must not be taken as applying to rocky masses in a river bed, nor the upper portions of any river, but only to the lower portions, where a large river flows tranquilly through an alluvial plain.

Art. LXII.—*On the Traces of Ancient Glaciers in Nelson Province.* By A. D. Dobson, C.E.

[*Read before the Nelson Association for the Promotion of Science and Industry, 3rd May,* 1871.]

The labours and investigations of scientific explorers, especially those so successfully conducted by Dr. Haast, prove, beyond doubt, that at a very recent period all the higher mountains of New Zealand were covered with perpetual snow. Large glaciers filled every valley, and most of the large rivers were glacial torrents. Since that period the climate has become more genial—the glaciers have receded into the mountain gorges, or altogether disappeared, and only the highest mountains are now covered with perpetual snow ; but these earlier glaciers have left traces behind them, showing the magnitude they had attained, and masses of moraine matter lie scattered over the face of the country in every direction.

The largest glaciers that existed during what may perhaps be correctly termed the glacial period of New Zealand, lay on the western slopes of the Southern Alps ; enormous masses of loose rock lie stretched in rivers and ridges between Hokitika and Jackson Bay, proving that these glaciers extended from the mountains to what is at present the coast line; and if the relative level of sea and land was the same at that time as it is now, the west coast of the Middle Island must have much resembled the North Polar lands described by Dr. Kane, where the glaciers descending from the mountains reach the sea, and, breaking off in enormous masses, float away, covered with rocks and moraine matter.

The glaciers, both ancient and modern, of the Southern Alps have been fully explored and reported upon by Dr. Haast, and are only mentioned here to show that, with these enormous traces of former glaciation in Westland and Canterbury, it is to be expected that similar appearances will be found amongst the Nelson mountains.

The mountains to the westward of Nelson rise to an altitude of from 5,000 to 6,000 feet above the sea level, and are covered with snow during the winter months; many streams rise amongst them, and at the head of nearly every large stream well defined traces of glacial action exist. I am not aware that these facts have ever been described before, and those unacquainted with the appearance of glacial phenomena, and also ignorant of the extent to which the country was once covered with snow and ice, might easily pass by these indications, or, if noticing indifferently, might perhaps mistake them for the traces of avalanches.

The ancient glacier beds are much overgrown with scrub and bush, the striated and polished rocks frequently covered with broken rock and grass, so that there is not often much to catch the eye of a casual observer.

The most clearly-defined glacier bed that I have seen west of Nelson is situated at the head of the Boulder River, a tributary of the Aorere, which falls into Golden Bay at Collingwood. The river takes its rise from a lake (Te Warau), which is 3,200 feet above the sea level, and occupies the lower end of a narrow valley formed by Lead Hill on the west, and a ridge which divides the Boulder River from Rocky River and the heads of the Anatoki on the east. Lead Hill is a mass of granite, which rises to a height of 4,450 feet above the sea, and has forced up the slate which forms the opposite ridge to the eastward to a highly inclined angle.

The valley in which the lake is situated lies between the granite and the slate, and is about three miles long from the southward; it commences amongst the mountain spurs, ending at the north in a cliff 200 feet high, over which the water from the lake falls in one unbroken sheet. Just above the cliff a dome of granite rises about 100 feet above the lake, its sides furrowed and polished, and every angle rubbed off, giving it the appearance of a huge grey snowball left standing on the hill side. All the surrounding rocks are also scored and polished for a height of about 150 feet above the lake. The height at which the scouring action of the glacier ceased is most distinctly marked, and here and there on the furrowed rocks large blocks of granite and slate lie strewn, as though placed there but yesterday fresh from the quarry.

On the western side of the valley, near the lower end, a number of granite blocks lying upon the slate show the height at which the ice formerly stood, and these blocks must have been brought down from the peaks at the head of the valley, or else from the west side, as no granite occurs on the east side. The glacier, when it attained its fullest size, was about four miles long from the *névé* saddle to the terminal face, which must have been about 200 feet high, and rested on the top of the cliff above described, over which the glacier would be forced as the daily motion carried it forward. At the foot of the cliff the deep ravine in which the stream runs is partly filled with large blocks of rock, lying as when borne down and thrown there by the glacier.

This interesting spot is within a day's walk of Collingwood, and a fair bush track exists for the whole distance, so that it can be easily reached; and, apart from its scientific interest, the deep blue lake, with its green and grey setting of birch trees and granite, forms a most pleasing scene, which would well repay the artist or lover of scenery for the labour of the ascent.

Several small glaciers existed at the heads of the Anatoki, and most probably one of considerable size at the head of Clarke River, but that locality I have not yet been able to visit.

The Mount Arthur range, which attains its greatest height (5,800 feet) in the Mitre Peak of Mount Arthur, gave rise to many glaciers. The most conspicuous remains that I have had the opportunity of visiting I shall attempt to describe. Commencing with the eastern side of the range, the principal one lay just at the foot of Mount Arthur. The terminal moraine occupied the bed of the stream at the point where the basin at the foot of the Mitre Peak contracts and the stream enters a gorge. A broad expanse of rounded rocks, kept bare now by the winter snows from the overhanging peaks, shows the amount of ice action to which the rocks have been subjected. This glacier was triangular in shape, the terminal face occurring at the apex of the triangle, and the ridge of the mountains formed the base. The area was about two square miles, and the terminal face about 3,000 feet above the sea level.

At the head of the Bâton a small glacier occupied an oval basin at the foot of Jones' Saddle, having an area of about 400 acres.

The terminal and lateral moraines are very distinct, although much covered in places with *detritus* from the mountain sides. The lower part of the old bed is a swampy flat, the moraines having formed a dam which retained all the mud gravel brought down the mountains by the rains. It is most probable that this glacier was fed by glaciers of the second order, which existed on the flat sloping mountain tops that surrounded it. A more beautiful scene than this must have presented when at its greatest size it would be difficult to conceive—the main glaciers lying in an oval valley surrounded on three sides by mountains rising 1,500 feet above it, full of cliffs and rugged pinnacles capped with large snow fields, must have been extremely grand.

Near the head of the Wangapeka, at the foot of Mount Target, is a small glacier, about one mile long and about 200 yards across in the widest part, in whose centre occurred an ice cascade 150 feet high, and the ice was here contracted to about sixty yards in width. The lower part of the bed is at present a swampy flat covered with grass, the moraines having dammed back all débris brought down by the mountain streams, the old bed has been filled up nearly level with the top of the terminal moraine. The terminal face is about 3,600 feet above sea level.

Much larger glaciers existed on the west side of the range than on the east; these for the most part poured their waters into the branches of the Crow River, a tributary of the Karamea. The two largest occupied the north and south branches of that stream; the northern one was about four miles long, and from half to a quarter of a mile wide. The terminal moraines being about 2,700 feet above the sea level, a large snow field supplied this glacier—the whole of the west slope of the main range from the peaks near Jones' Saddle to Hough's Saddle, and all the east slopes of the mountains forming the west side of the basin—containing in the aggregate about nine square miles. The old glacier bed has been very much filled with *detritus* from the mountains, which has buried the moraines, so that it is difficult to find unmistakable signs of ice action without careful search. The terminal moraine has been almost completely hidden, but may be found where the present stream has cut its way through it.

The glacier which occupied the southern branch descended from the north-east slopes of Mount Target, and is of considerably less extent than the one last described. I was unable when in that district to spare the time to search for signs of its terminal face, but I should think it must have been about 3,000 feet above sea level. These glacial remains, which I have attempted to describe, are only a few of the principal ones of a great number. At the head of every gully near the main peaks small flats are visible covered with grass, which undoubtedly have been formed by the filling up of old beds, the moraines acting as dams to retain the material washed down the mountains. The largest glaciers in all cases occurred near the highest peaks. During the period the line of perpetual snow must have been very much lower down the mountains than it is at present. I should be inclined to think that it was about on a level which is now only about 4,500 feet above the sea, and from the very distinct manner in which many of the old beds are still marked, and the unburied state of many of the moraines, I think the disappearance of the ice must have been at a very recent date. No one can behold Lake Te Warau or the head of the Bâton without being struck by the freshness of all the indications of ice action existing there. At Lake Rotoiti also are extensive glacial remains; though these have been frequently described before, it may not be out of place here to say a few words respecting them. The lake occupies an old glacier bed, and is about 2,060 feet above the sea level; the glacier descended from Mount Travers, and is about twelve miles in length and two miles wide, near the lower end. The terminal moraine now forms a series of low hills encircling the northern end of the lake, and the bed of the Rotoiti for several miles from the outlet of the lake is filled with ice borne rocks. The Black Valley, which lies at the northern end of the St. Arnaud range, was also filled with ice, and the road which leads from the Rundell to the lake passes along on a lateral moraine for some distance; large blocks of stone lie about the surface, the sharpness of their angles and the absence of any signs of water-wear clearly proving that their appearance there is due entirely to glacial agency.

Both the Spencer mountains and the St. Arnaud range must be very rich in glacial remains, and have been but little explored in their higher parts, being covered with dense bush, and lying back some distance from roads and inhabited country; their thorough exploration is a matter involving very considerable time, labour, and expense, and can only be undertaken by those whose duty leads them into such country, or those who have ample time and means at their command.

The examination of these phenomena clearly proving a wonderful alteration of temperature within a very late period, naturally induces the mind to seek an explanation of the change, and two hypotheses offer, I think, a reasonable solution of the difficulty.

1. That New Zealand has sunk during late periods, bringing the former snow line much nearer sea level.

2. That there formerly existed land to the southward, perhaps forming part of a southern continent, the proximity of which would naturally be attended by a great increase of cold in New Zealand, and its disappearance would be accompanied by a complete change in the climate of all neighbouring lands.

Which of these solutions is the right one I cannot attempt to say, and only offer them as suggestions, which must be taken for what they are worth. I feel most inclined to favour the former. There is, I think, but little doubt that these islands have been subjected to many, and very considerable alterations of level during recent periods, and a subsidence of a few hundred feet would necessarily make a very marked difference in islands possessing the physical configuration of New Zealand. But these speculations lead much further than can be followed in this paper, the object of which is simply to describe a few of the traces of the glacial period which exist in our immediate neighbourhood, in the hope that by the collection of a few observations (however erroneously interpreted) it may to some extent assist and lighten the labour of those whose wisdom and experience enables them to interpret correctly those signs which record the geological history of the later periods.

ART. LXIII.—*On the Remains of a Gigantic Penguin* (Palæeudyptes antarcticus, *Huxley*) *from the Tertiary Rocks on the West Coast of Nelson.* By JAMES HECTOR, M.D., F.R.S., Director of the New Zealand Geological Survey.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 13th November,* 1869.*]

THE fossil remains I have to describe were forwarded to me by Mr. James Duigan, telegraphist at Brighton, a goldfield township on the west coast of Nelson province, between the Grey and Buller Rivers. They were discovered by him in a ledge or reef exposed only at low water, and forming part of the Seal Rock, a bold headland which protects the anchorage of Woodpecker Bay.

With considerable difficulty, owing to the inaccessible position and toughness of the rock, he succeeded in extracting the slab in which the bones are imbedded, together with a few other fossils from the same strata.

The bones are thoroughly mineralized, and resemble the condition in which fossil reptilian bones are usually found, the osseous tissue being completely replaced by calcareous matter of dense close structure and dark brown colour.

The rock matrix is an impure sandy limestone, having a compact but flaky structure. The skeleton appears to have been complete when imbedded, but has been so crushed and broken that only wing and leg bones can be now identified and cleared from the matrix.

The most perfect bones are :—1. The femur of the right side. 2. Both humeri. 3. Part of left ulna, and metacarpals of each side. 4. Portions of ribs, vertebræ, pelvis, and sternum, all in a very fragmentary state, can be traced on the slab, but no portions of the skull can be recognised.

The clearing of the matrix from the bones had to be effected with great care, as the fossils are apt to break transversely into splinters, on which account only one surface has been exposed in some cases.

It was the character of the distal articulation of the humerus, showing enormous strength without much freedom of motion, that led me to recognise this bone as belonging to the wing flipper of a Penguin. (*a′* and *a′*, Pl. XVIII., figs. 1 and 5.)

* For preliminary notice see *Proc.* N.Z. Inst., Vol. II., p. 403. The publication has been delayed for the illustrations.

In examining these remains I have compared them with the largest sized Penguin commonly found on the New Zealand coast, which is the Crested Penguin (*Eudyptes pachyrhynchus*, Gray), and which is about 30 inches in total length, and stands about 22 inches high when alive.

In Plates XVII. and XVIII. the fossil bones have been drawn along with the corresponding bones of the recent bird, so that the enormous excess in the proportions, size, and massiveness of the extinct bird may be the more easily realised.

1. *Femur* (Pl. XVII. fig. 1).—This bone has only been partly freed from the matrix, but the whole of the anterior surface and both extremities of it are fully exposed. Its length is 5 inches, and the least diameter of the shaft ·7 inch. On comparing it with the femur of the recent *Eudyptes*, which is 3 inches in length, the chief difference observable is the great massiveness of the fossil bone, which is more cylindrical, and with less decided ridges and muscular impressions than that of the recent bird, which, though smooth, is almost triangular in its cross section. The angle at which the neck of the bone is set to the shaft is also less obtuse in the fossil, and the neck itself is proportionally longer, the length from the great trochanter to the articular surface being only two and four-fifths in the total length of the bone, while in the recent bone it is four times. The trochanter, also, instead of forming an acute crest-like ridge, smooth and convex externally, and excavated internally, is an expanded deeply pitted process that sends off two ridges on the external surface of the shaft that inclose a shallow depression. The external condyle has been partly destroyed, but there is sufficient to show that the anterior groove for receiving the patella was much wider and shallower than in the existing bird.

2. *Humerus.*—That belonging to the left side has been quite freed from the matrix, but has evidently been much bruised and injured before fossilization took place. The articular surface, where in contact with the ulna on the same side, is fortunately well preserved. The right humerus, the internal aspect and head of which only are freed from the matrix, is in perfect preservation. It is a strong compressed bone of greater proportionate size to the same bone in *Eudyptes* than was found to be the case with the femur. Its total length is 6 inches, while the humerus of the recent skeleton with which it has been compared is only 3 inches—the proportion being thus two to one, while the femur was only as five to three. The greatest width of the fossil bone is at the neck, where it is 1·7 inch, whilst the recent bone is widest at its lowest third. The marked difference in the outline of the bones thus produced is very obvious in the drawings (Pl. XVIII. figs. 1 and 4). Where most compressed, which is at one-third from the distal extremity, its thickness is only ·2 inch. The powerful processes for the capsular and ligamentous

attachments of the bone with the scapula are well shown in figs. 2 and 3, and far exceed in proportion the same parts in the recent bone. But, on the whole, in this and all the other bones compared, there is a marked agreement in structure and anatomical characters with those of the existing bird, the chief differences being in the total and proportional measurements.

3. *Ulna.*—There is only a fragment of the upper end of this bone, belonging to the left side (Pl. XVIII. fig. 6), which was found in the slab with its articular surface applied to the corresponding posterior condyle of the humerus.

4. *Metacarpals.*—On the surface of the slab the metacarpals of both wings are exposed, but not cleared from the matrix. Their length is 3·5 inches, and greatest width 1·1 inch. It happens that in the Museum there is a beautifully preserved fossil bone, that was collected by Mr. C. Traill from the white Kakanui limestone of Otago, and which the study of these remains led me to recognise as the left metacarpal probably of the same species of Penguin, though belonging to an individual of slightly larger dimensions, the total length being 4 inches. This very perfect fossil has been figured (Pl. XVII. fig. 3) along with an outline of the corresponding bone of *Eudyptes* (fig. 4), which is only 1·7 inches in length.

The Oamaru specimen possesses great interest, from its connecting the fossil remains from the West Coast, which are under consideration, with a discovery made by Professor Huxley in 1857, who recognised from a single bone of the foot (*tarso-metatarse*), which had been submitted to him by the Hon. W. B. D. Mantell from the same formation that yielded Mr. Traill's specimen, that a gigantic Penguin existed in New Zealand during the early tertiary period. The bone described by Professor Huxley has been re-figured from his woodcut,* along with the same bone of the Crested Penguin (Pl. XVII. figs. 5 and 6), for comparison with the other bones of the fossil bird, of which we have now fragments of probably three distinct specimens, unless, by some rare chance, Mr. Traill's specimen, gathered many years later, should be part of the same skeleton that Mr. Mantell's bone belonged to. As there is no reason for ascribing the bones from the east and west coasts to different species, I propose to include them under the name given by Professor Huxley—*Palæeudyptes antarcticus.*

In forming this new genus Professor Huxley states that the fossil bone he described approximates most to the characters of the Crested Penguin (*Eudyptes*), the skeleton of which I have used in the foregoing comparisons, but that it indicated the former existence of a bird twice as tall and massive as the largest existing species of this genus, and probably from 4 to 5 feet high. From the comparisons I have been able to make with the larger series of bones now obtained, I am convinced that this estimate is rather under than over the size of the extinct bird.

* "Quart. Jour. Geol. Soc.," XV., 672.

The age of the strata containing these fossil bones is a matter of some interest, and on this subject Professor Huxley remarks :—

"Whatever be the precise age of the fossil, it is not a little remarkable to find in strata of such antiquity the remains of a bird, the whole of whose congeners are at present absolutely confined to the southern hemisphere, and, therefore, in a broad sense, to the same great distributional area. If the strata be of pliocene age, the fact is in accordance with the relations which have been observed to obtain between the recent and pliocene faunæ of the northern hemisphere. On the other hand, the little that is at present known respecting the distribution of birds in time is not inconsistent with the ascription of a far greater antiquity to a genus as closely allied as *Palæeudyptes* to those which now exist."

I am now inclined to the opinion that the fossils belong to the earliest tertiary formations of New Zealand for the following reasons.

The Kakanui limestone, which is the same as the Ototara series of Mantell, and from which the specimen submitted to Professor Huxley came, was considered by Professors Forbes and R. Jones, who examined the associated fossils, to possess mixed characters of the eocene and upper cretaceous formations of Europe.*

This limestone is very widely distributed round the sea-board of the North Island, and affords a very distinct horizon, which closes the earlier tertiary deposits, as it nowhere, so far as I am aware, passes conformably into the marine tertiary formations of later date.

On the west coast of the Island, although the tertiary strata occur in detached areas, their relative age can be observed with a considerable amount of certainty.

Without entering fully into the discussion of the geology of these formations, they may be shortly described as follows, to explain the stratigraphical position of the bed from which the fossil bones were obtained :—

1. Underlying the gold drifts (*pleistocene*) in the county of Westland, and extending northwards up the valley of the Grey River are blue sandy clays passing upwards into a coarse shingle conglomerate, and which together represent the upper marine tertiaries on the west coast. Towards the base of this formation, which is at least 1,000 feet thick, calcareous nodules occur, containing *Struthiolaria*, *Ancillaria*, *Dosinia*, *Cucullæa*, and other fossil shells characteristic of the younger tertiary series, and closely allied to, or identical with species that still exist in the neighbouring seas.

2. Unconformably disposed to these, and of much higher antiquity, are the following groups of strata, to which I have collectively applied the term cretaceo-tertiary, as no well marked break that is common to all the sections

* "Quart. Jour. Geol. Soc.," VI., 329.

that can be inspected has been observed in their sequence; and, moreover, certain fossil forms are found in all the members of the series.

a. The highest beds are green calcareous sands, generally ferruginous, which are followed by tabular limestones, having a thickness of about 700 feet. These beds abound in fossils, of which *Pecten Hochstetteri* is the most constant and characteristic.

b. These calcareous beds, which represent the Ototara series, pass gradually into a compact chalk marl and then to tough argillaceous marl, which contain, along with *Pecten Hochstetteri*, many large forms of *Echinoderms* and a very large species of *Inoceramus.* The thickness of these beds is at least 800 feet.

c. Beneath the foregoing are finely laminated and extremely friable marly shales of a chocolate and grey colour, with thin, hard calcareous bands, with only few indistinct fossils, which are chiefly *Foraminiferæ.* The thickness of these shales is over 400 feet.

d. Tough blue clays, having a globular structure and ferruginous partings, succeed these, and gradually pass into a brown argillaceous and micaceous sandstone, with concretions of limonite, which contain a few characteristic fossils, chiefly littoral forms, such as *Cardium*, *Natica*, and a small *Echinoderm* (*Schizaster ?*) being forms that are not found higher in the series. The thickness of the clays and sandstones is probably not less than 1,000 feet.

e. They rest on an irregular surface of a great fluviatile formation, the upper portion consisting generally of conglomerates, which attain a thickness of 800 feet, and rest on fine micaceous sandstones, grits, and shales, but sometimes the conglomerates are absent, and the sandstones pass insensibly into the previous group.

On the surface of the conglomerates, and immediately succeeded by the fossiliferous sandstone, is frequently a seam of brown pitch coal, from 4 to 30 feet in thickness, but this, as might be expected, is by no means constant.

In the lower sandstone there is always more or less coaly matter, and abundance of fossil leaves of dicotyledonous trees, zamias, and palms, and locally fine seams of excellent, though friable, bituminous coal, attaining a thickness of 10 to 20 feet.

In some places on the west coast this formation passes downwards into a breccia of green and blue slate rock fragments, cemented with quartzose porphyry, but more frequently it rests directly on the primary slates and granite formation that constitute the framework of the district.

The section which I have thus described may be seen on the coast north of the Grey River, where the strata have a dip to the seaward of 10° to 12°, but they also present the same general character and order of succession in mountains in the northern part of the Nelson province, at the source of the Karamea River, where almost vertical sections, of 2,700 feet in height, can be observed, the cap of the mountain being formed by the tough marly limestone, so that the upper and friable members of the series are wanting, probably having been removed by denudation.

The strata at the Seal Rock, in which the Penguin bones were found by Mr. Duigan, appear to belong to group *a*, the fossils found *in situ* along with the bones being *Scalaria lyrata*, *Pecten Hochstetteri*, *Gryphæa*, sp., *Brissus Crawfordi* (a species of the same size and form as *B. eximius*, but with the ambulacræ radiating equally), *Cidaris*, sp. (with large plates), *Turbo*, sp. (with a flat base) ; and a large shark's tooth, *Carcharodon*, sp.

The following fossils received along with the above were stated to have been obtained from rolled stones on the beach :—*Venus*, *Dosinia*, *Lima*, *Fusus*, *Cassidaria*, *Echinus?* and the large *Inoceramus*. The *Inoceramus* is imbedded in white chalk, but all the other shells are in the same sandy limestone that incloses the bones. Although none of these fossils resemble recent forms, and the *Gryphæa* and *Inoceramus* are decidedly of cretaceous type, yet from other parts of the same formation, where more extensive collections have been made, sufficient evidence has been obtained to prove that it has to some extent the character of a tertiary deposit, but until the fossils have been thoroughly examined, and the per centage of existing forms ascertained, the equivalent age of the strata whether miocene or eocene, for they must be at least as old as these, cannot be determined.

From the evidence I have now advanced there can be little doubt that this fossil Penguin was entombed at a very early period, when the seas in this area were inhabited by several forms of the invertebrata that are now extinct.

Description of Plates XVII. and XVIII.

Plate XVII. fig. 1.—Front view of Right Femur of *Palæeudyptes antarcticus*, the Fossil Penguin from the Seal Rock.

Fig. 2.—Front view of Right Femur of *Eudyptes pachyrhyncus*, the existing Crested Penguin of New Zealand, 22 inches high.

Fig. 3.—Metacarpus of Fossil Penguin from Oamaru limestone, Otago.

Fig. 4.—Metacarpus of Recent Penguin.

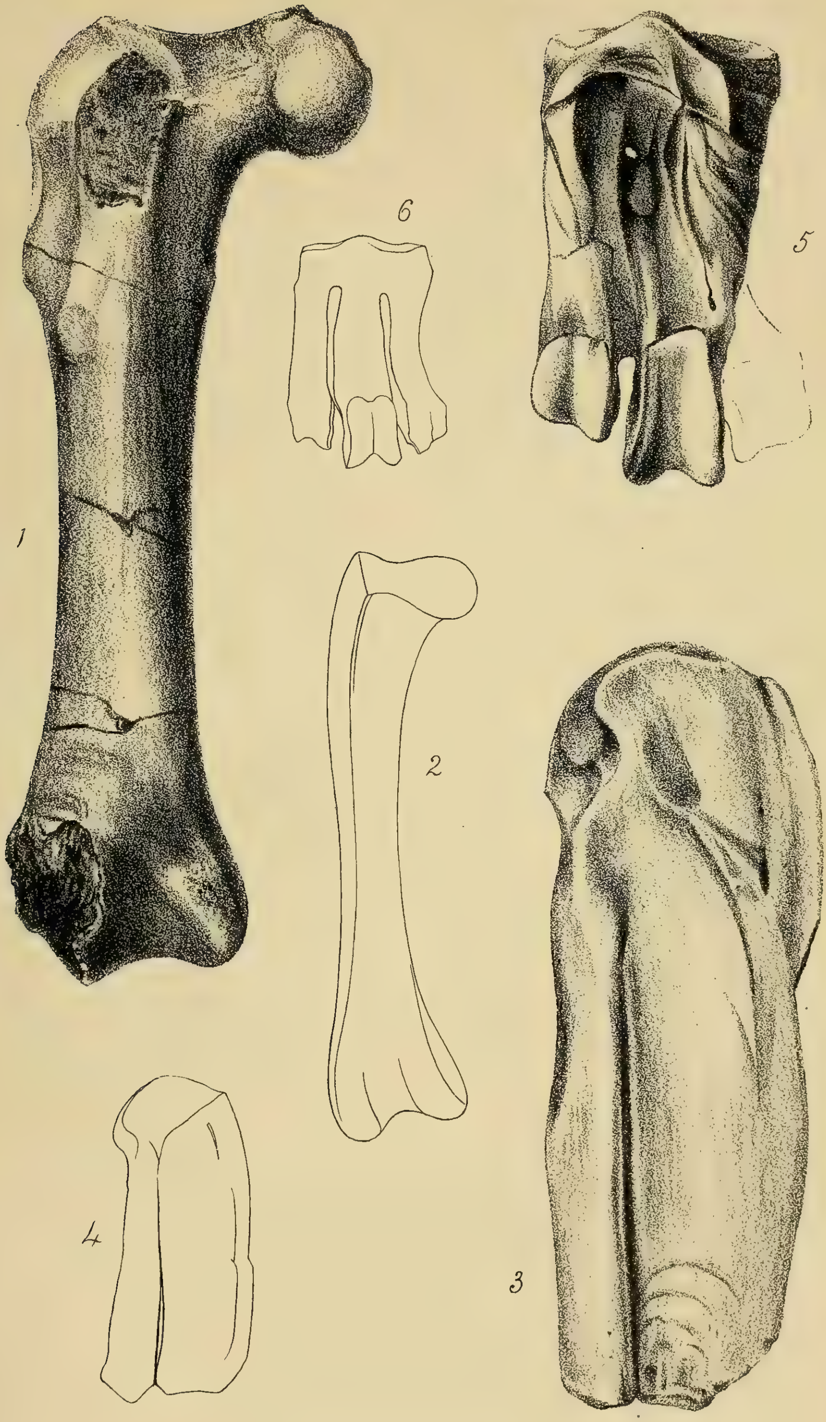
Fig. 5.—Tarso-metatarse of Fossil Penguin from Kakanui limestone, Otago, from Professor's Huxley's drawing.

Fig. 6.—Tarso-metatarse of Recent Penguin.

Plate XVIII., Fig. 1.—External, fig. 2—internal, and fig. 3—posterior aspect of Right Humerus of Fossil Penguin from the Seal Rock.

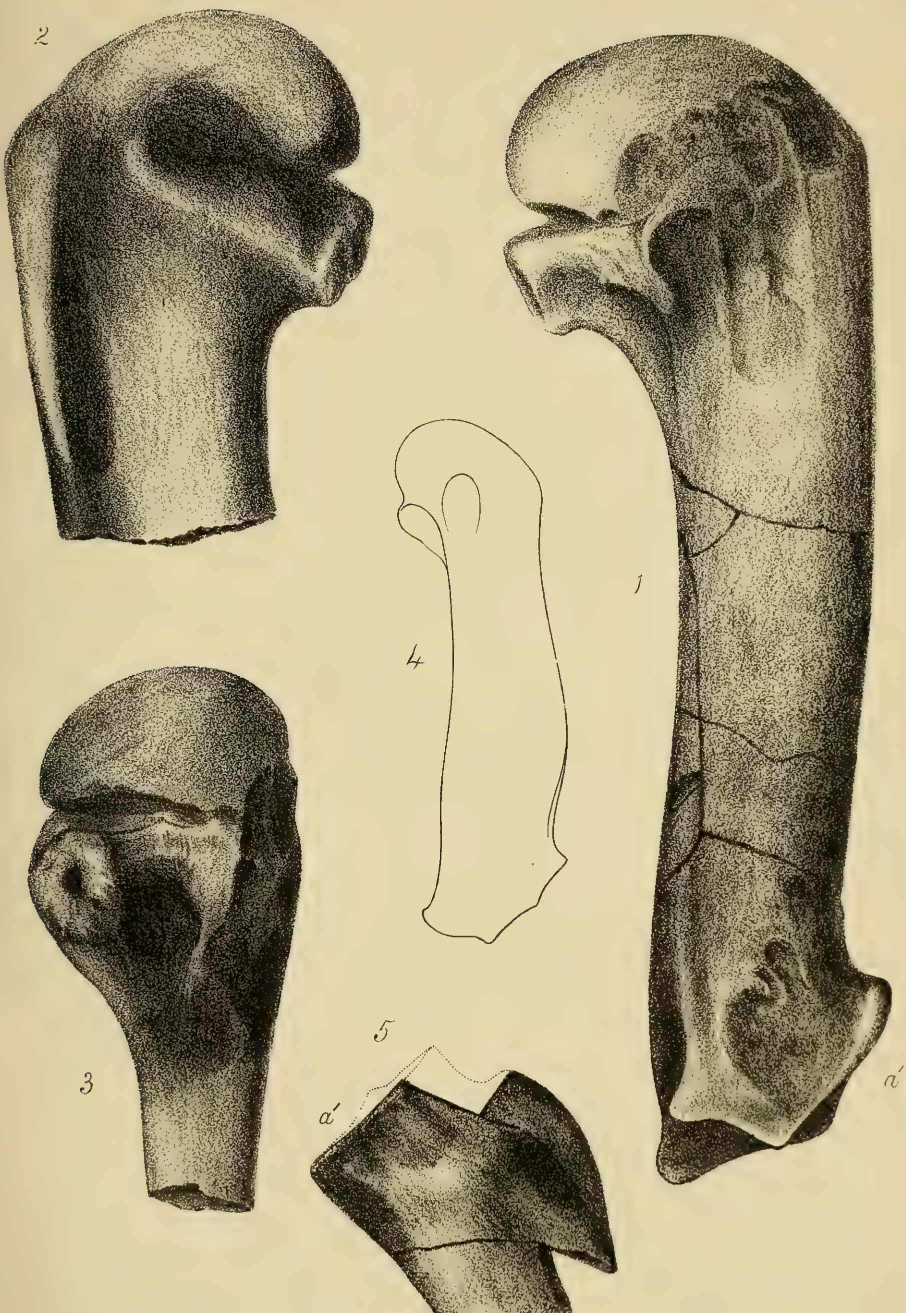
Fig. 4.—External aspect of Right Humerus of Recent Penguin.

Fig. 5.— Head of Ulna of Fossil Penguin, articular surfaces marked *a′* were in contact.



FOSSIL PENGUIN.

J. Buchanan del. et lith.



FOSSIL PENGUIN.

J. Buchanan del. et lith.

MISCELLANEOUS.—(*Cont. from p.* 164).

Art. LXIV.—*On the Sailing Flight of the Albatros; a Reply to Mr. J. S. Webb.* By Captain F. W. Hutton, F.G.S.*

[*Read before the Auckland Institute, 13th June,* 1870.]

In the second volume of the *Transactions* of the New Zealand Institute, p. 233, there appears a criticism by Mr. J. S. Webb, on a paper of mine, published in the "Phil. Mag." for August, 1869, on the flight of the Albatros, in which he says that I have not been happy in the mathematical treatment of the subject, having made a mistake at the outset of my calculations, and that the higher velocities that he derives from my data upset the conclusions that I have drawn. I am, therefore, almost compelled, in self defence, to criticise a little his criticism.

Before commencing, however, I ought perhaps to inform those who have not read my paper, that the object I had in view in that part of it to which Mr. Webb has taken exception, was to show as clearly and as simply as possible, that if an albatros started with a certain velocity it could, by slightly altering the angle at which it was flying, continue to support itself in the air without using its wings until its velocity had been reduced below a certain point, and I, therefore, pointed out the two main principles on which this depended, and omitted many minor points which would have to be considered if fully discussing the case. Any person who reads my paper will see that these calculations make no pretensions to accuracy, for the data on which they are founded are merely rough approximations. They are simply used as an illustration, and rough demonstration, of a previously propounded theory (see "Ibis," July, 1864); for, in order to *prove* the theory, both the resistance of the air to the bird and the velocities at which it sails must be obtained by observation and experiment, and they must then be shown by calculation to be not inconsistent with one another when connected according to the theory.

I will here, also, take the opportunity of explaining to those who notice discrepancies in my two papers, that after I had read the first to the Auckland Institute I received from England a copy of Dr. Pettigrew's paper on the flight of birds, and in the second paper (published in the "Phil. Mag.") I used his observations on the angle which the wings of a bird make with its body, as giving probably a more accurate result than taking the wings and body to be in the same plane, as in my first paper; and not unnecessarily to compli-

* See previous Articles, Vol. II., p. 227, and 233.

cate a subject in which no great accuracy was to be expected, I omitted the resistance of the air to the under surface of the body of the bird as being very small in comparison to that of the wings.

With these explanations I will now proceed to discuss the appendix to Mr. Webb's paper.

Page 234, line 4 from bottom, *et seq.*—"Captain Hutton first assumes that the number of feet the bird travels in one second = HE, and then that the bird will pass in the same time through the longer distance AE."

Mr. Webb has here fallen into a mistake through not having comprehended my meaning, which may not, perhaps, have been very clearly expressed. HE represents the actual velocity of the bird, and is the only line that could be determined by observation. AE represents the distance it would have passed through but for the counteracting influence of gravity, and must be calculated from HE.

Page 234, line 2 from bottom, *et seq.*—"The mistake leads him (Capt. H.) to the further error of adopting HE tan AEH as the measure of the vertical component of the atmospheric resistance instead of HE sin AEH."

Mr. Webb has again failed to comprehend my meaning, but this time from carelessness in reading my paper. AH is not taken by me to represent the height the bird would rise by atmospheric resistance, but by the direction in which the bird was flying—viz., slightly upwards; and this inattention has led him into the remark that I have "unaccountably adopted a totally different method to arrive at the vertical component of resistance in the case of the wings," the truth being that I have adopted "totally different methods" for dealing with two totally different things—viz., the angle of flight in the first case, and the resistance of the air to the wings of the bird in the second. It will, therefore, be seen that it is not I, but Mr. Webb, who has arrived at the "strange conclusion" mentioned a few lines further on. Even if it had been the atmospheric resistance that was here being considered, HE sin AEH would not be the measure of the vertical component, for it is the measure of the whole of the resistance both to forward as well as to downward movement.

Page 235, line 16.—"The whole force exerted by the bird is, in fact, HE + R." I do not know what Mr. Webb means by this, for HE does not represent a force at all, but the velocity of the bird, which is a very different thing, although it will, no doubt, have a certain ratio to the force exerted by the bird.

Page 235, lines 17–18.—"It is not LE but KE (= HE sin CEH) which represents the vertical component of the force actually at work."

How KE can be supposed to represent the vertical component of *any* force is more than I can understand. It is the same error as that previously made with regard to HE sin AEH.

Page 235, line 21, *et seq.*—"Captain Hutton goes on to say 'the total amount the bird will rise will be LE + HA feet.' Introducing the corrections just made, this amounts to saying that the upward pressure on the whole area of the bird = HE (sin AEH + sin CEH). This is a grave error."

No doubt it is, with Mr. Webb's additions and corrections, a very grave error indeed, but it is not of my making. The same confusion that has already been pointed out is again here very apparent. "The total amount the bird will rise," is not by any means the same thing as "the upward pressure on the whole area of the bird," although Mr. Webb has substituted one for the other. HE, HA, and LE, do not represent pressures, but spaces traversed in a certain time, or, in other words, velocities. As HE was originally taken to represent the *velocity* of the bird, or air (which must be the same thing), it could not possibly also represent the *force* or *pressure* of the air, which is a very different thing, although Mr. Webb has taken it to represent *both.* At the outset of my calculations I changed the pressure necessary to support the bird into an upward current of air moving with a velocity of 30 feet per second, and the problem then was to find what would be the horizontal velocity (HE) of the air which would give, when acted upon by the wings of the bird, a vertical component equal to 30. I then showed that when the bird was flying at an angle (AEH) with the horizon, the distance it would rise in a second (HE tan AEH) would have to be deducted from the 30. I next showed that when the velocity of the wind was HE, its vertical component, when acted on by the wings of the bird inclined at an angle CEH to the horizon, would be HE sin CEH cos CEH, and that, therefore, the two must together be made equal to 30 to enable us to find what the horizontal velocity of the wind (HE) should be, in order that it might just counteract the force of gravity. I must, however, here confess that, owing to a *lapsus calami*, I have, unfortunately, written in my paper "the force of the wind HE," instead of "the velocity of the wind HE," and twice afterwards, where the word "force" has been employed, it would perhaps have been better to have used the word "direction," and although this slip has in no way affected my subsequent reasoning, it may have confused Mr. Webb and led to his mistakes. So far, therefore, I must plead guilty, but I cannot allow that he has upset any conclusion that I have drawn; on the contrary, he has supplied me with a formula, which, as I shall presently show, completely gets over the only difficulty in the way of my theory.

Mr. Webb's equation (1) is not correct, for, as I have shown, HE sin AEH and HE sin CEH are not the vertical components of the resistance of the air, and equation (2) is not a legitimate deduction from (1), as in it force and velocity are confused together, consequently (3) and (4) are incorrect also.

I agree with Mr. Webb that it is hardly fair to compare an Albatros with a round shot, not, however, because a round shot is a projectile, for an Albatros when sailing is a true projectile also, but because the initial velocities are so very different. Instead, therefore, of the round shot formula I will take the one given by Mr. Webb.

$$R=\frac{1}{2}\,Q\,v^2\;\sin^3 I.A.$$

and take the body of the Albatros to be a cone of 20°. We shall then have

$$R=0{\cdot}0006\,\sin^3 10°\,A\,v^2$$
$$=0{\cdot}000003\,A\,v^2$$

which is very nearly that which I calculated would allow an Albatros to sail for half an hour, and is just half way between the resistances calculated in my first and second papers; and, therefore, if this formula may be relied upon, all the difficulties of my theory disappear, for, although something would have to be added for the resistance to the wings, something would also have to be deducted for the tapering away of the hinder parts of the bird, which is known to decrease the resistance considerably. At page 234, line 6, Mr. Webb remarks, "I do not know whether the merit of the demonstration belongs to him (Captain Hutton), he appears to claim it." I may, therefore, I hope, without being considered egotistical, be allowed to make a few remarks on the subject. In 1864, when I first took up the question, the prevailing opinions about it were various and confused, as pointed out by me in the previous paper that I read to the Auckland Institute. Even those authors who had seen that sailing flight must be due to previous momentum (such as Darwin in his account of the flight of the Condor), had no clear ideas of how the two were connected, and thought that probably the momentum was kept up, or increased, by the bird occasionally closing its wings and falling rapidly for some distance. I was, I believe, the first, in March, 1865, to enunciate the theory that it was by slightly increasing the angle of flight that a bird was enabled to sail, and my paper published in the "Phil. Mag." for August, 1869, was, I believe, the first attempt made to treat the subject mathematically, and to show, not only the mechanical principles on which it depended, but also that the resistance of the air was no insuperable objection to my theory. This is all I claim, and I do not know that any one has ever disputed either the truth of the theory, or my priority in enunciating it. A German named Prechtl, and a Frenchman named, I think, Maret, have both written books on the flight of birds, but they are rare and but little known, and I have not seen either of them, nor do I know the dates of their publication, and it is possible that I may have been forestalled by one or other of them.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

FOURTH ANNUAL GENERAL MEETING. *28th January*, 1871.

The Hon. W. B. D. Mantell, President, in the chair.

ABSTRACT REPORT OF THE COUNCIL FOR THE ANNUAL MEETING.

DURING the year eight general meetings and one special meeting have been held, and communications on fifty-nine subjects made. Of these forty-four have been forwarded to the Governors of the New Zealand Institute for publication in the third volume of the *Transactions*.

The subscriptions during the year amount to £97 12s., showing an increase of £25 3s. over the previous year. The statutory contribution of one-sixth of the year's income (£16 5s. 4d.) has been made towards the maintenance and extension of the Museum. £50 has also been devoted from the funds of the Society to the improvement of the Botanic Reserve. £20 has been expended in procuring additions to the library, and arrangements have been made for receiving the following publications:—"Quarterly Journal of Science," "Popular Science Review," "Nature," "Australasian," "Field," "Gardener's Chronicle," "Builder," "Engineer," and "British Mechanic," which may be consulted in the reading room at any time by members.

The balance in the hands of the Treasurer is £60 10s. 7d.

The number of members to whom the second volume of the *Transactions* was sent in May last was eighty-five. 103 members are now on the roll.

ELECTION OF OFFICERS FOR 1871: *President*—W. T. L. Travers, F.L.S.; *Vice-Presidents*—W. L. Buller, F.L.S., F.G.S., J. C. Crawford, F.G.S.; *Council*—J. Hector, M.D., F.R.S., J. Kebbell, W. Lyon, F.G.S., Robert Hart, W. Skey; *Hon. Secretary and Treasurer*—F. M. Ollivier.

New members—A. Allan, W. Colenso, F.L.S., James Prendergast, and F. J. Knox, L.R.C.S.E.

1. Dr. Hector called the attention of the meeting to a live Katipo (a poisonous native spider), which had been sent from Wanganui by Mr. Walter

Buller; also to specimens of a Beetle sent from Wanganui by Mr. Duigan; and read a communication recording an extraordinary flight of an army of these beetles, from which the sample had been captured, in the Patea district. The paper stated that they travelled with marvellous speed, having gone over forty miles of country in one night, and that a similar irruption had taken place on the coast in 1863.

Mr. Travers said this Beetle was very like one that made its appearance in Canterbury, the larva of which was most destructive to the grass; and he believed it originally came from Tasmania, where it proved very destructive to grass and crops. The most effectual remedy for the plague in that colony was found to be flooding the earth, as, after the water passed off, the dead larvæ were to be seen in the ditches in incredible quantities. Among some interesting particulars respecting this unwelcome stranger, Mr. Travers said it was nocturnal in its habits, being very seldom seen in the day; and he thought it was much to be regretted that it had found its way across Cook Strait.

2. Mr. Travers read the following description of Moriori Canoes, received from Mr. A. Shand, formerly Resident Magistrate at the Chatham Islands:—

"The Morioris had four kinds of canoes, but each much of the same kind or shape. One was called a 'Waka Puhara' or 'Korari,' made like the one sent to the Colonial Museum, with two keels. The stern-post was called a 'koua,' and carved, and the two pieces of wood projecting from the stern were called the 'puremu,' and were also carved. This canoe was generally 30 to 35 feet long, 4 to 5 feet deep, and the same in width.

"A 'Waka Rimu' was another kind, similar to the first, but having no korari about it, and only kelp put in the body of the canoe.

"A 'Waka Pahi,' the same as the one sent to the Museum, was the sort of canoe used to go to the islands, birding, etc. The size of a large one was—the keels each 30 feet, the koua 12 feet, the puremu 10 feet—about 50 feet over all; breadth 8 feet; depth 5 feet. The keels were made of matipou, the koua and puremu of akeake, the rest of such timber as the island afforded. The kelp used to make it float was the 'rimapa,' or broad flat bull kelp, which was dried and then put in, and taken out when done with, and replaced when rotten.

"The fourth kind of canoe was much the same as a New Zealand mokihi, but made with korari and rarauhe stalks, being quite low, and had wooden images of men made and placed theron, from twelve to twenty-four in number, with each a paddle tied to its hands, and then, with a fair wind, was started off to sea to the God Rongotakuiti, who replied by sending seals and shoals of blackfish ashore. It was called a 'Waka Ra.'"

3. Dr. Hector gave an account of the reports he had received from more than thirty stations respecting the magnificent meteor that passed

over New Zealand on the 1st instant at 8.30 p.m., which he stated had a general course from about a point west of north through the zenith of Picton, over which place it passed at less than thirty miles altitude above the surface of the earth, travelling with an apparent velocity of twelve miles per second. Its form was that of a ball intensely luminous, of a reddish hue, with a long very brilliant tapering tail, the light of which resembled burning magnesium wire, but giving off red sparks. It completely paled the light of the moon, which was shining brightly. The area over which it had been seen has a length of 700 miles, and a width of 300, from lat. 36° S., long. 122° E., to lat 46° S., long. 175° E. The apparent diameter of the head was 10′, and the length of the tail tapering about 1°. Some of the observations appear to indicate that its course must have descended towards the earth's surface, but this depends on mere estimates of angular altitude, which cannot be depended on. The prolonged detonation which followed the passage of the meteor does not appear to have been heard at all the stations, but chiefly at those in the vicinity of Cook Strait, where the path of the meteor intersected New Zealand, all the observers in the North Island having seen it to the west, and those in the South Island to the east. When nearest to Wellington it must have been at a distance, in a direct line, of fifty-five miles, which agrees with the time, five minutes, which elapsed before the report was heard. This shows that the report did not proceed from the final bursting of the meteor, but proceeded from it at the time when it was nearest to the observer. Indeed, from the length of the path in which the meteor was seen, its sudden disappearance, as if by bursting, must have been an optical illusion in the case of all the northerly observers.

Mr. Marchant stated that he had witnessed another meteor, almost equal in brilliancy to the above, on the previous evening (27th instant), passing from east to west.

Mr. Floyd, of the Telegraph Department, stated that this meteor was reported at several stations in the North Island, and appeared to have passed over Napier, on the east, to Patea on the west coast. Its colour was blue.

4. "On the Conducting Power of various Metallic Sulphides and Oxides for Electricity, as compared with that of Acids and Saline Solutions," by W. Skey, Analyst to the Geological Survey of New Zealand. (See *Transactions*, p. 311.)

5. "On the Electro-motive and Electrolytic Phenomena developed by Gold and Platina in solutions of the Alkaline Sulphides," by W. Skey. (See *Transactions*, p. 313.)

SECOND MEETING. 1*st July*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New members.—F. Allen, J. W. Buller, F. A. Cooper, Charles Hulke, M. Mosley, H. E. Tuckey, B.A., Captain F. W. Hutton, F.G.S.

The President then delivered the following

ADDRESS.

GENTLEMEN,—

It is my duty as President of this Society for the current year to commence the proceedings of the session by a few remarks. I propose, in doing so, in the first place to take a retrospective glance at the labours of the Society for the past year, and in the next place to make some suggestions as to the direction which its inquiries ought to take for the future. Any retrospective view, however, which I may be able to lay before you of the labours of the past year must, necessarily, be very imperfect, and must amount at best to a relation of matters, with which the majority of members may be as well acquainted as myself; but, nevertheless, it is often convenient to ascertain, by summarizing results, whether a Society professing to be a scientific one is properly discharging its functions. It is, in effect, our duty to determine to what extent we have added to the cumulative power of scientific thought, to what extent we have provided material calculated to aid ourselves and others in the progress of scientific enquiry. It has been well observed, in relation to recurrent periods in the progress of scientific investigation, that divisions of time are altogether artificial as compared with the activities of the human mind; and, therefore, in sketching the history of science during any such past interval as that to which I am referring, we are, as it were, only cutting out a fragment from the woof of a continuous fabric, which, whilst it may indicate the nature of the pattern, affords no definite hints as to its beginning or its end. Like my predecessor in this chair, I have found that the labours of this Society are so far bound up with those of other Societies affiliated to the New Zealand Institute, that I shall be compelled, even in the brief review I am about to lay before you, to refer to their proceedings as well as to our own, a course by no means improper, seeing that, after all, each society is but one of a series of grafts upon the tree of scientific knowledge which has been planted in this colony, and that the fruit which each of them bears must be good or indifferent, in proportion to the vigour of the common stock.

In looking over the results of the labours of the various societies during the past year, I find them divided by the learned editor of the *Transactions* of the Institute into five separate classes, under the several heads of Zoology, Botany, Chemistry, Geology, and Miscellaneous, and I find that in each of these divisions there have been important contributions from members of our own Society. In the department of Zoology we again find papers of great interest and high scientific value from the pen of Dr. F. J. Knox. Indeed, we may congratulate not only ourselves, but the whole colony, upon the fact that we still possess amongst us a veteran inquirer who, in the only occasional intervals of leisure which the struggle for existence permits the colonist to enjoy, is still ready and willing to devote himself to science for science's sake. Again, during the past year, has he added to that store of knowledge in regard to the *Cetaceæ* which frequent our shores, to which my predecessor referred when opening the proceedings of last session, and it may not be uninteresting to our valued contributor to learn that in all probability he will soon have an opportunity of examining the material portions of the skeleton of another animal belonging to the class referred to, (reported to be of a species hitherto quite unknown to whalers), which has recently been killed at the Chatham Islands. My son has just started for those islands, with the intention, amongst other things, of securing this skeleton, and I hope, in due time, to see it added to the already excellent collection possessed by our Museum. Nor is it alone by his writings that our valued member confers obligations upon us, for his papers have usually been accompanied by illustrative anatomical preparations of the greatest value, which he has afterwards added to the collections in our Museum. Dr. J. E Gray, of the British Museum, who has also long taken an interest in the same class of animals, transmitted some notes on the skull of *Balæna marginata*, which were read during the course of the late session.

The successful introduction of the English Trout into many parts of this colony gives special interest to inquiries respecting the native species of *Salmonidæ*. The unrivalled excellence amongst fishes of almost every species belonging to this family as an article of diet, and its consequent commercial value, have given an importance to this class of fishes which is enjoyed by none other except the Newfoundland Cod, and we accordingly find that in every one of the Australian colonies its introduction has been deemed one of the most important duties, if not the most important, which devolved upon the various acclimatisation societies. It is, therefore, interesting to find that we possess, in this country, not less than three species of Salmonoid fish, (which were examined and described by Dr. Hector in a paper read before our Society during the past year), showing conclusively the adaptability of the waters of our rivers to fish belonging to this valuable family. In this connection I may refer to the recent establishment of an Acclimatisation Society in this province, and it may be gratifying to you to know that one of its first objects has been to take the necessary steps for the introduction of the European Trout. Receiving ponds will shortly be constructed in the Botanic Gardens, and I hope that in a few years our beautiful rivers will afford us one of those opportunities of healthy recreation which make country life at home so attractive, and the want of which has hitherto been so much felt all over this colony. We cannot, indeed, too highly appreciate the labours of the acclimatisation societies in other parts of the colony, and to those who have had opportunities of seeing the admirable results already flowing from those labours, it is a source of sincere regret that we, in this province, should have so long neglected our share of the work. Let us hope that, although late in the field, our Society may yet be able to add something to the general stock of benefits which the efforts of its predecessors have conferred upon the colony.

In noticing the department of Zoology, I must specially call your attention to the valuable contributions to our knowledge of the Ornithology of this country which we have again received from our Vice-President, Mr. Buller, and from Mr. Potts. It is gratifying to find that the General Government, recognising the importance of Mr. Buller's labours in this branch of science, have given him material assistance towards the publication of a work upon this special subject; and I understand that it is his intention to proceed to England for that purpose in the course of the present year. Independently of the honour which must be reflected upon the colony by the fact that its Ornithology has been fully and satisfactorily investigated by one born and bred on its soil, and almost self-taught in Natural History, we may look forward to many material advantages from Mr. Buller's proposed residence in England, for he has promised to give his best aid in procuring additions to our collections in Natural History, and in furthering the efforts of our acclimatisation societies to restore the balance of life which has been so rudely disturbed by our colonization. Mr. Potts, in a second paper, has again conveyed to us, in a most attractive form, a large mass of useful and varied knowledge upon the same special subject, and I have no doubt that the store of matter, bearing on the face of it the mark of diligent and accurate inquiry and observation, which has been placed at Mr. Buller's command in these papers, will materially facilitate the undertaking in which he is about to engage.

Although not strictly within the compass of this address, it would perhaps be improper that I should pass over the labours of men like Dr. Otto Finsch, of Vienna, and Dr. Günther, of the British Museum, who have both taken great interest in special departments of the Natural History of these islands—the former having published admirable critical notes upon our Avifauna, which have been translated for the use of members unacquainted with the German language, and the latter having published several papers on our Fish and Reptiles. I mention these facts, not merely as a recognition of the services which these eminent men have thus rendered to science in connection with this colony, but in order to show you that subjects, which many persons here treat with little consideration, are deemed worthy of special attention by persons at home occupying positions of world-wide celebrity in the realm of science.

In the department of Botany the great majority of papers published in the *Transactions* of the Institute are contributed by that indefatigable botanist, Mr. Kirk. Amongst these papers are carefully prepared lists of the remaining native and of the introduced plants observed by him in various localities in the Auckland province—lists which, in the future, will be of very great value in regard to that most interesting biological inquiry, the "replacement of species." It would be well if all those who have the opportunities of doing so would from time to time collect the Flora, both native and introduced, over extended areas in the neighbourhood of all our centres of population, in order that, by means of successive comparisons, we might be able to arrive at some idea of the rate at which this process is going on. In few countries, if indeed in any, do the means of obtaining reliable information upon this important subject exist to a greater extent than in New Zealand; and it will undoubtedly be a matter of reproach hereafter if we neglect the opportunities now afforded to us of accumulating facts which will tend, when carefully examined and collated, to elucidate points of importance at present buried in obscurity. I had occasion to observe, during a recent visit to some of the alpine regions of the Nelson province, the enormously increasing destruction of the native alpine and sub-alpine Flora, owing, partly to the habit of firing bush districts, in order to replace the original vegetation by one better suited to pastoral purposes, and partly to the fact that the scanty herbaceous native vegetation was gradually being eaten out by the sheep and cattle, now roaming in large numbers over districts which, less than ten years ago, were practically as little known as the interior of Africa. Indeed, I have no doubt, from the present comparative rarity of many plants which were formerly found in abundance in such districts, that in a few years our only knowledge of them will be derived from the dried specimens in our herbaria.

Returning to my special subject, I find that in the department of Chemistry, with one exception, the whole of the papers published in the *Transactions* have been contributed by Mr. Skey, the diligent and accurate Analyst to the Geological Survey. I have no pretensions to chemical knowledge which would justify me in offering any criticisms on Mr. Skey's labours, but the highly favourable manner in which they have been referred to in works of authority devoted to such subjects, warrants me in believing that the papers in question contain matter of high practical value. If I correctly appreciate the object of several of these papers, as well as of some former papers from the same contributor, they are intended to aid in determining the best mode of economically and efficiently separating gold from the various substances, both earthy and metallic, with which it is usually associated in the gold mines of this country; and seeing the enormous waste which must result from the employment of crude methods of extraction, we cannot too highly appreciate the discovery of any economical means of avoiding or mitigating the national loss which must ensue from such waste. But it is not alone in regard to the development of this source af our wealth that the labours of Mr. Skey have proved valuable to the colony, nor do the papers which have appeared in the *Transactions* afford the least idea of the extent of those labours. In order to understand these points it is necessary to refer to the Laboratory records, and those who have not yet done so will then not only be gratified and surprised, but will be able to appreciate the advantages which the colony at large derives from this branch of our scientific institutions. The only paper not contributed in this department by Mr. Skey is one from Mr. Hughes, of Hokitika, containing a detailed and valuable account of some of the properties of the tutu poison. The careful manner in which the subject appears to have been investigated by Mr. Hughes induces me to express a hope that we shall see, in future volumes of the *Transactions*, further recorded results of the chemical labours of that gentleman.

In Geology the principal contributions are from Captain Hutton and the late Mr. E. H. Davis, whose melancholy death by drowning, whilst in the performance of his duties, has deprived this colony of a talented and zealous worker in the field of science. These papers give part of the general results of the investigations of the Geological Department of the colony during the past year, and contain matters of considerable interest in connection with the material resources of the colony. It is quite needless for me, in addressing this Society, to call attention to the extreme value of geological investigations in a country so peculiarly circumstanced as New Zealand—one in which, as must be apparent even to the casual observer, mineral wealth must always play a conspicuous part. It is, therefore, of the highest importance that we should possess a staff of officers in connection with this department of science who are able and willing to direct its investigations to purposes of permanent and practical utility, and whose aim will rather be diligently and honestly to collect and record facts from which sound deductions may be drawn than to indulge in theoretical speculations, which, however interesting as subjects for debate, can add little, if anything, to our stock of useful practical knowledge. It is fortunate for the colony that the labours of this department are under the direction of a gentleman so well qualified for the duties it involves as Dr. Hector, and it is satisfactory to know that his services, and the character of the work he is carrying out, are receiving their due recognition, both at the hands of his own immediate employers, and at those of leading scientific men at home. I may be permitted to observe, without infringing the wholesome rule which prohibits the introduction of political subjects into our discussions, that it would tend greatly to the advantage of the colony if additions were made to the present staff, which would permit its labours to be more divided, and thus leave its head the necessary opportunity and leisure to collate and digest the results obtained.

The miscellaneous papers in the *Transactions*, contributed by our Society, contain many of considerable value and interest, but it would lead me too far were I to notice their contents in this address. I may, however, refer to the circumstance that in many parts of the colony attention is being directed to inquiries into the origin and history of the Maori race, and we may hope that, before it is too late, we shall see on record all the facts yet obtainable which may be calculated to throw light upon this, at present, obscure subject.

In conclusion I propose to offer a few remarks upon the work before us. It has been observed that the progress of science, even during a single year, must greatly depend upon the recurrence of special phenomena in nature, to give occasion for inquiry, experiment, and speculation. This may be specially true in regard to some of the sciences, but certainly it is not strictly applicable to all, for, when we look around us, and even at our very feet, we find abundant matter for consideration and observation, which has remained untouched by former observers, and which still waits to be recorded. In former parts of this address I vindicated in some degree the direction which, as it appears to me, our labours should take in some of these departments of inquiry, and it is satisfactory to think that, whatever the result may be to the immediate political condition of the colony (apart from purely scientific considerations) from the works which are being undertaken and prosecuted by the Colonial Government, these works will afford invaluable opportunities of pushing on inquiries in various branches of the Natural History of this country, in a manner and with a rapidity which we could otherwise scarcely have hoped for. The construction of lines of road and rail, through tracts of country hitherto comparatively unknown, will give to the geologist and botanist, to the miner and agriculturist, and indeed to all who are engaged, either theoretically or practically, in inquiring into, or in developing the resources of the country, the greatest facilities for carrying out their objects; and we may look forward, in this aspect of the matter, to results of the highest importance and value. It behoves all who take an interest in these results, and who possess the leisure and opportunity of recording observed facts, to do so carefully; and I may observe that the Government itself could, by instructions to the more skilled of the officers engaged on the works, give material aid towards accumulating observations. I will not weary you with further remarks, and will now close this address by expressing a hope that all who take an interest in the progress of science in New Zealand will give their services to the work, remembering that the great object at present in view is, not the propounding of theories and speculations in order to account for some observed appearance, but the careful collection and arrangement of accurate data, from which we may hope, in time, to arrive at a sound knowledge of matters affecting the material welfare of the country; and which may simultaneously be applied towards the solution of those important biological problems, which are now engaging the attention of eminent scientific men, in connection with "the origin, development, and life history of species or races."

1. Description by Mr. E. Stowe of a New Shell found by the late Mr. E. H. Davis, and which he proposed to name *Imperator Davisii.* (See *Transactions*, p. 218.)

The President remarked that he was with Mr. Davis when the shell was found, and that it inhabits pot-holes worn in the sandstone rock that can only be reached at low tide.

2. "On some New Species of New Zealand Plants," by J. Buchanan, of the Geological Survey of New Zealand. (See *Transactions*, p. 224.)

This paper contains descriptions of *Haloragis aggregata*, n. sp., *Danthonia Raoulii*, a. *australis*, n. sub-sp., *D. semi-annularis*, d. *alpina*, n. sub-sp., *Acæna glabra*, n. sp., *Celmisia lateralis*, n. sp., *Rostkovia novæ zelandiæ*, n. sp., and *Carex pyrenica*, n. sub-sp. They were collected by Mr. H. H. Travers, in the Nelson mountains, and were all found at a considerable altitude.

3. "Observations on the Kiore, or Indigenous Rat of New Zealand," by F. J. Knox, L.R.C.S.E. After a careful examination of the Black Rat, described by Mr. Buller as the Native Rat, the author could find no point of anatomical difference, except that it had forty instead of thirty joints in its tail. The hair and fur differ in colour and softness, but it had been microscopically examined by Mr. Buchanan, and was found to have the same structure, the coarse hair being marked in both with scaly bars, and the fine hair or fur being simply striate—this being very different from the structure of that of Rodents allied to the rabbit, in which the fur is longitudinally grooved as well as striate. The author presented a splendid skin of the Brown or Norway Rat, which measured 12·5 inches in length, without the tail, which was 8 inches in length. He also stated that if Mr. Buller's rat was the real *Mus rattus*, as had been suggested, it was the first he had seen, it not being common in Scotland.

The President reminded members that in Sir George's Grey's collection of Maori legends there is a circumstantial account of how the natives in one of their canoes from Hawaiki introduced the rats in boxes.

4. A letter from Mr. Robert Hart was read by Dr. Hector, calling attention to a report that a telegraph pole, with the Government brand, had been cast up on the Chatham Islands, as proving a set in the ocean currents from New Zealand to the eastward.

The President said the circumstance had a most important bearing on the question of the transfusion of species of plants among the islands of the South Pacific, and that the existence of the drift described by Mr. Hart had already been specially pointed out by his son in the account he gave of the Chatham Islands, printed in Vol. I. of the *Transactions* of the Institute, p. 173.

5. "Preliminary Notes on the Isolation of the Bitter Substance of the Nut of the Karaka Tree (*Corynocarpus lævigata*)," by W. Skey, Analyst to the Geological Survey Department. (See *Transactions*, p. 316.) The author announced that he had succeeded in isolating the bitter principle of the Karaka berry, and had found it to be a crystallizable resin, analogous to the active poisons picrotoxine and digitaline. Mr. Skey proposed to name the new resin "Karakine."

The President then requested Dr. Hector to explain the various interesting additions to the collections in the Museum, which were on the table.

Dr. Hector first called attention to the Neck of a Moa which had been lent to the Museum for a time by Dr. Thomson, of Clyde, in Otago. This wonderful specimen is the most perfect fragment of the large extinct birds that has ever been found. It consists of six joints of the neck held together by the skin and muscles of one side. Some portions of the feathers still remain, and prove that the plumage of the Moa was more like that of the Emu than that of the Kiwi, which is the only allied bird now living in New Zealand. In alluding to the plumage of the Kiwi, Dr. Hector pointed out that although Mr. Buller and Dr. Finsch, in their last papers on the subject, are inclined to restrict all our Kiwis within two species, and to do away with *Apteryx mantelli*, still the examination of many specimens in the Museum shows that *Apteryx australis* is peculiar in not having the shafts of the feathers prolonged beyond the plumes, which is the case with both *Apteryx mantelli* and the Grey Kiwi, *A. oweni*, the skins of which are, in consequence, harsh to the touch.

A cast of the Egg of the Moa-like bird of Madagascar (*Æpyornis*), presented by Dr. Finsch, of Bremen, was exhibited and compared with models of the chief Moa eggs that have been found in New Zealand. The largest of these, 9·5 inches long, was that found by Mr. Fife at the Kaikoura Peninsula, but it looked quite small beside the *Æpyornis* egg, which is 12·9 inches long.

Dr. Hector corrected a mistake about the egg found at the Kaikouras, which, it had been stated in the newspapers and repeated by him in a paper to the Zoological Society, was found in a Maori burial place in the hands of a human skeleton. Mr. Buchanan, however, had been assured by Mr. Fife, the discoverer of the egg, when he was at Kaikoura in 1866, that this was not the case, but that the egg was found in alluvial soil when digging a few feet below the surface. One of the models exhibited was of an egg restored by Mr. Mantell from small fragments.

Mr. Mantell explained that he had restored, more or less perfectly, about twenty eggs, and that he had, as a rule, found them imperfect at one end, as if a hole had been artificially formed for the purpose of extracting the contents, and perhaps to allow of the shell being used as a water vessel. All the shells he had found were near old Maori cooking ovens, which he had no objection to see assigned to the prehistoric period, seeing that New Zealand history only goes back for a few years. He was quite certain, however, that the Maoris in the south at the date of his early explorations in 1846 were well acquainted with the former existence of the Moas and the circumstances which led to their extermination.

Attention was then directed to tracings, by Mr. Cockburn Hood, of Footprints of Moas recently discovered in sandstone layers at Poverty Bay, and to a section showing their geological position, which is a very recent formation. (See *Transactions*, p. 124, *et seq.*)

Skins of the North Island Kokako (*Glaucopis*), which were recently obtained alive, were shown by Dr. Hector to determine satisfactorily that the differences that distinguish *G. wilsoni* and *G. olivascens* are due to sex.

Captain Hutton exhibited several birds that are additions to the New Zealand list, but not yet determined; and also several new minerals he had recently obtained at the Thames, among which are native Copperas (Sulphate of Iron), a rarely found mineral, on account of its being soluble in water, and Mallite, a very rare and interesting compound of an organic acid with an earthy base.

Specimens of Auriferous Quartz, Zinc-blende and other interesting ores, were also exhibited from the Caledonian Mine and the Perseverance Lode, Collingwood.

Third Meeting. 22nd *July*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New member.—T. Cockburn Hood, F.G.S.

1. "Australian Geography and Topography, with some New Zealand Comparisons and Contrasts," by J. C. Crawford, F.G.S.

(abstract.)

The author first gave a sketch of the geological structure of the Australian continent, describing the rocks under the following heads:—

The frame work of Australia consists of three islands or groups of old rocks, with probably some additional ones in the northern parts.

On the western side we have the granitic and metamorphic range of Western Australia.

On the eastern side the great cordillera, consisting of granites, upper silurian rocks, and carboniferous sandstones of great thickness, containing valuable seams of coal.

In the centre of the south-west the South Australian group of palæozoic slates and sandstones.

Mesozoic rocks are not extensively found, unless a large part of the carboniferous rocks of New South Wales and Queensland should prove to be of triassic age.

The coal rocks of Victoria are triassic, and occupy a considerable area of that colony.

Professor McCoy has examined cretaceous fossils from the centre of Australia.

Marine tertiary rocks occupy a large portion of the interior.

Although trap rocks are found extensively in Australia, appearing to have broken through the sandstones in extensive sheets, no true sub-aerial craters have been discovered, except in Victoria, and there are no known active craters of eruption in Australia.

In considering these features of the different divisions of Australia in detail, the peculiar formation of the mountains, the remarkable features of the rivers, and the distinctive characters of the bush land, are very clearly described. Slight sketches, brief outlines of the explorations of Sturt and others into the interior and across the "island continent" to the Gulf of Carpentaria, are given; while a short account of a journey from Sydney to Adelaide in 1832, gives a direct personal interest to the paper, which concludes with the following contrast between Australia and New Zealand:—

"The most obvious contrast between Australia and New Zealand is that the former everywhere gives a nearly horizontal outline, while the aspect of the latter is towards the vertical. Consequently, in Australia the mountains are generally without grandeur, while New Zealand possesses some of the grandest, and at the same time the most varied mountain scenery in the world. Picturesque beauty in Australia is generally caused by rock scenery—scarps of sandstone, or huge bosses of granite, when they break the uniformity of the usual nearly level surface, have a pleasing effect. In the cañons of the Grove and the Cox, where deep valleys have been eroded from the sandstone, bounded by cliffs of great height, we have grand and wild effect, but cañons must be sought for; they do not strike the eye of a traveller as he passes through the country, and nine-tenths of the inhabitants of Sydney, although they daily see the Blue Mountains in the not very far distance, have never seen these deep and gloomy valleys, and hardly know of their existence. The open forest of the usual country, the grassy glades, the timbered spurs of the western slope gently falling into open plains, are all entirely different from a New Zealand scene. The fiery glare of the mid-day sun glancing through the shadeless trees, and the rich purple hues of the sunset, are equally absent from the New Zealand landscape, or are modified and softened by the moister air of the ocean-surrounded colony. Although tree ferns and palms are well known in Australia, the regions where they are found bear no proportion in area to the mass of the country, so that they are practically unknown to the bulk of the inhabitants. Every New Zealander knows a tree fern, a cabbage tree, or a nikau palm. The New Zealand forest, particularly in the North Island, is of tropical aspect. Take a description of a South American jungle—it would fit in, word for word, for that of a New Zealand forest. The Australian bush stands by itself; it has a peculiar character, different from anything elsewhere. Australian lakes are few, and many of them shallow and liable to be dried up. In New Zealand the mountain lakes of Otago are equal to those of Switzerland or of Scotland, and in Canterbury and Nelson the continuation of these lakes to the N.N.E. offers scenery of the grandest description, although inferior in beauty to that of Otago. In the North Island, Lakes Taupo, Rotomahana, etc., with their geysers, hot water cascades, and deposits of silica, offer objects of beauty and interest which are unknown in Australia. New Zealand is a well watered, Australia a badly watered country. In the former colony one can hardly go for a few hundred yards without finding a stream, whereas, even in the better parts of Australia, the traveller may ride for a whole day before reaching a stream or a water hole. Australia has a continental, New Zealand an insular climate. Steady weather is the rule in Australia; in New Zealand constant change is the fashion. In Australia the mountain ranges only in one instance exceed 4,000 feet in height; in New Zealand Mount Cook approaches Mont Blanc in elevation, and heights of 8,000 feet are common. In the North Island are the volcanic cones of Mount Egmont, Ruapehu, and Tongariro, the two former about 9,000 feet in height. The small cones of Victoria are mole-hills in comparison, and are exceeded in height by numerous minor ones in the province of Auckland. In fact the New Zealand cordillera is on such a scale of magnitude that it would well form the backbone of a continent. The rivers of the provinces of Canterbury and Otago, if united on lower plains, might make a Ganges or an Indus, and the western rivers alone of the province of Wellington might, united, equal the Rhine or the Rhone. Such scenery as that of the sounds and harbours of the south-west coast of New Zealand—Milford Sound, Bligh Sound, Dusky Bay, etc.—is quite unknown in Australia. These deep inlets penetrate into the mountains, and cliffs several thousand feet in height look down upon the tiny ship which ventures into these solitary waters. In fine, geographically there are many points of resemblance between Australia and New Zealand, while topographically there is great contrast. The flora and the fauna are, upon the whole, essentially different."

Dr. Hector in remarking on Mr. Crawford's paper, mentioned the recently discovered diamond bearing deposits in the Mudgee River in New South Wales. The diamonds are found in abandoned gold workings, and must have been repeatedly overlooked by the diggers. Their immediate source is from a bed of conglomerate or cemented drift, small areas of which have been preserved by cappings of basaltic lava. According to Dr. Thomson, who had recently published an interesting paper on the subject, about 2,500 diamonds were obtained in the first five months of systematic working, and many thousands have since been collected. He recommended the study of Dr. Thomson's account to explorers for minerals in New Zealand, and especially in the north-west districts of the province of Nelson.

Mr. Hood remarked that one river only on the eastern slopes of the Australian Alps—the Clarence—contains the Murray Cod in abundance. He had noticed high pillars of basalt standing out in the central plains of Australia. He also stated that the Saurian remains from Australia bore considerable resemblance to those from New Zealand, but that the former were smaller.

2. A letter from Mr. Duigan, of Wanganui, called attention to the great disturbance of the electric telegraph system of the colony, which was experienced on the 13th February last, at the same time the s.s. 'Airedale' was lost. He attributed it to the same influence as that which gives rise to the auroral displays, and suggested that this disturbance may have caused an irregularity in the deviation of the 'Airedale's' compasses.

Dr. Hector remarked that it was quite recognised that the magnetic needle was affected during auroral displays, but not to the extent of seriously affecting a ship's compass. He had been attached to an expedition in 1858, during which it was his duty to assist in watching the deviation of the magnetic needle during perhaps the most brilliant auroral displays on record, and under these circumstances, and while using remarkably sensitive instruments, the actual deviation was very slight. The disturbance of the telegraph, on the other hand, is a very important and interesting feature, and, as the subject is attracting much attention, he thought the author deserved the thanks of the Society for having placed the fact on record.

The President thought it would be advantageous if Government would cause a systematic record to be published of such disturbances of the telegraphic instruments, which, he had been informed, were unusually frequent throughout New Zealand.

3. "Notes on St. John's Nursery Garden, Wanganui," communicated by R. Pharazyn, F.R.G.S. The paper contains an account of the nursery, with statistics by the proprietor, showing the rate of growth of introduced trees.

(ABSTRACT.)

This garden is situated at about five chains from the foot of St. John's Bush, a wooded cliff some 90 feet in height, bounding the town of Wanganui on the north-west. The garden is, from its situation, exposed to almost the whole of the sun's warmth, and is also completely sheltered by the cliff from the prevailing wind—the north-west. Besides this natural protection, the north-western boundary of the garden is screened by a hawthorn hedge extending along its whole length, and averaging in height about 28 feet. Behind the hedge is a running stream, the percolation from the Virginia Lake, by which the whole of the garden can be irrigated. The spot on which the nursery is laid out was formerly the old bed of the Wanganui River, and subsequently an ancient forest. On the surface, therefore, is an average of from 3 to 4 feet, in many places deepening to 6 feet, of decayed vegetable matter, while the subsoil is a rich alluvial deposit. Its extent is five acres, of which about two and a half are orchard, one devoted to nursery stock, and the remainder to specimen trees and shrubs.

The following table will give some idea of the luxuriant growth of the plants in this garden, to place which on record is the object of this communication :—

Age (from Nursery Stock.)	Names.	Height.		Spread of Branches.		Trunk at Base.	
		ft.	in.	ft.	in.	ft.	in.
3	Cupressus goviniana	17	0	14	0	2	1½
3	,, torulosa	7	8	7	0	1	4
3	,, lawsonii	9	1	8	0	2	0
4	,, benthamii	19	3	20	0	2	11½
3	,, pendula	7	0	6	0	0	7½
2	,, knightii	7	9	6	0	0	6
3	,, sempervirens stricta ...	15	0	3	6	1	1
4	,, macrocarpa	24	10	22	6	3	1
3	,, ditto (denser in habit) ...	18	4	20	6	2	10
3	,, corneyana	9	2	12	0	1	0
2	,, schubertia (from seed) ...	4	6	4	6	0	4½
3	,, sempervirens	9	0	8	0	0	10½
3	,, craigiana	10	0	10	0	1	0
5	Oyster Bay Pine	11	0	14	0	1	9
3	Cryptomeria lobbii	15	0	8	6	1	6
2	,, elegans	7	6	6	0	0	9
3	Pinus insignis	22	0	10	6	3	0
4	,, sylvestris	11	6	10	0	1	10
3	,, canariensis	11	0	4	0	1	4
3	,, maritima (from seed) ...	10	6	9	0	1	2½
3	,, austriaca	8	9	7	0	1	4
3	,, strobus	5	9	6	0	0	9
3	,, coulterii	8	6	7	6	1	5
3	,, longifolia	4	9	4	0	1	1

Age (from Nursery Stock.)	Names.	Height.		Spread of Branches.		Trunk at Base.	
		ft.	in.	ft.	in.	ft.	in.
3	Biotia aurea	3	6	3	6	1	8
3	Cedrus deodara	8	0	7	0	0	11
3	„ atlantica	6	0	6	0	0	8½
3	Araucaria imbricata	4	1½	4	0	0	6
3	„ bidwellii	4	6	5	6	0	6
3	Wellingtonia gigantea	12	8	8	0	2	7
	„ do. (last year's growth)	6	8	—		0	8½
5	Taxus baccata	8	4	8	0	1	6
3	Quercus ilex	14	6	8	0	1	2
5	„ robur (from seed) ...	17	6	10	0	1	5
4	Magnolia grandiflora	12	0	12	0	1	0
5	Betula alba (from seed)	20	0	16	0	2	0
3	Arbutus	12	4	10	0	1	11½
3	Laurestinus (Hedge)	8	0	6 (base of hedge)			
4	Laurus nobilis	12	0	6	0	1	10
3	Taxodium sempervirens	9	0	9	10	1	1
3	Fraxinus excelsior (from seed) ...	10	3	—		0	7
3	Abies excelsior	8	4	—		0	11
3	Cratœgus crus galli	9	0	6	0	—	
3	Oxycedrus juniperis	6	0	8	0	1	0

The above measurements were taken by me personally, and I consider them, in the main, correct.—Francis Williamson, Proprietor.

I was present when the above measurements were taken, and I consider that they are generally correct.—Henry T. Pycroft.

4. Captain Hutton exhibited a specimen of the Southern Mutton Bird, or Titi of the natives, which he had discovered to be *Puffinus amaurosma.* He stated that, though common, this bird had never been previously mentioned in scientific lists as occurring in New Zealand.

Fourth Meeting. 26*th August*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New member—A. T. Bothamley.

1. "On the Bats of New Zealand," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 184.)

Dr. Hector mentioned finding large numbers of the Long-eared Bat last summer when loosing the sails of H.M.S. 'Clio' in Milford Sound. The mistake of Dr. J. E. Gray, which Captain Hutton had referred to, in supposing that Forster had named the Long-eared Bat *Vespertilio tuberculatus*, had, he remembered, been already pointed out, but the paper having been mislaid, he was unable to state the name of the author, or in what publication the correction had appeared. He considered that the change of name from *Mystacina tuberculata* to *M. velutina*, as proposed by Captain Hutton, was necessary.

2. "On a New and Rapid Process for the Generation of Sulphuretted Hydrogen Gas for use as a Re-agent in Laboratory Operations," by W. Skey, Analyst to the Geological Survey of New Zealand. (See *Transactions, p.* 321.)

Dr. Hector said that those who work in a laboratory would appreciate the great advantage of this process over the old ones.

3. "On the Geographical and other Features of some Little-known Portions of Wellington Province," by H. C. Field. (See *Transactions,* p. 128.)

Dr. Hector described the geology of the country referred to by Mr. Field, and said he considered that large parts of it were well adapted for settlement.

4. "On the Microscopical Structure of the Egg-shell of the Moa," by Captain F. W. Hutton, F.G.S. (See *Transactions,* p. 166.)

Dr. Hector asked whether the structure of the Ostrich egg was known.

Mr. Hood asked the same question with regard to the egg of *Æpyornis,* and suggested that, from its large size, it might be found analogous to that of the Kiwi, and not to that of the Struthious birds.

Captain Hutton said that the structure of the Ostrich egg was well known. It was something like that of the Moa, but with the outer layer thinner, and the prisms often rhombic. He was not aware that the egg of *Æpyornis* had ever been examined, and thought the suggestion of Mr. Hood a very good one.

5. "Notes on the Presence in certain Fibres of a Substance susceptible of some striking Colorific Changes when chemically treated," by W. Skey. (See "Report of Flax Commissioners, 1870–1," p. 92.)

(ABSTRACT.)

If *Phormium,* Manilla, or Sisal fibre be submitted to the action of ordinary bleaching agents for a short time, and afterwards treated with alkalies, they immediately turn to a red or brown colour, showing the presence of an oxidizable substance distinct from the fibre. This substance is insoluble in hot or cold water, alcohol, ether, chloroform, or weak hydrochloric acid. That it is not present in such fibres as hemp, flax (*linum*), cotton, and *rheea,* is shown by the fact that they do not give this particular reaction.

The President remarked that the discoveries of Mr. Skey, acting, as they did, differently on different fibres, would be a very valuable means of detecting adulteration.

6. "On the Microscopic Characters of the Fibres of New Zealand Flax, as

distinguished from those of Manilla or Sisal," by Captain F. W. Hutton, F.G.S. (See "Report of Flax Commissioners, 1870–1," p. 90.

(ABSTRACT.)

This paper described a method of isolating the ultimate fibres by boiling in a solution of potash, and a table of their measurements was given, from which it appears that the average length of the ultimate fibre of *Phormium* is nearly twice that of either Manilla or Sisal, while the average diameter is not much more than half that of Manilla, which, again, is much less than Sisal. The cell wall of *Phormium* is also much thinner than either of the others.

FIFTH MEETING. 16*th September*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New member.—H. Blundell (Crown Lands Office).

1. "Notes upon the Historical Value of the 'Traditions of the New Zealanders,' as collected by Sir G. Grey, K.C.B., late Governor-in-Chief of New Zealand," by W. T. L. Travers, F.L.S. (See *Transactions*, p. 51.)

Mr. J. T. Thomson said that the paper that he had read on the same subject some eight months ago before the Otago Institute (see *Transactions*, p. 23) could not have been known to Mr. Travers, as it was not yet published. He said that he had been much struck with the resemblance between the songs of the Maoris and those of the Oranglauts, a tribe being in the Indian Archipelago, but spread far and wide; their languages also are much akin to one another, but that of the Oranglauts is more Malayan than that of the Maoris.

Captain Hutton said that, of the birds mentioned by Mr. Travers as supposed to have been brought here by the Maoris, the green parakeet (*Platycercus novæ zelandiæ*) had a wide range, though not found actually in the islands whence the Maoris are supposed to have come. A very similar species, however, *P. pacificus,* is found in those islands, and it is probable that our bird would have been at once recognised by the Maoris as similar to one in the islands they had left, and thus, perhaps, it came to be supposed that they had brought it.

Dr. Hector drew attention to the fact that the Maoris have distinct names for all natural objects, and that the same names are used throughout all parts of the Islands. He knew of no savage race that equalled them in this respect, and thought this practice was adverse to the idea taught by their traditions, viz., that the Maoris, as we now find them, had spread slowly by natural increase from a few canoe loads of original settlers. It is far more probable that, after the whole country was populated, one tribe got stronger than the others, and spread over the Islands, conquering the rest and carrying with them their own names and traditions, which may have nothing to do with their first coming, but refer only to their early fights among themselves.

Mr. Travers said that the chief point of his paper was to show that the usually supposed date of the Maori landing, about 350 years ago, was much too recent, as it was impossible that so much could have been done in so short a time.

2. "Notes on the Lizards of New Zealand, with Descriptions of Two New Species," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 167).

Dr. Hector said that the lizard from White Island, described by Captain Hutton, was the only one ever obtained there. He believed that the specimen had been brought to the Colonial Museum by the officers of H.M.S. 'Brisk,' in 1868.

3. "Observations on the New Zealand Bats," by F. J. Knox, L.R.C.S.E. (See *Transactions*, p. 186.)

SIXTH MEETING. 30*th September*, 1871.

W. T. L. Travers, F.L.S., President in the chair.

1. "Notes on the Habits of some of the Birds of New Zealand," by W. T. L. Travers, F.L.S. (See *Transactions*, p. 206).

Captain Hutton drew attention to the important bearing on the Darwinian hypothesis of the peculiarity of the Whio, or Blue Duck, mentioned by Mr. Travers, which does not show any solicitude for the safety of its young like other ducks. Now the Blue Duck, having no allied forms found elsewhere, must be considered as one of the original inhabitants of New Zealand, whereas all the other ducks are, in comparison, colonists, their generic centres of distribution being in the northern hemisphere. There never having been any destructive animals in New Zealand till man came, this original duck never seems to have acquired instinctive fear, which the ancestors of the other ducks must have acquired by experience in other parts of the world before they migrated to New Zealand.

Dr. Hector stated his experience that Wekas were much more easily snared in the South Island than in the North, owing, no doubt, to the greater experience they had acquired of the treachery of men in the island which had the denser native population.

2. "On some Experiments showing the Relative Value of New South Wales and New Zealand Coals as Gas-producing Materials," by J. Rees George, C.E. (See *Transactions*, p. 146.)

The results of this inquiry show that, of all coals tried, the best is that from the Grey River, if the value of the coke, ease of working, and other circumstances are taken into account; but if mere gas-producing is the test, the Collingwood coal is superior. Both are, however, far in advance of the Sydney coal. The author stated as an unusual and interesting fact that the "slack" of the Grey coal gives more gas, and of better quality, than the screened coal.

Dr. Hector thought that if the scheme of communication between the coal mine and the port, which Mr. Blackett and he had recommended, were adopted, the coal might be put on board at 8s. per ton. The quantity ascertained to exist is at least 4,000,000 tons, but there is reason to believe that a much greater extent of the seams will prove to be available when the industry is fairly started. He said Mr. George's results agreed very closely with those obtained by small experiments in the laboratory, and he had no hesitation in confirming the high opinion of the value of the coal that had been expressed by the author of the paper.

The Hon. Mr. Waterhouse drew attention to the waste of coal that was taking place in various parts of the colony through wilful firing of the seams, and suggested that it might be advisable to have legislation on the subject.

Dr. Hector informed the meeting that a coal seam, six miles north of the Grey River, was set fire to by some diggers more than a year ago, and is still burning.

3. "Notes in Support of the Alleged Alkalinity of Carbonate of Lime," by W. Skey, Analyst to the Geological Survey of New Zealand. (See *Transactions*, p. 323).

4. Dr. Hector described the position of the portion of a wreck of a vessel that was found many years since on the West Coast, near Arnott Point. Portions of the wreck, which had been sent by Mr. Mueller, Chief Surveyor, together with a plan and description of the locality, were on the table. The fragment is 20 feet long, 12 feet broad, and consists of three layers of planking bound together with brass bolts and screw trenells of wood. It lies 300 yards in a direct line from high-water mark, and nearly three-quarters of a mile up from the mouth of a small creek.

Dr. Hector said that it could not be very old, and that it showed how rapidly the coast drift formed in some situations, as this wreck must have been cast up when the beach line was less advanced by 300 yards. The difference of level has not yet been accurately ascertained, but must be very slight.

The Hon. Mr. Waterhouse suggested that it might have been thrown up by an earthquake wave.

Dr. Hector doubted this, owing to the shape of the coast.

Captain Hutton said we have no evidence of earthquake waves ever reaching New Zealand from the westward, which would be necessary to account for the casting up of this wreck.

5. An interesting series of specimens illustrating the different stages of development of the Brown Trout, from the egg to the full-grown fish, were on the table, having been presented by Mr. Howard, the Curator of the Acclimatisation Society of Southland.

Seventh Meeting. 14*th October*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New Members.—H. Blundell, sen. (Willis Street), W. H. West, and S. Locke, R.M.

1. A series of Chinese Medicines was exhibited, that had been presented by Mr. Warden Beetham.

2. "The Results of the Destruction of Forests upon the River Wolga at Astracan," by Dr. A. Wojeikof, of St. Petersburgh.

(abstract.)

The author states that nowhere in the old world is the influence of man on the physical configuration better seen than in Russia, as there some of the operations long ago effected in Western Europe (such as the clearing of forests and the cultivation of the land) are of recent date, and we can examine if the change of climate caused by the destruction of forests is as great as it is stated to be. The observations on the Wolga, made at the harbours of Astracan, furnish us with some means of doing so. With this view four ten-year periods are compared, as otherwise the anomalies of single years would be too conspicuous.

—			High Water.			Height in Eng. inches.	Days Elapsed.			
	(a.) Covered with ice.	(b.) Opened.	(c.) Beginning.	(d.) Highest.	(e.) End.		a-b.	b-c	b-d	c-e
1830-37.. ..	Dec. 18	March 22	April 30	June 16	August 17	104	94	39	86	109
1838-47.. ..	„ 14	„ 23	„ 28	„ 18	„ 31	90	99	36	86	125
1848-57.. ..	„ 22	„ 27	„ 29	„ 14	Sept. 12	113	95	33	79	136
1858-67.. ..	„ 11	„ 29	„ 22	„ 13	Oct. 31	117	108	24	76	191
General mean..	„ 16	„ 25	„ 26	„ 15	Sept. 15	106	99	..	..	..
Earliest ..	1844, 1857. Nov. 21	1837. Feb. 20	1835. March 25	1848, 1864. May 25	1831. June 30	1867. 147	Highest.			
Latest	1856, 1857. Feb. 6	1833. April 17	1856. May 19	1865. July 4	1862. The water did not fall to 0 till January.	1840. 59	Lowest.			

The deductions drawn from these results are as follows :—

(1.) Though the opening of the river from ice now happens a little later than in former times, the high water begins earlier, so that the time elapsing between the opening and the beginning of high water is diminished from thirty-nine to twenty-four days, and the highest flood now arrives seventy-six days after the opening instead of eighty-six.

(2.) The period of high water is becoming longer, and the height of the water generally a little increasing. In the continental climate of Eastern and Central Russia the earth is covered with snow for four or five months in the year, and the rivers are frozen for nearly the same time. Even in Astracan, in 46° 40′ north latitude, the river is frozen for nearly 100 days, and the middle temperature of winter is 21·7° Fahr.. The rivers rise in spring, when the snow is melting. From Astracan to 51° north latitude, the land is generally a steppe and unaltered, but to the north the basin of the Wolga was covered with beautiful forests. Now, with the settling and cultivation, with the enormous increase of factories, and steam navigation on the rivers, the forest has been devastated to a great degree. In wooded countries the snow lies longer in spring, as it is protected by the trees—in some cases the difference may be a month. It melts slowly, and does not cause the disastrous floods which occur in a bare country. It will be seen also that the end of the flood arrives later and later. This gives an indirect answer to the question whether the quantity of rain has diminished or not after the felling of the wood. The table leads the author to think that there has been no diminution, but it must be remarked that in a wooded country more of the rain is retained by the roots, mosses, and fallen leaves, and, in consequence, less of it is free to reach the mouth of a river. In an open country most of the water which falls during the rains of summer runs to the rivers, destroying the arable land, so that even a greater quantity of rain may profit the surrounding country very little, and the inhabitants may be in the right when complaining of drought, if the land is cleared of forests, as seems to be the case in the basin of the Wolga. The complaints of the agriculturists are general, and the observations on rainfall have not been of sufficient duration to decide the question.

The position of the Wolga basin affords indirect evidence on this point, as its rainfall is gathered into an inland sea—the Caspian—the level of which has greatly risen since 1866, and as most of its waters are poured in by the Wolga, we must infer that this river now collects more water than it did formerly.

Dr. Hector said that the paper just read, the manuscript of which had been sent to him by the learned author, related so a subject of peculiar interest to New Zealand meteorologists, as the effect on the climate produced by the clearing of forests can be observed in this country without the complications due to distant influences which affect continental climates.

Mr. Hood thought that ten years was too short a time to judge of the effect. The climate of Egypt, Canada, and Scotland had been altered by the clearing of forests, and he considered that trees should be extensively planted.

Mr. Blackett remarked that there was no doubt that the clearing of the forests in the province of Nelson had made the floods there much more serious than formerly.

The President said that of late years the destruction of forest had been so great in France that the Government had been spending large sums of money in replanting. Floods in the Hutt River had much increased since clearings had been made, and they would probably still further increase unless steps were taken to preserve the forests. The same thing had also occurred in the province of Canterbury.

Mr. J. A. Wilson remarked that Dr. Wojeikof's paper applied more to trees preventing the melting and blowing away of snow, and the case was, therefore, not quite similar to that of New Zealand. He thought that it would be very desirable to obtain observations of the snowfall on the globe as distinguished from the rainfall.

3. "Critical Notes on some of the Birds of New Zealand,"* by Captain F. W. Hutton, F.G.S. In this paper the author gave reasons for the alterations made in the nomenclature, etc., in the "Catalogue of New Zealand Birds," now in the press.

4. "On Experiments made to determine the Value of Different Coals for Steam Purposes," by J. R. George. (See *Transactions*, p. 151.)

Mr. Marchant remarked that the coal imported from England was of very variable quality, and much of it very inferior, so that the tests were hardly fair.

5. "Notes on the Anatomy of the *Kanae* (*Mugil* sp.)," by F. J. Knox, L.R.C.S.E. (See *Transactions*, p. 189.) The author described a specimen from Porirua with five spines in its first dorsal fin. He also claimed to be the first to point out that the Mullets live entirely on the *Diatomaceæ*.

Captain Hutton thought that as the Mullet with five spines agreed in all other respects with the common Mullet of the north, the possession of a fifth spine must be looked on as a monstrosity, and not as proving a new species.

EIGHTH MEETING. 28*th October*, 1871.

W. T. L. Travers, F.L.S., President, in the chair.

New members.—James Brogden, W. S. Reid.

The Hon. W. B. D. Mantell, F.G.S., was chosen Electing Member of the

* See "Cat. Birds N.Z.," Hutton, Colonial Museum, Wellington, N.Z., 1871, p. 71.

Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

Presentation of books from Harvard College, U.S.A., the Smithsonian Institution, U.S.A., the Flax Commissioners, and Mr. Crompton, were placed on the table.

1. The President read the following extract from a letter addressed to Dr. Hector by Professor Agassiz, which accompanied the presentations from Harvard College.

"I have just received the diploma of membership of the New Zealand Institute, which you have forwarded to me. Please present my thanks to your learned Society for this distinction. I have been more delighted in receiving it than I can express. Certainly, when remembering the recent date of the colonization of New Zealand, there can be no more surprising evidence of the rapid progress of modern civilization than the publication of the *Transactions* of your Institute. Not that the printing of a book in any part of the world is now-a-days any marked event, but the volume before me is more instructive, and better put together, than the proceedings of most learned societies of a long standing. I have requested my friend, Mr. T. G. Cary, who takes care of the affairs of the Museum of Comparative Zoology in Cambridge, to forward to you a series of the publications of our Institution; and I would now take the liberty of requesting you to send me also the first and second volumes of your *Transactions and Proceedings*. With our volumes you will also receive a set for each of your associated societies, which I beg you to forward. Allow me also to request you to send me whatever specimens of living and fossil animals you can spare, and to let me know what I could send you in return. I have a series of casts of Mastodon heads, of different ages, which might be interesting, and can offer any of the natural productions of North America you may wish, or at least procure them shortly if they are not at hand. It is my earnest desire to secure for our Museum as complete a representation of the living and extinct fauna of New Zealand as possible, before the progress of your settlement has made it impossible to bring together complete collections of the original fauna of your islands. I would particularly value specimens of all the species described in your *Proceedings*. I need scarcely add that specimens of the fishes described and figured by you would have a special interest for me. I shall direct my assistants in the different departments of the Museum to write to members of your Institute who work in the same field, and beg you may secure for them a friendly response."

2. "Notes on the Practice of Out-door Photography," by W. T. L. Travers, F.L.S. (See *Transactions*, p. 160.)

3. "On the Alkalinity or Acidity of certain Salts and Minerals, as indi-

cated by their Reaction with Test Paper," by W. Skey, Analyst to the Geological Survey of New Zealand. (See *Transactions*, p. 325.)

4. "Observations on an Albino Eel," by F. J. Knox, L.R.C.S.E.

(ABSTRACT.)

The stream which passes my residence at Johnsonville abounds with eels, and, so far as I can observe, to the exclusion of any other fish. The *Gallaxias*, for instance, whilst it is numerous in the Tukapuha, which empties its waters into Porirua Harbour, is not found in the Ngahauranga, although the latter stream arises in the same group of hills, and is derived from the same locality.

The Albino specimen, of which I place the skin and skeleton before the Society, was observed, day after day, moving about towards dusk in search of food. It resembled a portion of soiled calico, and had a rather repulsive aspect, more especially as the eyes were distinctly visible, being of a peculiar dead hue, and readily distinguished by their circular form. The specimen was ultimately brought to me by a keen and successful eel-catcher, who, although he had captured thousands, had never seen one of this description before. He appeared to consider it diseased, otherwise I would not have had the pleasure of bringing it under the notice of the Society.

I have added my usual table of measurements, together with the dissection. Its weight (recent) was 10 ounces.

Measurements.

	Inches.
Snout to tip of tail	20·5
„ nostrils	·1
„ centre of eye	·6
„ angle of eye	·7
„ gill aperture	3·0
„ pectoral fins	3·1
„ cloaca	9·0
„ dorsal fin	6·5
„ anal fin	9·1

Lateral line well marked; mucous apertures divided by 0·2 inch, secreting abundance of mucous. The abdominal viscera appeared perfectly healthy. I examined the entire intestinal tube with great care, and observed no parasites.

5. Dr. Hector read a letter from Dr. Thomson, of Clyde, giving the account of his exploration of the cave in which the Moa's neck was found some months ago.* It is an irregular fissure in mica schist rock, about 50 feet in depth, with three shelf-like ledges or floors, on which the bones have lodged. There are two entrances—one on the hill side, and another by a funnel-shaped depres-

* Incorporated with Art. IV. *Trans.*, p. 111.

sion in an alluvial flat. On the first or upper floor were found traces of a fire and charred bones. On the second, by scraping away the loose dust to the depth of two feet, leg bones, ribs, vertebræ, a pelvis, toe bones, tracheal rings, and pieces of skin and muscle were found. At the lowest level were found fragments of egg-shell and the bones of a bird with a keeled sternum. Dr. Thomson has obtained bones of at least eight birds, and a perfect skull with lower jaw and trachea attached, and a femur, with well preserved muscular tissue, was also obtained at the spot where the neck was formerly found. The position of the cave is opposite Alexandra, at the foot of the Obelisk ranges. From another locality in the same district Dr. Thomson also sent twenty feathers of the Moa that were obtained by a digger 18 feet below the surface in recent alluvium.

6. "On some Moa Feathers," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 172.) The author said that, while these feathers had the form peculiar to Struthious birds, they were quite different to those of any known species, and that they showed that the bird to which they belonged was allied more to the American *Rhea* than to any of the Struthious birds of the old world.

In the course of the discussion which followed, the President, and also the Hon. Mr. Mantell, alluded to the injustice that had been done to the late Mr. Rule, of Nelson, who took the first Moa bone to Professor Owen, and who had been represented in some quarters as being an illiterate seaman, ignorant of such matters, whereas he was an educated medical man, who was perfectly aware that the bone was that of a bird when he took it to England.

Ninth Meeting. 25*th November*, 1871.

James Hector, M.D., F.R.S., in the chair.

The chairman announced several valuable presentations to the Museum and library — including the "Transactions of the Zoological Society" of London, Professor Owen's latest work on the Moa ; ferns, etc., from the island of St. Paul, presented by an officer of H.M.S. 'Blanche,' who had obtained them while on the island after the wreck of H.M.S. 'Megæra,' and some Seal skulls brought by the officers of H.M.S. 'Blanche,' from the Auckland Islands.

Dr. Hector reported the successful introduction for the first time of English Trout into two streams of the North Island—the Kaiwarrawarra and the Hutt. He also made some remarks on the enormous quantity of fish that was cast up on the sea coast by the late S.E. gale. Among them were hardly any of the kinds usually obtained by the fishermen. Of eleven species collected, three are new to science, and six others had never formerly been found in the seas round New Zealand. They were mostly of the Cod family, deep sea fish, with slender tails, the formation of which would render their efforts to escape from rough or broken water of little avail. He hoped that a small work, which is at present in course of publication from the Museum, would assist in extending our knowledge of the fishes, as it gives a scientific description of each species, and figures of about forty species that are commonly used as food.

1. "Notes on the Remains of a Stone Epoch at the Cape of Good Hope," by B. H. Darnell (See *Transactions*, p. 157). Specimens of stone implements from the Cape Colony were exhibited. The object of the author was to point out the similarity of the conditions under which these flakes were found to the chert flake deposits of New Zealand, which contain Moa bones. Unlike the Maoris, however, the aborigines at the Cape are not known to have used stone implements within historical times.

Some discussion ensued as to the manner in which these flakes were formed, Dr. Hector maintaining that such flakes, though no doubt sometimes used as knives, must have frequently been formed accidentally where masses of chert were used in the cooking ovens, and from flakes thus formed, the best would be selected for knives.

Mr. Mantell stated that he had never seen stone of a kind that would "fly" when heated and quenched with water used by the natives for their ovens, and that in the ancient ovens he had examined, the chert only was found in flakes.

Dr. Hector pointed out in explanation of this that the ovens examined by Mr. Mantell were near the coast where the chert does not occur *in situ.*

2. "On the New Zealand *Chitonidæ*," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 173.) The author pointed that New Zealand is very rich in Chitons, there being twenty-one species, three of which are new. Mounted specimens of all but one species were exhibited.

3. "On the Cause of the Suspension of Clay in Water, and its Precipitation therefrom by certain Substances; with Notes on Professor Jevous' Electrical Theory in relation thereto," by W. Skey.

(ABSTRACT.)

The author of this paper shows that the cause of the persistent suspension of clay in water, and its precipitation therefrom by certain substances, as pointed out by him in 1868,* is connected with their chemical affinity for the water used; that, in fact, clay is capable of combining to any extent with free water" (such as distilled water), and in the hydrous state is suspended

* "Chemical News," No. 168.

for an indefinite time. The precipitating effects of the salts and acids, he cites, is due to the exercise of a higher affinity for water on their part; these affinities being superior to those of clay for the same liquid, the clay is partially dehydrated, and thus brought into a condition resembling that of solid clay, both physically and chemically, in which state it precipitates mechanically.

The substance having the greatest precipitating effect upon clay in water is sulphuric acid, one part of which is effective upon 25000 parts of the mixture.

Generally, spring water is sufficiently charged with salts to effect the clarifying of clay water in twenty-four hours or so.

A solution of magnesia, a substance which one would take to be quite inert, soon clarifies clay water, though it requires 7000 parts of water to dissolve it.

The author shows how water may thus be purified for use. He then demonstrates that most, if not all, natural clays, if only mixed with a *small* quantity of water, do *not* remain persistently suspended. This he attributes to the presence, sometimes of salts, sometimes of carbonic acid. He then shows that clay-slate, brick, etc., or any other kind of indurated clay, is resolvable into the most hydrated clay direct by simply pulverizing it in pure water.

The author lastly discusses Professor Jevons' theory for the explanation of this suspension and precipitation of clay in water.

This theory was broached in the "London Chemical News" under the heading "On the so called molecular movements of microscopic particles," and is an attempt to attribute the phenomena under consideration to the agency of electricity.

Professor Jevons conceives these particles, as they persistently suspend themselves in water, to be charged with electricity, by which they move about, owing to a series of electrical attractions and repulsions, and so remain suspended by reason of these motions; the insulation of these charged particles being, as he thinks, sufficiently provided for by the use of *pure* water.

The effects of certain salts upon the mixture (in precipitating the particles) he ascribes to the fact that such additions render the liquid an electric conductor, so that the electricity passes off instantly, and thus restores to the particles the same electrical state as the surrounding liquid, when they lose all power of electrical movements.

The author of the present paper shows that theoretically and experimentally this theory of Professor Jevons is quite incompetent to explain these phenomena in the case of clay at least, if not also for the other substances he cites; but that, as stated before, they are susceptible of explanation on the assumption of a very large *quantitative* affinity of this substance for water—but an affinity of a very weak intensity; so weak that most of the common salts are able to overcome it, and so remove the clay as a chemical precipitate.

The Hon. Mr. Mantell said he had noticed that a tub of muddy well water was always cleared by the rain-water running into it from the roof of his house.

Captain Hutton remarked that chlorophyll presents an analogous case to clay. It is suspended in water, but precipitated by some salts such as protochloride of tin.

4. "On a Form of Electro-magnetic Seismograph, adapted for indicating and registering Minute Shocks," by W. Skey. (See *Transactions*, *p.* 330.)

5. "On a New Process for the Manufacture of Sulpho-cyanide of Potassium," by W. Skey. (See *Transactions*, p. 330.)

6. "On the Absorption of Copper from its Ammoniacal Solution by Cellulose, in the presence of Caustic Potash," by W. Skey. (See *Transactions*, p. 332.)

7. Dr. Knox presented some further dissections of New Zealand Bats, and read some descriptive notes.

The Chairman drew attention to the skilful manner in which these delicate preparations had been made, and stated that the Museum is indebted to Dr. Knox for a large number of similar preparations which require a great amount of accurate knowledge and long practice for their production.

AUCKLAND INSTITUTE.

First Meeting. *29th May*, 1871.

His Honour T. B. Gillies in the chair.

A letter explaining the cause of absence of the President was read by the Secretary.

New members.—C. Mellsop, F. Dawson, M.R.C.S., William Atkin.

The Chairman then read the President's opening

ADDRESS.

At the commencement of a new season it seems incumbent on the occupant of this seat to open the proceedings by some slight review of the progress which has been made in carrying out the objects to which this Institute and its allied societies in New Zealand are specially devoted, and of the prospect which lies before it of continuing and extending the course of usefulness in which it has made so hopeful and creditable a commencement. I find, from the preamble of the Act under which the Institute is constituted, that its objects, in addition to the establishment of a public museum, laboratory, and public library, are "to promote the general study and cultivation of the various branches and departments of art, science, literature, and philosophy."

Amongst the many subjects which this comprehensive definition embraces, the development of the natural history of these islands, in its various branches, has necessarily taken the foremost place.

The most natural and obvious work of the colonist is to explore the country of his adoption, to search out its resources, to investigate its peculiarities, to realise its possessions, and to note its wants: and if here and there one, to the ordinary energies of the early settler, adds the zeal and knowledge of a scientific explorer, the field of investigation is to such an one only enlarged and its interest intensified, but the natural bent and tendency of his researches will probably remain the same.

In the early stages of every society the practical must always preponderate over the speculative, and man has still left in him so much of the instinct of the gregarious animal that, whatever the previous habits and structure of his mind may have been, the early colonist inevitably either becomes *entraîné* by the materialistic tendencies around him, or abandons the colony in disgust.

So long as unexplored fields remain accessible to research they will naturally afford the strongest stimulus to the curiosity of the most active minds, and, even before the grand generalisations of modern times had given those studies the greater importance they now possess, they have always been found peculiarly fascinating in new countries.

But in our day such investigations have a far higher aim and importance than they have ever had before. The vast mass of observations and information collected in past time has in our own afforded a solid basis for general laws, and has furnished the elements of speculations the most brilliant, and results the most unexpected. The search after unknown or undescribed specimens of the fauna and flora of a new country is not now a mere dry cataloguing of long names—not simply making collections of curious individual specimens, or searching out of minute or unimportant and perhaps fantastical varieties of previously known species, interesting only to the minute student in those special sciences—but, in the expanded range which thought and investigation have taken, every new fact becomes a fresh link in the great chain of truth, and the discovery of some apparently insignificant fossil, plant, or animal in New Zealand may serve to establish or to discountenance theories of the greatest magnitude and deepest interest, not merely to a local scientific coterie, but to the whole world of science.

In the curious spectacle of the succession of species, first developed by the researches of the geologist, and which, in fact, is the very alphabet of palæontology, what can exceed the interest afforded by seeing this great law of nature, previously known only from the fossil records of the remotest past, brought down even to our own day by the recent extinction of the Struthious birds formerly so much developed in New Zealand? And again, linked in the great question of the distribution of species, and the resulting hypothesis either of the different former disposition of sea and land, or the evolution, under similar conditions, of more or less similar forms of life, who can foresee the light that may arise from complete lists, even of the most humble of the plants still growing on our coasts, and the comparisons these will afford with the productions of the islands of the north? The correlative changes too, which are occurring in infinite ramifications in our fauna and flora, and even in the configuration of the country, in consequence of the disturbance of the previously existing order of nature by the intrusion of new organisations, are so rapid that no time is to be lost if the aboriginal types and conditions are to be recorded, and the order of their extinction, hybridization, or metamorphosis noted.

The observation and collection of our natural fauna and flora, both living and fossil, are, undoubtedly, and ought to continue to be, amongst the most important and by far the most pressing objects to which the attention of these societies can be devoted; and most of the associated societies, and our own in particular, are so fortunate as to possess indefatigable and accomplished workers in these fields, to whom the past success is almost entirely owing. Chiefly by their means are our museums becoming worthy representatives of the primeval New Zealand, instructive guides to the natural history as well as to the industrial resources of the colony; and to them we owe the interest which the two volumes of *Transactions* already published unquestionably possess, for they contain no ephemeral controversies or disputable theories, and very few matters of mere local interest; but they consist chiefly in undoubted records of the great truths of nature, results of painstaking research and laborious explorations, rounds in the ladder of knowledge, equally necessary for everyone who would scale its height, whether here or in the great centres of scientific knowledge in the capitals of Europe.

In these branches of scientific knowledge, it appears to me—an unscientific and therefore hardly competent witness—that the labours of the New Zealand Institute as a whole, and of our own branch of it in particular, leave nothing to be desired, save only that the labourers were more numerous. Our secretary, Mr. Kirk, Captain Hutton, and Mr. Gillies, have amply redeemed us from any imputation of failure in this province; and I trust that they will continue to enrich our museum, and to give value to our published *Transactions* by their contributions; and, while they do so, the interests of natural history will be safe. One other subject on which the field is still open to original research has not been so effectually laboured. I allude to that most interesting branch of ethnology which ought to be so peculiarly the object of study in this part of New Zealand—the history and peculiarities of the native race. It is curious that while many excellent papers on this subject have been read before the New Zealand Institute, not one has come from Auckland, where by far the greatest number and the most important tribes of the natives live.

But while the branches of science connected with natural history have been assidiously cultivated with so much credit to the Institute and advantage to the colony, and while some attention has been given to a few purely local topics, I apprehend that we have hitherto overlooked others in which, indeed, no opportunity of original research is open to us, and no hope of discovery affords a stimulus to the student, and in relation to which all that is left to us is the humbler duty of introducing and encouraging, or, to use the current term, of "acclimatising" lines of thought which are being pursued with such vast effect elsewhere, and which are so rapidly enlarging and revolutionising recently received ideas on such subjects, that one who should stay in these remote parts of the world, with only the ordinary manuals of chemistry, astronomy, meteorology, biology, and physics generally to refer to, would soon fall so far behind the science of the day that even the very terminology of the most recent papers wonld become scarcely intelligible.

Long since the time when I, and many here present, first settled in this colony, arose the first notice of ozone: the explanations of Fraünhofer's lines, and the wonders which the analysis of the spectrum has revealed, are still more recent. The dynamic theory of heat, suggested indeed by Bacon and the philosophers of the succeeding age, and made demonstrable by the experiments of Count Rumford and the deductions of Davy and Faraday, can only be said to have been vivified into a fertile principle since the publication of the works of Grove and Tyndall; and without some clear knowledge of all these, to which the most assiduous study of the standard books even to a comparatively recent date would afford no clue, what conception could be formed of the objects and results of some of the most interesting investigations of the day—of the observations for instance of the two recent total eclipses of the sun, the whole interest of which depended on observations with the spectroscope and polariscope?

Now the assisting the student, under the disadvantages of colonial life, in keeping himself duly up to the intelligence of the age, appears to me an object of the Institute almost as important as the prosecution of discoveries in botany, geology, and palæontology.

While, therefore, I would desire that we should still afford the greatest place in our plans to research in natural history, I would seriously call the attention of the members of the Institute to the question, whether it is not time to attempt some regular and systematic encouragement to progress, and some opportunity of improvement in other branches of science; whether we cannot by that means enlarge the basis of support on which we rest, and secure larger and more frequent attendance at our meetings?

I find there is some danger of our being supposed to be a Society exclusively for the study of natural history, and therefore uninteresting to those unversed in the branches of science included in that term. If we do not remove that impression, and evince the catholicity of our interest in science, we may run the risk of finding ourselves without the support of that portion of the intelligent public which is not devoted to zoology, botany, and geology.

"*Non omnes arbusta juvant humilesque myricæ.*"

And if we would take our proper position before the public, as a point of union and a rendezvous of all persons having any taste for scientific pursuits, we must embrace, as far as we are able, all the objects which attract the attention of curious and inquiring minds. The disadvantage of attempting any contact with such subjects as astronomy, spectroscopes, theory of heat, light, and sound, meteorology, biology, chemistry, the microscope, sciences employed in manufactures, such as metallurgy, is that in their pursuit we cannot hope much to enrich our published *Transactions*. As there is no room for original research, so it could rarely happen that the author of a paper would wish to see it published in our printed volumes. One paper has indeed been presented to the Institute at Wellington, containing the admirable observations for longitude made by Mr. H. Jackson, and they will be an ornament and a credit to the *Transactions* of the current year; but we cannot hope for many repetitions of such trains of observations as that, requiring as they did the steady persevering application of a year; and I cannot learn that even that paper has created the interest in the subject which its importance and value deserve. On such subjects it must be rarely that any new light can be thrown here. I presume not the most strenuous supporters of "local industries" would recommend any one under such difficulties as a colony presents to devote himself to the study, as a pursuit, of any of the higher branches of experimental physics; and very few indeed amongst us can even spare the leisure to follow, with accuracy and completeness, the published information on these subjects, scattered as this is through the papers and memoirs read before many different societies.

But I apprehend that it would be quite within the reach of many or most of our members to throw together, with less aim and completeness than would be required in a formal lecture, such a sketch of some branch of science as would suffice to interest the less informed on the subject, and to draw out from the more informed their contributions to the common fund of knowledge; and so we might attain to what I conceive to be the true object of societies like ours, the enabling and inducing its members to club together their several information and knowledge, and so correct and enlarge their own views by comparison with those of others.

In this manner, by announcing beforehand the subject intended for discussion, and the paper with which it would be opened by way of text, I apprehend we might have very interesting evenings, where many would join in explanation or discussion; and any one possessing instruments or drawings would be induced to make them available for the amusement and instruction of the Society. The effort which I believe the Council is about to make to obtain selections at least from the "Transactions" of the various scientific societies in England will, I trust, not a little facilitate the step I propose—one perhaps hitherto impracticable, but which the now rapid expansion of the colony in wealth and intelligence, and the new resources opening up around us, and stimulating inquiries and awakening curiosity hitherto dormant, seem to render not only possible but necessary.

A list of donations to the Library and Museum was read by the Secretary, who drew attention to several of the objects which were laid on the table.

1. "On the Flora of the Isthmus of Auckland and the Takapuna District,"

by T. Kirk, F.L.S. (See *Transactions*, p. 228.) This paper was the second on the flora of the district—the first, which was confined to the flowering plants and ferns, having been published in the *Transactions* for 1870, p. 148. The author commenced by pointing out the wide difference between the present state of our knowledge of the phænogamic portion of the flora and of the lower Cryptogams, the flowering plants and ferns being well known, while the extensive orders which form the bulk of the Acro-Thallogenic section of the flora have received but a small amount of attention.

2. "On the Occurrence of Foot-prints of a Large Bird, found at Turanganui, Poverty Bay," by Archdeacon W. L. Williams. (See *Transactions*, p. 124.) The occurrence of these foot-prints was made known to the writer two or three years ago, by Mr. Millar. Being unable to remove them at the time, he took steps for their preservation by covering them with a mixture of lime and sand to preserve them from the influence of the waves, and thus obtained an excellent cast, which has been presented by him to the Museum of the Auckland Institute, together with a portion of the original impressions.

3. "On the Occurrence of Foot-prints of the Moa at Poverty Bay," by His Honour T. B. Gillies. (See *Transactions*, p. 127.)

4. Mr. Kirk exhibited some Eggs of the Kiwi (*Apteryx mantelli*), from Whakatane, which showed a deviation from the ordinary type. They were of the same length as the usual form, but of greater width, and narrowed sharply towards the extremities, so that the width was rendered prominent. Mr. Kirk stated that he had seen specimens of the same form from the forest at Mareitai. Eggs of the ordinary form, also of the Albatros, from the Museum collections, were exhibited for comparison.

5. A fine specimen of the Tuatara (*Sphenodon punctatum*, Schtz.), captured on the Ruarimu Rocks by Major Mair, was exhibited. In the note which accompanied it Major Mair stated that it was confined to a small cone-shaped elevation in the centre of the islet, where it was found in the holes of sea-birds. The common striped lizard (*Mocoa zelandica*, Gray), is plentiful in the lower parts of the islet, but the two kinds keep thoroughly apart.

6. "On the Alluvial Deposits of the Lower Waikato, and the Formation of Islands by the River," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 333.) The author conclusively showed the fresh-water origin of these deposits, and accounted for the occurrence of littoral plants as detailed by Mr. Kirk in the *Transactions* N.Z. Inst., Vol. III., p. 147, on the supposition of their having been introduced from the Middle Waikato basin after the formation of tne Taupiri Gorge.

7. The Rev. A. G. Purchas exhibited the female insect and larvæ of one or two species of *Lampyridæ*, which he had obtained from some of the drives

on the Thames goldfields. He stated that their luminosity in some cases was most remarkable.

Second Meeting. 26*th June*, 1871.

T. Heale, President, in the chair.

New members.—Dr. J. L. Campbell, J. S. Buckland.

The monthly list of donations to the Library and Museum was read by the Secretary.

1. "On the Nativity in New Zealand of *Polygonum aviculare*, L.," by T. Kirk, F.L.S., (see *Transactions*, p. 238); being a reply to a note by Mr. Travers on *Polygonum aviculare*, at page 336 of Vol. III. of the *Transactions.*

Dr. Purchas remarked that he had observed the plant on his first arrival in the colony, and did not believe that it had materially increased since that time.

The President stated that thirty years ago, a time when the common Dock, as a naturalized plant, in the North Island was only known on the sea-beach at Hokianga and one or two similar localities, the Knot-grass occurred to about the same extent as at the present day. He had always considered it indigenous.

2. Some microscopic preparations of *Phormium*, the colour of which was remarkably well preserved, were exhibited by Mr. T. F. S. Tinne.

3. "On the Use of Vulgar Fractions instead of Decimals in the Compilation of Mathematical Tables," by R. J. Pearce. A synopsis of this paper was read by the author, but, owing to its abstract nature, discussion was postponed until the next meeting.

4. "On Eclipses," by T. Heale.

(abstract.)

The author explained that total or annular eclipses could only take place when the line of syzigies coincided with the line of nodes, and partial eclipses of the sun and moon when their angular distances did not exceed 12° and 15° respectively; that since nineteen synodical revolutions of the nodes occupy 6585·78 days, and 223 revolutions of the moon, 6585·32, the relative positions of the bodies are brought back at the end of that period of 18 years and 11 days to the same position they occupied at the commencement of it, except the small amount of motion due to the 11 hours of difference, and apart from the effects of perturbations, and that all the eclipses recur under nearly the same circumstances as before. The knowledge of this period, and of the order of previous eclipses, as seen from one place, enabled the priests in the dawn of

history roughly to predict the future ones. Owing to the complexity of the moon's motions, approximate truth only was obtainable, even down to the eighteenth century, and the computation was made by the circuitous method of the nonagesimal. In our day, owing to the perfection of the tables published in the "Nautical Almanac," the computation of eclipses or of occultations of stars by the moon is rendered very easy.

These phenomena are predicted in the "Nautical Almanac" generally from the centre of the earth, and their visibility is stated within certain parallels of latitude. But, from the effects of parallax, these times may vary by two hours either way for a place on the earth's surface, or the occultation may not occur at all in some positions within the limiting parallels.

An independent prediction is therefore required for every place; this may be made approximately by a graphical projection of the figures of the bodies in their true proportions and relative positions, which requires only a pair of compasses and a scale of chords, such as is to be found on a foot rule, so as to show the times within a very few minutes. If accuracy is required, the true relative positions of the two bodies can then be taken out for the assumed times, and the error to be applied to these assumptions ascertained by simple computations in spherical and plane trigonometry.

In our day the mere occurrence of the phenomena at the exact times predicted for them has lost the interest it had for our forefathers, to whom it appeared wonderful and mysterious; but a new source of interest in total eclipses of the sun has arisen, from the means which the spectroscope and polariscope afford for investigating the curious phenomena of the *corona, red flames* and *sierra*, and the means which photography supplies, with the aid of a suitable telescope, equatorially mounted with clock motion to keep the object steadily in the camera, of taking accurate pictures of the momentary appearances.

The various hypotheses to account for these appearances have now subsided into a clear knowledge that the sun is surrounded to a depth of two or three seconds of arc, corresponding to a depth of 900 to 1,200 miles, by an atmosphere chiefly of hydrogen, but mixed with the incandescent vapours of many other metals in a most tumultuous condition; that prominences, consisting essentially of hydrogen heated far beyond any temperature obtainable on this earth, shoot out from it to a height of 90,000 or 100,000 miles in very short intervals of time, and that outside that to an indefinite distance extends a radiated luminous envelope, which cannot be considered material, but which gives spectra strikingly similar to those of the Aurora and of the zodiacal light; that these effects seem to be associated with electrical discharges, and may hereafter prove a visible link between radiated heat, light, and electricity, the intimate connection of which is shown in many ways.

Some remarks were made upon the apparently small density of the vapours near the sun under so prodigious a vertical pressure.

The author then referred to the projected expedition to Cape York to witness the total eclipse of 12th December, and expressed a trust that it would furnish a quota to the scientific information derived from the many expeditions sent by the Governments of Europe and America to many parts of the world to witness the eclipses of 1868, 1869, and 1870, which would be worthy of the young energies and rising greatness of Australia.

This paper was copiously illustrated by large diagrams.

5. Mr. Dyson suggested the desirability of procuring drawings and specifications, or, if practicable, working models of the machinery used in various manufactures, for display in the Museum. He believed that an exhibition of this kind would be highly attractive to the public, and of direct practical value to those about to embark in manufacturing pursuits.

Mr. Tinne supported the suggestion, and stated that the Superintendent was engaged in obtaining information relative to several manufactures which it was desirable to introduce into the colony.

The President considered it doubtful if manufacturers of machinery would care to forward drawings and specifications of their respective machines simply for exhibition, although there could be no doubt of the actual value of information on the subject. He ventured to suggest to members the desirability of making themselves acquainted with the new adaptations of force to industrial pursuits which were continually being reported in the scientific periodicals of the day, and instanced the adoption of nitro-glycerine for blasting purposes in the Welsh slate quarries as being well worthy of careful study by all who were interested in the Thames goldfields.

THIRD MEETING. 31*st July*, 1871.

T. Heale, President, in the chair.

New member.—H. A. Mair.

The list of donations to the Library and Museum was read by the Secretary. It embraced a large number of valuable books from Captain F. W. Hutton, F.G.S.; models of the egg of the Moa, presented by the Director of Colonial Museum; fine specimens of crystallized sulphur from White Island, presented by Major Mair; and Moa bones from Turanganui, presented by Archdeacon W. L. Williams, were laid on the table, and excited considerable interest.

The President stated that arrangements had been made for lighting the Museum with gas, and keeping it open for the convenience of visitors on

Wednesdays until 9 p.m., so as to afford persons engaged in business during the day an opportunity of becoming acquainted with its contents; it was hoped the experiment would prove successful. A series of instructive lectures was also in contemplation.

1. The President invited remarks on any of the papers read at the previous meeting. With regard to the paper read by Mr Pearce, "On the Substitution of Vulgar Fractions for Decimals, in the Compilation of Mathematical Tables," he remarked that he had carefully examined that gentleman's calculations and found that in several cases the results given could not be relied upon, as they had evidently been obtained from a series of approximations. Although highly appreciating the great amount of patient labour which Mr. Pearce had bestowed on the subject, he could not anticipate that the proposed substitntion would be attended with beneficial results.

Mr. Pearce exhibited further calculations in support of his proposition, and expressed his belief that its adoption would result in a great saving of time, and entail advantages in other directions.

2. "Description of a Simple Form of Rain-guage," by Archdeacon W. L. Williams.

(ABSTRACT.)

The writer pointed out that the rain-guages in common use were constructed on some arbitrary scale, and supplied with a measuring glass graduated to hundredths of an inch in proportion to the collecting aperture of the instrument; consequently the breakage of the glass disabled the instrument until another could be procured, a matter often involving considerable difficulty and delay, especially in a newly settled country. He proposed to utilize the ordinary ounce glass, which could be readily procured, by adopting a rain-guage with a circular aperture of $10\frac{1}{2}$ inches, so that each $\frac{1}{100}$ of an inch of rain would be represented by half an ounce. A simple correction was supplied for the slight error involved in the adaptation.

Mr. Peacock admitted the value of the form now proposed, but advocated the great superiority of a self-registering guage.

Mr. Kirk remarked that while fully prepared to admit the advantages afforded by self-registering instruments, he considered they were even more exposed to the risk of accident than the ordinary kind, and were attended with the further disadvantage of extra cost in the first instance. The form now proposed could readily be manufactured in zinc or copper, so as to be adapted to any kind of receiving vessel, and the ounce glass could be procured from any druggist at a small cost. It supplied a recognised want—a cheap rain-guage for the use of settlers, and was therefore calculated to increase the number of observers of rain-fall which varied in different localities even in this province to a much greater extent than was generally supposed.

3. "On the Botany of the Titirangi District of the Province of Auckland," by T. F. Cheeseman. (See *Transactions*, p. 270.) This paper describes the chief physical features of the district, and the principal characteristics of its flora.

Mr. Kirk considered the paper a valuable contribution to our knowledge of the botany of the north. As compared with the remainder of the country north of the Auckland isthmus, the flora of the Titirangi district exhibited but few peculiarities, the most striking being the presence of *Viola filicaulis*, *Myriophillum pedunculatum*, *Myostis australis*, *M. Forsteri*, and the absence of the beech (*Fagus fusca*), and one or two other trees. The peculiar distribution of the beech in this province was worthy of a passing remark. From the East Cape southwards to Otago it occurred frequently in forests, but to the north it was entirely absent from large areas; it occurred at the Thames, Waihekei, and Wairoa, but was entirely absent from the isthmus and from the Titirangi district, and was not known to occur in the Kaipara; it occurred sparingly at Wainui, the Kawau, and more freely at Omaha, but was absent in the Great Barrier Island. It appeared again at Whangarei, which was the most northern locality known on the East Coast; although on the West Coast it was said to be abundant in the Hokianga ranges, and again at Kaitaia. It seemed highly probable that in former periods the beech occupied a more prominent position in the flora of the north than it held at the present time. The minute *Hymenophyllum*, now described for the first time, was an interesting plant. On examining some of the specimens collected by Mr. Cheeseman, he was at first inclined to consider it a form of *H. minimum*; but from further specimens received from Mr. Springall, who collected it on fallen trees at the Great Barrier, he found it was a new species. He believed it had been discovered in other localities, and would probably prove to be widely distributed, although easily overlooked from its small size, or entirely missed from its habitat being frequently on lofty trees; in general appearance it resembled its southern congener *Trichomanes armstrongii.*

Mr. Cheeseman's remarks with regard to the number of plants enumerated by him as indigenious in the district being considerably larger than had hitherto been enumerated from any district of similar area, must be received with some qualification, as the number recorded from the Auckland Isthmus and North Shore, a district having an area less than one-fifth of that now under consideration, is nearly identical.

4. "Note on *Megapodius pritchardi*, Gray," by Captain F. W. Hutton, F.G.S. (See *Transactions*, p. 165). This paper treats of a megapode in the Auckland Museum, previously described by Mr. Buller at page 14 of *Transactions* of the N. Z. Institute, Vol. III., as a new species, which he proposed to call *M. huttoni.* Captain Hutton considers it identical with *M. pritchardi*, Gray. A specimen of the bird was exhibited, also one of its eggs.

5. "Notes on the New Zealand *Asteliads* with Descriptions of New Species," by T. Kirk, F.L.S. (see *Transactions*, p. 241.) The writer described the general characteristics of the New Zealand members of the genus, more especially of the lowland forms, and drew attention to the prominent position which the genus occupies in the flora of the Colony, notwithstanding its comparatively small number of species. The paper was illustrated by a series of dried specimens of each species in various stages of flower and fruit, with the exceptions of the alpine *A. nervosa.*

The President remarked that he had analysed the gum exuded by *A. trinervia* when cut down, and found it to contain over 90 per cent of water. In addition to the economic purposes to which the genus had been applied, as enumerated in the paper just read, he would state that the thin pellicle of the leaves of *A. banksii* and *A. solandri*, and perhaps of other species, was twisted into wicks for lamps and candles by the Maoris.

Fourth Meeting. 28*th August*, 1871.

T. Heale, President, in the chair.

New members.—The Venerable Archdeacon Maunsell, T. Fish, J. W. Hall.

The monthly list of donations to the Library and Museum was read by the Secretary.

1. "On a Mode of Communication between a Station on a Line of Railway and a Train in motion on the same Line," by G. Rayner.

(abstract.)

A wire is laid between the rails on strong insulators fixed on the sleepers with cast iron brackets, all joints being made beneath the wire. The connection from the carriage (in which the instrument is placed) with the wire, is by means of a light copper wheel, as large as convenient, beneath the carriage. The parts bearing this wheel are perfectly insulated from the carriage. The connection is continued from a bearing connected with this wheel.

The pressure of the wheel on the wire would be very slight, being regulated by means of counteracting weights on pulleys, thus enabling the person in charge to maintain a pressure merely sufficient to meet any deflections of the wire, which would also avoid wear to the same.

In case of an earth being required, to complete the circuit, a connection is made with the iron axle of the carriage, which communicates with the iron rails, thus forming an earth.

The paper was illustrated by a model.

In the discussion which ensued the ingenuity evinced by the author in his adaptation of an old plan was generally admitted, but it was agreed that the position of the telegraphic wire would render it liable to constant injury from accidental causes, and consequently deprived the invention of practical value.

2. "A Description of the Foundation of the Lighthouse in the Ponui Passage," by J. Stewart, Assoc. Inst. C.E. (See *Transactions*, p. 135.) The paper was illustrated by numerous diagrams.

In the discussion which ensued it was stated that the mode of lighting adopted at the Bean Rock Lighthouse and the one now under consideration allowed the use of kerosene in the place of colza or other expensive oils, and required only a single attendant at each lighthouse.

3. "A Comparison of the Indigenous Floras of the British Islands and New Zealand," by T. Kirk, F.L.S. (See *Transactions*, p. 247.) In this paper were stated the chief points of resemblance and divergence exhibited by the two floras, first from a physiognomical point of view, and subsequently in a more detailed form, from a systematic comparison of the principal orders and genera.

Considerable discussion followed.

4. "Notes on the Local Distribution of certain Plants common to the British Islands, and New Zealand," by T. Kirk, F.L.S. (See *Transactions*, p. 256.) The author gave a detailed statement of the distribution in New Zealand of the seventy species common to both countries, accompanied by a concise account of the British distribution of each form, interspersed with critical notes on structure and affinities.

The President stated that the Museum had been lighted with gas, and was kept open on Wednesdays until 9 p.m., with highly gratifying results as to the number of visitors. The question of the erection of new buildings was now absolutely forced upon the Council, as it had become imperative to take down considerable portions of the old structure on account of its dilapidated condition. He read a circular on the subject, which had been drawn up by order of the Council for distribution amongst its members, requesting their aid in carrying out the improvements, which received the unanimous approval of the meeting.

Fifth (Special General) Meeting. *2nd October*, 1871.

The Rev. A. G. Purchas, M.D., in the chair.

The Chairman stated that the meeting had been made special in order to report the results of the preliminary inquiry undertaken by the President and Secretary, with regard to the support likely to be accorded for the erection of a new building, to consider the propriety of increasing the number of members of the Council, and of calling for building plans and estimates.

New members.—Edward Kinlock, William Lodder, William Gorrie.

A list of donations to the Library and Museum was read by the Secretary.

Owing to the advanced period of the evening it was decided to postpone the reading of a paper on the Defence of Auckland Harbour, by Dr. Stratford.

1. Note accompanying a Tomahawk formerly belonging to the Cannibal Chief Taraia, presented to the Museum by Dr. J. L. Campbell.

This tomahawk was given by Taraia to the writer, who says concerning it: "You have it even as he untwisted it from his wrist. The flax leaf, then green, has dried in more than a score years, during which it was buried in one of the drawers of my office table. You have his autograph on the handle carved by himself."

2. "Notes on a Thermal Spring near Helensville, Kaipara," by Robert Mair. In the winter of 1864, accompanied by a friend, the writer visited a thermal spring near Helensville, Kaipara. He made no notes at the time, but gives the following details from memory:—

At the head of the Kaipara Estuary there is an extensive plain, bounded on the south-western side by sand-hills about 500 feet in height, and on the north-eastern side by the winding Kaipara River; a great portion of it is extremely low and swampy; the vegetation consisting principally of tea-tree scrub (*Leptospermum scoparium*) and *Phormium tenax*. The land is good, but near the river bank is under water during unusually high tides; and at one time the whole of this plain was probably beneath the waters of the Kaipara Estuary.

The spring is situated on this plain about a quarter of a mile from the western bank of the river, and two miles below Helensville; in the centre of a small swampy watercourse, we found it issuing from a hole a foot in diameter. Though a current of cold surface water mingled with it, the temperature was 120 degrees. Little clouds of vapour rose from the spring, the water of which was perfectly clear, and had a slight inky taste.

During the following summer several persons from Mr. McLeod's station at Helensville visited the spring, and on their return reported that the water in it was quite cold. Unfortunately I was unable to test the accuracy of this statement by another visit, but nevertheless believe it to be a fact, as the locality of the spring was well known to those who visited it on this occasion.

Mr. Kirk stated his impression that the spring was intermittent.

Dr. J. R. Nicholson stated that he had visited the spring, and was acquainted with persons who had been there frequently, but he had never heard any statement supporting Mr. Kirk's view of the case.

3. "On the New Zealand Species of *Pittosporum*, with Descriptions of New Species," by T. Kirk, F.L.S. (See *Transactions*, p. 260.) The author gives a summary of our knowledge of the New Zealand species of this genus, especially with regard to their distribution, and describes several new species collected in the North Island.

Sixth Meeting. *7th November*, 1871.

The Rev. A. G. Purchas, M.D., in the chair.

New members.—G. S. Kissling, S. Thorne, R. Hobbs, S. Rapsin, W. Earl.

The monthly list of donations to the Library and Museum was read by the Secretary.

The Chairman alluded in feeling terms to the loss the Society had sustained since its last meeting in the decease of Mr. S. J. Stratford, M.R.C.S.E., and to the ardent interest he had uniformly manifested in its success.

The Secretary detailed the measures that had been taken to carry out the resolutions passed at the last monthly meeting. A fair measure of success had been experienced in canvassing for subscriptions, although, owing to the absence from Auckland of several members of the Building Fund Committee, it had not been possible to get through this necessary work so fast as was desirable. The late Dr. Stratford had confirmed his verbal offer of a donation of £100, reported at the last meeting, by special bequest, on condition that four other sums of £100 each, or eight of £50 each, should be contributed to the fund by members of the Society within three months of the date of his decease. Five donations of £50 each had been already promised towards complying with these conditions. Application had also been made to the Provincial Executive to place the sum of £1,000 on the provincial estimates for the coming session in aid of the fund, on condition that at least an equivalent sum should be raised by private subscriptions, and he was happy to state that the application had met with a ready and genial assent.

1. "On the Defence of Auckland Harbour," by S. J. Stratford, M.R.C.S.E. The chief object of this elaborate paper was to point out the great facilities for the defence of the harbour afforded by the volcanic cones of Mount Victoria, North Head, Rangitoto, and Brown Island. It was copiously illustrated by an extensive series of plans and sections, and excited considerable discussion, the general opinion expressed being that the series of forts would prove far too costly for the resources of the colony in its present condition, notwithstanding the large amount that might be realised by the sale of Fort Britomart and the Albert Barracks, which the author proposed to make available for this purpose.

2. "On the Habit of the Rata (*Metrosideros robusta*)," by T. Kirk, F.L.S. (See *Transactions*, p. 267.) The author pointed out the fallacy of the common opinion that the Rata was a climber which ultimately strangled the tree which formed its support, and showed that it was at first an epiphyte which sent roots down to the soil; these roots ultimately formed stems or trunks, often of large dimensions, the supporting tree being usually destroyed.

Considerable discussion ensued, which resulted in the general adoption of the view expressed by the author.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. 1*st March*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New members.—Mr. Robison, Captain Clogstoun.

The balance-sheet for the past year was read and adopted. It showed that the total receipts to 29th October, 1870, were £207 19s. 6d., and the expenditure for the year £190 16s. 3d., leaving a balance in hand of £17 3s. 3d.

Some discussion took place in reference to a collection of grasses laid on the table by Mr. Armstrong, and it was decided "That the President, Mr. Armstrong, and Mr. Wilkie, the chairman of the Grass Committee, should form a committee to take into consideration the best mode of displaying them in the Museum for the instruction of the public, to report at the next general meeting."

Several presentations of works to the Society were laid on the table.

Dr. Powell moved that the words "which members shall be thereupon considered elected," shall be added at the conclusion of Rule XII, as it now stands.

Mr. Davie seconded the motion.

After much discussion it was pointed out that by Rule XLII no alteration of any existing law shall be made, except at the annual meeting in November, or at a special general meeting summoned for that purpose. It was finally decided, on the motion of Dr. Turnbull, seconded by Mr. George Hall, "that the Council be requested to take into consideration the propriety of amending Rule XII."

The President then read his inaugural address entitled, "On Moas and Moa Hunters." (See *Transactions*, p. 66.) At the conclusion of the address discussion ensued.

Mr. Davie was of opinion that the author had not by any means clearly established that the Moa-hunters were a distinct race from the Maoris. He thought that the fact of the extreme rarity of implements betraying any degree of finish in the kitchen-middens of the Moa-hunters might be accounted for by the abundance of material at hand, the implements being roughly chipped, and thrown aside when done with; whereas those of a rarer material, on which time and pains had been bestowed, would be treasured and carried about.

The Rev. Mr. Fraser spoke in favour of the theory of two races, but pointed out that the Maoris might have been identical with the Moa-hunters. There was no doubt that in Europe the Palæolithic and Neolithic races co-existed.

Mr. Boys said he had seen quantities of Moa bones lying on the surface of the ground on the Waipara Plains.

Mr. Hart, on the other hand, stated that in cutting a mill-race in the Riwaka Valley, Nelson, a ship's copper bolt was found four feet below the surface, and at a distance of seven miles from the sea.

The Rev. Mr. Stack stated in reference to the good preservation of Moa bones lying on the surface of the ground, that the Maoris took great care to protect the plains from fire on account of there being their rat-hunting grounds, and he thought that the accumulation of decayed grass would cover and protect the bones from atmospheric influences. Also that Moa is the name given by the natives of the Friendly Islands to birds generally, and that the Cassowary is found in the Samoan group, so that the natives in their few traditions of the Moa might be investing the bones of this bird with the plumage and attributes of the Cassowary. He said that there were still living intelligent old Maoris, learned in traditions reaching back to their immigration. In one tradition of a fight with a Taniwha, they very accurately describe a crocodile or alligator. This tale they must have brought with them, and it is therefore highly improbable that they should have lost all traditions of the Moas, supposing that their ancestors were acquainted with them.

Dr. Haast replied in support of the theories advanced in his paper.

Second Meeting. *5th April,* 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

His Excellency Sir G. F. Bowen, G.C.M.G., President of the New Zealand Institute, was present.

New members.—Mr. Kennaway, F. Strouts.

Presentations of books were laid on the table.

1. The Chairman of the Grass Committee brought up a report. (See *Transactions*, p. 292.)

2. "An Inquiry into the Influence of Railway Gauge upon the Constructive Cost and Working Expenses of Railway," by E. Dobson, Assoc. Inst. C.E. (*Printed and circulated separately.*)

Some slight discussion took place, in the course of which His Excellency the Governor remarked that the narrow gauge had not realised all that was expected of it in Australia, but thought that the adoption of the narrow gauge being at that time novel, and in some degree experimental, it would not be fair to draw conclusions from the results obtained there.

3. "Additional Notes on Moas and Moa-hunters," by Julius Haast, Ph.D., F.R.S. (See *Transactions*, p. 90.)

4. "Some Observations on the Annual Address of the President of the Philosophical Institute, delivered 1st March, 1871," by the Rev. J. W. Stack. (See *Transactions*, p. 107.)

5. Dr. Powell drew attention to some remarks by Mr. Sclater, quoted in one of the morning papers, casting doubt on the existence of a distinct species of rat in New Zealand, and suggesting that the so-called Kiore was merely the common brown rat (*Mus decumanus*).

A discussion ensued, in the course of which some of the older colonists present expressed opinions in favour of the existence of the Kiore as a distinct species, but much doubt seemed to hang over the question.

6. "On a New Species of Rail (*Rallus pictus*), Painted Rail," by T. H. Potts. (See *Transactions*, p. 202.)

7. The President exhibited a specimen of *Hatteria punctata*, the large lizard of the North Island.

Third Meeting. *3rd May*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

1. "Notes on *Harpagornis moorei*, an Extinct Gigantic Bird of Prey; containing Description of Femur, Ungual Phalanges, and Rib," by Julius Haast, Ph.D., F.R.S. (See *Transactions*, p. 192.)

2. "On a New Species of Gull, *Larus* (*Bruchigavia*) *bulleri*, Potts," by T. H. Potts. (See *Transactions*, p. 203.)

3. Dr. Powell exhibited the circulation of the protoplasm in the cells of *Nitella hookeri* under the microscope.

The President informed the members that the Honorary Secretary had received instructions to call a special meeting of the members of the Institute to consider the advisability of reducing the subscription.

Fourth (Special) Meeting. *7th June*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

Mr. Fereday proposed, and Mr. Inglis seconded, "That the subscription be reduced to one guinea."

Mr. Fraser moved, as an amendment, "That from this date the subscription to the Society be—for the first year of membership two guineas, and for every subsequent year one guinea."

The amendment was seconded by Dr. Powell.

Mr. Fereday, by permission, withdrew his original motion in favour of the amendment.

Dr. Turnbull moved, as an amendment, "That the subscription continue two guineas as heretofore, but that the Council be directed to expend one pound of the subscription in purchasing an annual ticket of membership of the Literary Institute for each member."

Mr. Enys seconded the amendment *pro formâ*.

Amendment put and negatived.

The Rev. C. Fraser's amendment was then put as a substantive motion, and carried.

It was proposed "That the life subscription be reduced from twenty to ten guineas," and carried.

The ordinary business was then proceeded with.

New members.—Shirbrooke Walker, Norman Planta Thompson, and Mr. Broadfoot.

A minute of the Council was read, recommending that John Matthews, M.D., of 4, Mylen Street, London, be proposed as an honorary member of the Society.

Fifth Meeting. *5th July*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New members.—William Mills, John Matthews, M.D., London (honorary).

1. The President exhibited models of eggs of the Moa which had been presented to the Museum by Dr. Hector.

2. Proposed by Mr. R. W. Fereday, seconded by Mr. Inglis, "That the following gentlemen be appointed a committee for carrying into effect the resolution passed at the general meeting held on the 7th June last, for collecting and reporting upon the Soils of the province :—Messrs. H. R. Webb, J. D. Enys, J. F. Armstrong, G. Hall, Dr. Haast, Andrew Duncan, R. Wilkin, and the mover." Carried.

Sixth Meeting. *2nd August*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—Mr. Stuckey.

1. "Notes on a New Species of *Apteryx* (*A. haastii*, Potts)," by T. H. Potts. (See *Transactions*, p. 204.)

2. "Notes Respecting the Discovery of the Egg of the Moa in the Kaikoura Peninsula," by J. D. Enys.

(ABSTRACT.)

Having seen in the "Wellington Independent" of 8th July, 1871, that, at a recent meeting of the Wellington Philosophical Society, Dr. Hector stated that the Moa egg found at the Kaikoura Peninsula, and bought by the trustees of the British Museum from Mr. Fyfe, was found in alluvial soil when digging a well, and not in connection with any human remains,* I have put on paper the few notes which I shall now read. Dr. Hector makes this statement on the authority of Mr. Buchanan, who affirms that Mr. Fyfe had given him information to that effect. As I was the person from whom Dr. Haast obtained the information, as given in an appendix to his paper on Moas and Moa-hunters, I beg to state that being on a visit to the Kaikouras at the latter end of 1861 I was shown by Mr. Fyfe the Moa egg, together with a human skull and a black stone adze, which he kept in a box together, as having been found together when digging the foundations for the store close to his house. Mr. Fyfe observed at the same time that he had only preserved the skull of the skeleton with which the egg was found, and that the Maoris had no traditions whatever of a burial place in that locality, although one of their pahs is situated about a mile from the spot. Concerning the rumour which was published in the "Lyttelton Times," when the egg was sent home, that the skeleton in question was found in a sitting posture, I have no recollection of Mr. Fyfe's mentioning the subject to me. I had some trouble in pursuading Mr. Fyfe to separate the egg from the heavy stone implement, as I feared that the egg would be damaged by it. He would not separate the skull, as he did not wish to disassociate the things which were found together. Since writing these notes I have asked Mr. John Innes, who was living at a station in the neighbourhood at the time the egg was found, if he remembered the circumstances under which it was discovered. He entirely confirms the correctness of the account I have given, and adds that the egg was found, as far as he remembers, in the early part of the year 1860, or end of 1859.

SEVENTH MEETING. *6th September*, 1871.

Rev. C. Fraser, Vice-President, in the chair.

1. The Chairman read some remarks on the proposed revival of the Colonists' Society, suggesting its incorporation with the Philosophical Institute.

Dr. Powell exhibited a New Method of Sub-stage Illumination for the Microscope, invented by Mr. John Matthews, of London.

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* See p. 363, *ante*.

Eighth Meeting. 4*th October*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—J. A. Bird.

The Rev. James Wilson proposed, "That Messrs. Palmer and Wilkin act as Auditors." Seconded by Dr. Barker, and carried.

Valuable presents of books were laid on the table, from Mr. George Hart, Dr. Powell, and the Director of the Colonial Museum.

1. The President exhibited a collection of British *Algæ*, very nearly complete, presented to the Museum by Dr. Gray, of the British Museum.

2. "On some New Species of New Zealand Plants," by J. F. Armstrong. (See *Transactions*, p. 224.)

3. "On the Naturalized Plants of the Province of Canterbury," by J. F. Armstrong. (See *Transactions*, p. 284.)

Ninth Meeting. 11*th October*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

1. "Continued Creation *versus* Darwinian Evolution," by Dr. A. C. Barker.

An animated discussion ensued, in which Dr. Haast, the Rev. James Wilson, the Rev. C. Fraser, Dr. Turnbull, and Dr. Powell took part, all being more or less opposed to the principles enunciated in Dr. Barker's paper.

Tenth Meeting. 18*th October*, 1878.

Julius Haast, Ph.D., F.R.S., President, in the chair.

Presentations of books were laid on the table.

1. Dr. Haast read a communication on the latest results of Deep Sea Dredging in the Atlantic and Mediterranean, undertaken by Professor Carpenter and Professor Gwynn Jeffreys.

2. "Observations on a Paper read by Mr. A. Bathgate before the Otago Institute, 11th January, 1870,* 'On the *Lepidoptera* of Otago,'" by R. W. Fereday, Corresponding Member of the Entomological Society of London. (See *Transactions*, p. 214.)

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* See *Trans.* N.Z. Inst., Vol. III., p. 137.

SPECIAL MEETING. 30*th October*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

The Honorary Secretary read clause 7 of the Act to establish the New Zealand Institute, regarding the election of nominees to the Board of Governors of the Institute.

On the motion of Dr. Coward, seconded by Mr. George Hall, His Honour W. S. Rolleston was unanimously elected.

ANNUAL GENERAL MEETING. 1*st November*, 1871.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New members.—Mr. Dymock, Colonel Ballard.

The nomination for the election of Honorary Members of the New Zealand Institute was made, in accordance with Statute IV.

The following report was read by the Secretary and adopted :—

ANNUAL REPORT.

The Council, in submitting their report for 1871, congratulate the Institute on the fact that a society, having for its prime object the pursuit of science, has received at the hands of the public so large a measure of support.

Seven new members have joined the Institute during the session.

The Society, in keeping up the subscription, has had a definite object in view, viz., the providing a library of scientific works, chiefly of reference, and the nucleus of such a library having now been formed, the time has arrived when the subscription may be safely lowered in uniformity with the other societies affiliated to the New Zealand Institute.

By resolution of the subscribers at a special meeting, held 7th June, it was decided that in future the annual subscription be reduced to one guinea, except for the first year, the first subscription being two guineas, as heretofore.

In conformity with this reduction, the life payment has also been reduced from £20 to £10.

The amount of work done by the Institute during the past year, and papers read, though of considerable value and interest, have not been so large and numerous as might have been expected ; and the Council would point out how desirable it is that members should exert themselves to infuse life into the Institute by recording observations, or, at least, by giving regular attendance at the general meetings and taking part in the discussions.

Twelve papers have been read during the session.

The Committee appointed to report on Native and Introduced Grasses have sent in a voluminous report. (See *Transactions*, p. 292.)

Numerous gifts of books have been received during the year.

Since the Council submitted their last report £82 8s. 1d. has been expended in the purchase of scientific books.

A Library Committee has been appointed to arrange for the issue of books and periodicals, and they hope that very shortly the books may be accessible to the members.

The Council beg to point out that donations of works of reference will be gratefully received, as it would confer a great benefit on the community that books of occasional reference should be generally accessible instead of being shut up in private libraries.

A further sum of £20 has been sent home to Mr. Nottidge for a Microscope, making altogether £40, and the Council hope that the Institute will shortly be in possession of a first-class instrument.

Five pounds have been voted for the purchase of a Marine Aquarium of the best construction for the Institute. £54 19s. has been handed over to the Trustees of the local Museum in accordance with Rule III., section 1, of the rules of the New Zealand Institute.

Arrangements have been made for the additional comfort of the members on the evenings of meeting.

The receipts for the year ending 30th November, 1871, amount to £188 6s. 3d., and the expenditure to £159 8s. 2d., leaving a balance in hand of £28 18s. 1d.

The Honorary Secretary stated that the Council recommended the alteration of Rule VIII., so that it might be possible to substitute a conversazione for the annual dinner.

It was moved by Mr. Fraser, "That the words 'or conversazione' be added after the word 'dinner' in Rule VIII.;" seconded by Dr. Coward, and carried after some discussion.

A number of presents were laid on the table.

Election of Officers for 1872: *President*—His Honour Mr. Justice Gresson; *Vice-Presidents*—W. B. Bray, R. W. Fereday; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—Dr. Powell; *Council*—Julius Haast, Ph.D., F.R.S., Rev. Canon Wilson, and George Hall, *vice* W. B. Bray, R. W. Fereday, and W. Rolleston, retired.

Adjourned Meeting. *20th December*, 1871.

His Honour Mr. Justice Gresson, President, in the chair.

The President, on taking the chair, said a few words in acknowledgment of his election to the office.

1. Dr. Haast then read a further paper on Moas and Moa-hunters, being the third communication on the subject. (See *Transactions*, p. 94.) Some discussion took place.

2. Dr. Haast also exhibited some casts of Foot-prints of the Moa presented by the Director of the Colonial Museum, and said that he hoped to have been able to show the members some of the original foot-prints, Mr. Munday, late of Christchurch, having forwarded a specimen to the Canterbury Museum, but it had, unfortunately, not yet come to hand.

3. Dr. Barker read a second communication on "Continuous Creation *versus* Darwinian Evolution."

A discussion ensued, in which several members took part.

4. Mr Fereday read a paper "On a Simple Method of Supplying Water to the Christchurch Fire Engines."

Mr. Bray said that a great objection to Mr. Fereday's plan was the risk of leakage.

OTAGO INSTITUTE.

First Meeting. 21*st February*, 1871.

J. S. Webb, Vice-President, in the chair.

New members.—Dr. Hammond, Johannes Graff, James Wilson.

1. "Description of a Simple Contrivance for Economising the Current of Large Rivers for Gold-sluicing, Town Supplies, and Mill-power," by J. T. Thomson, F.R.G.S. (See *Transactions*, p. 141.) The author exhibited a model of his proposed method, and explained the principles of its working. A few days afterwards this model was tried at the Water of Leith in the presence of several members of the Institute, and it worked satisfactorily.

2. "Notes on Captain Hutton's paper on Sinking Funds," by J. S. Webb and R. Wilding. (See *Trans.* N. Z. Inst., Vol II., p. 236, and Vol. III., p. 325.)

3. "Notes on the Botany of Otago," by John Buchanan, of the New Zealand Geological Survey, were then read by Mr. Webb.

A piece of schist, with veins of quartz running through it, from Tuapeka, and two large lumps of antimony ore, estimated to contain over 70 per cent. of metal, were laid on the table.

Second Meeting. 18*th April*, 1871.

The Rev. D. M. Stuart, in the chair.

New members.—Dr. Deck, W. H. Baker.

1. "A Rock Pool and its Contents," by Peter Thomson. (See *Transactions*, p. 219.)

A conversational discussion took place, and it was agreed that it would be better to allow the establishment of a Field Naturalists' Society to remain in abeyance until the spring. Mr. Thomson promised to obtain rules of a cognate Society, at Elie, Scotland, and other information on the subject.

THIRD MEETING. 17*th July*, 1871.

J. S. Webb, Vice-President in the chair.

New members.—Professor Sale, John Douglas, Henry Tewsley, George Miller, A. F. Oswin.

The Chairman said that it had only dawned upon him late in the afternoon that he would have to occupy the chair that evening, and therefore the few remarks he should presently have to offer had been very hurriedly prepared. It had been arranged that Mr. J. T. Thomson should preside that evening, but that gentleman was at present engaged every night in astronomical observations in connection with an observatory at the Hutt, Wellington, with which his own observatory had been connected by telegraph, and as explained in a note which he held in his hand, his presence there to-night would interrupt a work in which many persons were engaged.

The Honorary Secretary read the Annual Report, of which the following is an abstract:—

In presenting the second annual report of the Otago branch of the New Zealand Institute, the Council has much pleasure in congratulating the members upon the advance made during the past year. The number of members is now 124, showing an increase upon the proceeding year of 44. The receipts from subscriptions amount to £112 7s., and £90 9s. have been transferred to the Library Fund. During the year four Council, and eight ordinary meetings of the Institute have been held, at the latter of which several papers of importance and interest have been read. The first important instalment of our Library arrived safely from home a few days ago, and consists of many valuable works of reference. Mr. Justice Chapman has presented a few works, principally on science.

The Chairman then gave the following

ADDRESS.

Those who by former experience have become acquainted with the difficulties with which associations such as ours have to contend—how quickly the interest at first taken in them by their members abates—how little they usually accomplish of the career sketched out for them by their founders—how often a struggling existence is followed by a premature dissolution—will be ready to agree with me that the success of the Otago Institute is a proper excuse for self-congratulation on the part of those who took an active interest in its formation. If we measure what we have accomplished by what might have been done by the same men in the same space of time, there is not room for boasting; but how few are the human institutions which are not examples of the same shortcoming! That is not the proper standard by which to measure our results. Let us rather remember how little many of us ventured to hope for, and contrast it with a success which we did not two years ago venture to expect. I, for one, at any rate, can say that the number and pleasant character of our meetings, the quality of the papers which have been contributed, and the constant accession of new members which the Institute has enjoyed, are all matters in which I have suffered a pleasing disappointment. We may, I think, assure ourselves now that the premature collapse which some sceptical critics predicted for our association is not in store for us. This fortunate fact must confirm us now in the judgment which led us at the outset to give to the Institute as wide a range as possible, and to open our meetings for contributions from students in every field of human culture. The varied character of the papers which have been read before us have sustained the interest in our proceedings, and I sincerely hope that this variety will always be available to us. On an occasion like this it is not possible to omit a reference to the fact that another great instrument of culture has just been brought into active existence amongst us. I do so the more readily because what it occurs to me to say on the subject leads up directly to remarks I have to make on a subject which I have much at heart. We shall, I trust, share in the advantages which must flow from the establishment of the University of Otago. Its professors and its students will, I have no doubt, make their mark in our history. Already one object of our solicitude appears likely to find in the University that faithful guardian which it has so long stood in need of. I allude to the Provincial Museum, which, if common report may be credited, is to share the fortunate destiny of the building in which it has been deposited. I trust that amongst the students at our University there will in future years be always found at least a few ardent naturalists who will take a pride in assisting to render more complete a collection which has been so nobly begun. As yet our Society has done very little for the Museum. Some of the reasons for this I need not here allude to. If the arrangement I have just spoken of is, in fact, to be made, there is an end to that state of things which made those who were both able and willing to add to the provincial collections hesitate about expending their time and labour in that direction. But, irrespective of the causes of inactivity to which I allude, I have to confess that the Institute has up to the present time disappointed me in the work it has been able to do for the cause of Natural History. It has found but few naturalists to join its ranks, and has done little to bring even these into that close communication which is so helpful to students in any department of knowledge, and which to the naturalist is all but indispensable. When the Society was formed, I confess that I looked to its becoming chiefly a Naturalists' Club. It leaped at once to something of a far higher character, and in that expansion what I had presumed would be its distinctive feature appears to have fallen altogether into the background. A proposal to establish some measure of sectional working, which was discussed by your Council, was set aside as premature, and events have shown that the course then taken was prudent. To be successful, such arrangements should be preceded by a feeling that they are wanted. I am heartily glad that at length such a feeling has arisen amongst those members of the Institute whose delight is in Natural History. The projected Field Club will, I hope, be formed at once, and there can be no doubt that good fruit will follow. This is not the proper opportunity to urge the claims of Natural History. It is recognised that one of the functions of this Society is to foster the study of Nature in all its forms, and I make no doubt but that it will assist the proposed Field Club in a liberal manner. In return the naturalists amongst us will, I am sure, enable the Institute to deal liberally with the Museum. I look forward to large additions to the botanical and geological departments of the Museum as an immediate result of the association of working naturalists, and make no doubt that a respectable contribution to the transactions of the Society will also be forthcoming. One branch of Natural History ought to be excepted from the remark I made as to the little attention paid to it by the Institute. Almost every one of our members takes a deep interest in geological studies, and all are hoping that our meetings will provide the means whereby a better acquaintance with the geology of the land we live in will become available to us. Dr. Hector has told us that the proper embodiment of the results of a geological survey is a map. The beautiful maps which enrich the Museum embody for us the results of long and arduous research. But it is only those who have more leisure and more special knowledge than, I suppose, most of us possess, who can gather from such a record all that it is fitted to teach. I desire to appeal to those members of the Institute who have had opportunities of acquainting themselves with the physical geography and geology of this province to unlock these maps for us. No task could be undertaken which would meet with more grateful recognition, both on the part of their fellow members and the general public. No papers could be presented to us which would interest a wider circle—none which could be more worthy of preservation in the annual volume of our *Transactions.* Even slight sketches like that of the geology of the North Island by Mr. Crawford, which is to be found in the first volume of the *Transactions,* would be both interesting and useful. But something of greater detail would be even more acceptable, and no one need fear to find himself tedious, however minute his exposition of particular features of the country may be. I know that some of our members who live in the interior could assist in this work by explaining for us the special features of the localities with which they are acquainted. I hope they will not forget us, although they cannot join in our meetings. The work of this Society will not be finished until a full description of Nature in all the aspects she presents to us in Otago has found its way into our *Transactions*; and it is only by the concurrent work of many that this can be accomplished. I shall ask a gentleman whom you all know by name, and whom I have the pleasure of seeing present to-night, to tell you what he kindly told me this afternoon of the interesting work in connection with the zoology of this colony which the Director of the New Zealand Institute has in hand. The investigations we can make in Otago will help forward this work, whilst it will in return provide a basis from which we can start in future researches.

Captain Hutton, at the request of the Chairman, then addressed the members of the Society. He said that the Geological and Museum Department was taking steps to bring out a descriptive catalogue of New Zealand birds at once, which he hoped would soon be followed by catalogues of the mammals and fishes. The Rev. Mr. Cambridge had undertaken to work up the spiders, and Mr. Pascoe, of London, the beetles, and he hoped that others would soon be found to take up the other orders, and that before long they would be able to bring out a New Zealand fauna to match the flora of Dr. Hooker. He then proceeded to make a few remarks on the birds in the Otago Museum. He said that this collection possessed an especial value, as it had been catalogued for the New Zealand Exhibition. The collection was a very good one of the birds of the South Island, and it possessed four species that had not yet been named as New Zealand birds—viz., a sandpiper, of the genus *Tringa*; a gull (*Larus jamesoni*), and two petrels, *Puffinus amaurosoma*, or the Mutton Bird, and *Puffinus opisthomelas*. These two birds he had been able to identify with *Procellaria tristis* and *Procellaria gavia* of Forster, thus settling two points which had long puzzled ornithologists. The collection also possessed four birds not yet represented in other museums—viz., *Lestris catarractes*, *Eudyptes antipodes*, *Thalassidroma marina*, and a swallow shot at Nelson. He had also been able, by going over the collection, to strike out from the catalogue four birds whose sole claim to belong to New Zealand rested on that catalogue—viz., *Thinornis rossii*, *Nesonetta aucklandica*, *Procellaria æquinoctialis*, and *Graculus stictocephalus*. The Museum also possessed the eggs of the Brown Linnet, only one nest of which had previously been found.

In order to carry into effect a recommendation contained in the annual report, it was resolved that the words quoted be added to Rule III. of the Society, which then stood as follows :—"From and after the 1st September, 1869, any person desirous of joining the Society may be elected by ballot, by being proposed, in writing, at any meeting of the Council or Society, by two members, on payment of the annual subscription for the year then current."

Election of Officers for Year ending 30th June, 1872: *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—R. Gillies, T. Hocken, M.R.C.S.E.; *Council*—W. N. Blair, E. B. Cargill, S. Hawthorne, M.A., J. McKerrow, G. S. Sale, M.A., J. T. Thomson, F.R.G.S., P. Thomson; *Honorary Secretary*—D. Brent; *Honorary Treasurer*—J. S. Webb.

Fourth Meeting. 16*th September*, 1871.

T. M. Hocken, M.R.C.S.E., Vice-President, in the chair.

This was the first meeting of the Society held in the Otago Museum. The objects necessary to illustrate the papers to be read had been gathered into the Botanical Room, which being large, and containing no table cases, is well adapted for the purpose of meetings.

New members.—Mrs. Burn, Professor Shand, D. Ross, Mr. Jennings.

1. "On Recent Moa Remains in New Zealand," by James Hector, M.D., F.R.S. (See *Transactions*, p. 110.)

Mr. J. S. Webb explained that this paper had been held back with the view of getting additional information from a late discovery of Moa remains in Otago, which, however, had not yet been obtained; also, that some of the matter contained in it had already been forwarded to a scientific periodical, but that none of it had been read before any scientific society.

2. "Notes on Moa Remains," by W. D. Murison. (See *Transactions*, p. 120.)

Mr. Gillies mentioned, as a proof that the Moa had survived in this island till a comparatively recent period, that old whalers, here in the early days of the settlement, used to say that they had seen dogs gnawing the bones of the Moa. The absence of traditions among the Maoris here on this subject could be accounted for by the fact that those who lived here were slaves, were not descended from the old inhabitants, and knew little or nothing of the country.

Mr. Alexander Bathgate said that he was at Clyde soon after the Moa neck, referred to by Dr. Hector, had been found. Dr. Thomson had shown it to him, and also a pelvis and sternum, found in the same place as the neck. From what he could judge as to the size of the bird of which these bones had formed part, and from the information given by the miner who found the pelvis as to the height, from the floor of the cave, of the lower surface of the rock under which he had found it, and under which the other bones had also been found, he concluded that such a bird could not have got under the rock easily. It must have either crawled in, or perhaps the rock might have afterwards fallen upon it. The miner who found the Moa neck chanced to do so while searching for guano, which was found in considerable quantities in caves and hollows of rocks in the Dunstan District. This guano was also found on the Old Man Range; and at the Leaning Rock, and was used by the people of Bendigo Gully and Cromwell for manuring their gardens. It must have been deposited by some bird. There were now no birds existing there in numbers sufficient or likely to produce such deposits. The guano was pure, and not nearly so strong as Peruvian guano. It is, however, too strong for plants if applied in too great quantities. Some few years ago a letter had appeared in the "Dunstan Times" from a miner, who stated that he had seen some large bird walking, in the dusk of the evening, along the crest of a hill somewhere beyond the Nevis, and that it was going very fast. He mentioned the fact because Dr. Hector had stated the possibility of the Moa having existed at a very recent period in some of the open birch forests on the West Coast. It was also strange that the portion of the neck had been found on the same range on which the writer to the newspaper had said he had seen the bird walking.

The Chairman said, in reference to this, that he remembered the writer had also stated that he had seen the foot-prints of the bird, and described them as those of a large bird, with a hind toe, which the Moa did not possess. If the writer, therefore, meant it to be understood that he had seen a Moa, he was convicted out of his own mouth.

Mr. A. Bathgate said that he was at Mr. Murison's station a day or two after the bones obtained there were found. He inspected the surface of the ground there, and found it covered with small chips of chert and fragments of Moa egg-shells, which were lying exposed. In talking the matter over, he, and the other gentlemen present, at first conjectured that the bones might have been sufficiently green to have been used as fuel, as some were a good deal burnt, a fact which lent a colour to the supposition. But on second consideration they recollected that there were no large bones, such as those of the leg, to be seen in the oven which he saw opened, but only smaller bones. A number of the larger bones were found in a gully about 300 yards away, and from this they concluded that the Moa-hunters had left the legs and other comparatively fleshless parts there, and had only carried the parts they liked best as food to the oven. There must have been a great number of the birds in that district, as on the other side of the Maniototo Plain, distant about eight or ten miles in a direct line, a miner at work in that part told him that every time he washed up he used to get numbers of pieces of egg-shells, some of which he gave him, and the largest of which was fully an inch square. Mr. Bathgate laid on the table some of the tracheal rings of the Moa, which he found in the oven opened at Mr. Murison's station, and some specimens of the egg-shells which he procured from the miner referred to.

3. "Work for Field Naturalists," by P. Thomson. (See *Transactions*, p. 138.) The author's motion for the formation of a Field Naturalists' Society was seconded by Mr. J. S. Webb, and carried.

4. "On a Supposed New Species of Duck,"* by A. C. Purdie. (See *Transactions*, p. 213.)

Mr. Maitland, on or near whose property the bird had been shot, said that it looked very long for its size when in the air; its flight was heavy; it made a peculiar whistling cry; the flock flew in a wedge shape, and always kept close together. One of them had been shot, and they numbered when last seen only ten, but he hoped they would remain in the neighbourhood, as they had done up to the present time, and increase.

In answer to a question, Mr. Maitland said that the birds whistled with their mouths, not with their wings.

A member said that the bird might be the Australian Whistling Duck, as a late number of the "Otago Daily Times" had suggested.

Mr. Purdie said that the bird was not an Australian Whistling Duck, specimens of which he had seen.

Papers by Dr. Hector and Mr. J. S. Webb were held over till a future meeting.

The Chairman had on the table a powerful Microscope, and various interesting microscopic objects.

The books recently acquired for the Library of the Society and various scientific papers were on the table.

Fifth Meeting. 31*st October*, 1871.

His Honour Mr. Justice Chapman, President, in the chair.

New members.—W. A. Young, A. Stuart, H. F. McLean, F. C. Fulton.

It was unanimously resolved that Mr. Justice Chapman be appointed the Member of the Otago Institute to vote in the election of Governors of the New Zealand Institute.

1. "Notes on the Fur Seal of New Zealand, *Arctocephalus cinereus*, Gray (?)," by James Hector, M.D., F.R.S. (See *Transactions*, p. 196.)

2. "On the Fur Seal of New Zealand," by J. S. Webb. (See *Transactions*, p. 199.) After reading this paper Mr. Webb drew attention to a point in the natural history of Seals, which he thought would be of more interest to the meeting than any discussion about mere names or different points in classi-

* Determined by Captain Hutton to be *Dendrocygna eytoni*, Gould, or Whistling Duck of Australia.—Ed.

fication. The specimens of the Fur Seal and the Sterrink which were in the Museum served admirably to show the fact that the development of the organ of hearing and of the limbs of seals are proportional to one another. In the Sterrink, or Sea Leopard, there was no external ear, while in the Fur Seal that organ was quite conspicuous and fairly developed. It would be noted at the same time that the limbs, especially the fore limbs, were much larger in the specimens of the Fur Seal than in the Sterrink, although the latter was by much the larger animal. The same rule was observable throughout all divisions of the family. By the aid of its powerful fore limbs the Fur Seal could raise the greater part of its body above the water, and its power of locomotion on land was very considerable. Thus the fully developed ear went along with the increased capacity and necessity for using the sense of hearing. He regretted that he had been unable to extend his paper so as to fulfil the promise of the title under which it had been announced—"On the Sea Bears of the Southern Hemisphere." He had found it impossible to secure all the evidence required to support some conclusions he had arrived at. He hoped, at some future meeting, to present another paper, in which he would include a sketch of the habits of the Eared Seals. He could offer nothing original on that subject, but there were many points in the natural history of these animals which he was sure would interest his fellow members. One of these was their extraordinary capacity of going without food during the period at which they visited the land for the purpose of breeding. No other known mammals approached them in this respect.

An animated conversation ensued, in which many members took part, during which Mr. R. Gillies said that he would like to mention a circumstance connected with the habits of the Seal, but that it partook so much of the marvellous that he hesitated whether or not he should mention it. He must not be understood as himself believing what he was going to relate, but it could do no harm to tell what he had often heard related as a genuine fact, and it might lead those who had the opportunity of observing the habits of the animal either to confirm the accuracy of the statement or to refute it. Often in such statements there was a groundwork of truth. Anyone who had ever been about old whaling or sealing stations must have seen collections of round smooth stones of various sizes, but mostly about the size of cannon balls, lying on the beach. On asking any of the "old hands" what these are, you will at once be told that they are "seals' ballast," and, on inquiring further, what seals' ballast is, you will be gravely told that the Seal is a migratory animal, and that when it is about to take a long journey it will trim itself exactly to the proper weight for long and easy locomotion through the water. At such times it comes ashore, picks up one of those stones, swallows it, and goes into the water again to try the effect. It dives and swims about, and if it finds it requires more ballast it comes ashore again and repeats the dose. Should it, however, find that it has too much dead weight on board, it has the power of unloading itself, by vomiting one or more stones out upon the beach, till, in fact, after repeated trials, it has trimmed itself to the exact specific gravity necessary for its purpose. Hence these stones are always termed "seals' ballast." The whole story seems so extraordinary as to be altogether too much to swallow, still he had heard it so often amongst old whalers and sealers that he thought there must be some slight foundation for it. He might mention that Moeraki Beach was a place much frequented by the Seal, and they are often caught there; a few days ago, when there, as many as three at one time were seen ashore, and one of them, a very large one, was caught and killed.* The different museums in New Zealand could easily get supplied with specimens from Moeraki by making proper arrangements with anyone resident there.

Mr. Peter Thomson said that Mr. Gillies need not be so sceptical about the habits of the Seal, with reference to the seals' ballast, as he (Mr. Thomson) could of his own knowledge corroborate the accuracy of his statement. He had lived a great deal about old whaling and sealing stations, and had no doubt whatever about the facts related, and the stones—the seals' ballast—could be seen there at any time by any one. He had never seen the animal swallowing or discharging the stones, but he had seen the stones taken out of their inside when being cut up. The only error into which Mr. Gillies had crept, was in supposing that it was when about to take a long journey that the Seal took the ballast on board. The real fact of the case was that at certain seasons the Seal got so fat that it was with difficulty it could dive or swim under water. At these times it came ashore exactly in the way described by Mr. Gillies, and loaded itself with the proper amount of ballast necessary to enable it with facility to pursue its avocations in the briny deep. Whatever was the reason for its taking the ballast on board, he had no doubt whatever of the fact, and felt no hesitation whatever in stating so.

3. The President then read the following notes by Mr. Martin Chapman, "On Sir William Thomson's Hypothesis that the Germ of Life is derived from Meteors":—

I enclose a report of a speech made by Sir William Thomson, President of the British Association, at Edinburgh. I send it on account of the theory there propounded of the advent of organic life on our planet. At first sight it struck me as being, to say the least, attractive; but on further consideration I came to the conclusion that Sir William had not considered the subject very fully. My objections to the theory, or rather hypothesis, are as follows:—

1. Assuming the meteorites which reach the earth to have been planets or

* A Sea Leopard, or a Fur Seal?—Ed.

fragments of planets having organisms, it must be clear that any atmosphere which these little planets might possess must be of a density proportioned to the attraction of the planets themselves, as we know that the density of our atmosphere is due to the weight or gravitation of the atmospheric column, which is in direct proportion to the attractive energy of the earth, and when you diminish the attraction by ascending a high mountain, you find, in about four miles or less, that the density is reduced one-half. Now, as the attraction exercised by a mass, even 100 miles in diameter, would be thousands of times less than that of the earth, even at a distance of four miles from its surface, such a planet would have an atmosphere more rare than the most perfect artificial vacuum capable of being produced by the air pump; and even if such small masses had organisms capable of existence in such a highly attenuated atmosphere, they would be incapable of enduring our atmosphere. But the meteors which reach our earth are to be measured by inches, or at the most by feet, and weighed by pounds. So that their atmospheres (if any) would only be an infinitesimal degree denser than interstellar space. How then can we conceive that any organism capable of living in such an atmosphere could survive when plunged suddenly in our dense atmosphere?

2. These little planets (assuming them to be such) all move in an orbit round the sun, which crosses or approximates to that of the earth; the velocity with which they move (the so-called planetary velocity) is infinitely greater than that of a cannon ball; the necessary result is that the instant they enter our atmosphere, they take fire with such energy that in a few seconds the smaller ones are dissipated into vapour, which, condensing, falls gently to the earth—the so-called cosmical dust, which, I believe, is always to be found in our air; (see "Tyndall on Heat.") It is only the larger ones which reach the earth in a tangible shape, and you know how very rare they are. They are always in a state of intense heat, indeed, of fusion. Now, what chance would any organism (even the mythical salamander) have of surviving such a conflagration?

3. The third objection which I take is, I think, as strong as any. The hypothesis only shirks the question how organic life began, by attempting to conceal it by substituting the question how organic life arrived on this earth. If organic life existed on these little planets (which according to Sir William have once been portions of some larger planet destroyed by a cataclysm) it must have had a beginning somewhere; and if it began on these planets, where, as far as we can see, the conditions of life would be less favourable than here, why should not organic life also begin on our planet? If the Creator created by direct act, why should not that act have been done on this planet, as well as on others? If, on the other hand, the Creator created by establishing laws, by the operation of which life was gradually evolved from matter,

again the question suggests itself, why should such beneficial laws not come into operation on this planet, as well as on others? I should not be surprised if this hypothesis were to generate a considerable amount of controversial writing and discussion before very long. I therefore give you my views at once, without being influenced by those of any others. I only hope that they will not prove tedious to you.

After reading that portion of Sir William Thomson's address which contains the hypothesis criticised, Mr. Webb suggested that though some of Mr. Chapman's remarks would undoubtedly apply to organised beings of even a comparatively low type, it was evident that these were not the forms of life Sir William Thomson had in view. It was impossible to say how little such forms as the globigerinæ of the Atlantic depths might be affected by the conditions existing on a meteoric mass. The fact that many aerolites exhibited but very slight traces of surface vitrification showed that the heat to which they had been subjected could not have been very excessive. He adduced other considerations leading to the same conclusion. Evidently Sir William Thomson, who was a firm supporter of the doctrine that the earth had once been a molten mass, had thought this hypothesis necessary to explain the first appearance of life on our planet after it had cooled down to a habitable condition.

4. "Account of some Presents recently received from the Smithsonian Institution and the Museum of Comparative Zoology of Harvard College," by J. S. Webb.

(ABSTRACT.)

The author stated that this was the first occasion on which a presentation of this sort had been made to the Society by other than private individuals. He then proceeded to give an interesting account of the origin and progress of the Smithsonian Institution and Harvard College, stating that "the most interesting feature to ourselves of the operations of the former institution is the great system of international exchanges which it has inaugurated, and by which we now profit for the first time. These exchanges are not confined to books, and I hope that some day or other we may be able to court an interchange of museum specimens, which will be of great value to those who pursue the study of Natural History.

"In the foregoing account of the two great institutions, to which we are indebted for these presents, the word 'dollars' has been reiterated in a conspicuous manner. I have laid this stress on it purposely, in order to present a forcible contrast to the state of things here. It may be doubted whether this Museum would now be in existence had the New Zealand Exhibition of 1865 not been organised by some enthusiastic spirits amongst us. Virtually, at the end of six years, it still contains nothing more than a part of the collections gathered from various sources for that exhibition. The enthusiasm and the liberality of this community in the cause of science seems to have expended itself in that year. The notable examples of a very different spirit, some of the overflowings from which have reached us in these welcome presents, will, I hope, not be without their effect upon us. This is not the place to suggest what needs to be done, but I desire emphatically to express my conviction that one of the foremost duties of this Society lies in this direction, and that it is high time that some steps were taken to fulfil it.

"Another point which is worthy of attention in connection with the institutions whose politeness to us we are signalizing, is the energetic system of exchanges which both of them maintain. If the Otago Museum were constantly in the receipt of specimens with which it could afford to part, these institutions, and many others, would gladly exchange with it. These exchanges would not necessarily be confined to Natural History specimens. In exchange for properly prepared series illustrating our products and industries similar illustrations of those of other countries could be obtained. As the humour of the day is to talk much about immigration, and to bewail the slow influx of people from other countries, I may suggest that every such exchange would establish a permanent advertisement of the resources of the colony in some populous locality, which would become an inexpensive and useful emigration agent."

Some other presentations were announced, and together with scientific periodicals were on the table for the inspection of members.

Sixth Meeting. 14*th November*, 1871.

R. Gillies, Vice-President, in the chair.

The nomination for the election of Honorary Members of the New Zealand Institute was made in accordance with Statute IV.

1. "On Proportion applied to Geometry," by D. Brent, M.A. The author gives an outline of the treatment of proportion in the fifth book of Euclid, and shows how arithmetic should be applied to geometry, and to magnitude in general. In concluding he states that, "although in favour of the substitution of a chapter of arithmetic applied to magnitude for the now nearly obsolete fifth book of Euclid, he does not, therefore, advocate the introduction of arithmetical or algebraical symbols of quantity into pure geometry—far from it, for in the very absence of these symbols consists its great value for mental training, inasmuch as at every step there is an appeal to the reason. The pure geometry also more clearly exhibits the processes of the demonstration and the relations of the figure than does the younger and far more powerful sister

science analytical geometry, in which, by the use of symbols, the reasoning is carried on independent to a great extent of the ideas of the magnitudes themselves."

2. "Notes upon the Experiments on the so-called Psychic Force recently made by Mr. Crookes,"* by J. S. Webb.

(ABSTRACT.)

In this paper the author said that he would not offer any arguments for or against the theories of professed spiritualism. The subject was one of which, so far as regards its more recent manifestations, he knew nothing. He claimed that Mr. Crookes had not made enough experiments, nor taken sufficient care in them, to establish his deduction that a hitherto unknown natural force had been discovered. He then criticised the experiments in detail, showing, firstly, that no attempt had been made to verify the experiments, or ascertain the "personal error" of the observers; secondly, that the circumstances of the experiments were not accurately remarked, and that they were annoyingly fantastic and wanting in precision; thirdly, with reference to the instrument used in the second experiment, the author states that "the dimensions of the mahogany board used in this case are carefully given by Mr. Crookes, and he informs us that when the apparatus was adjusted before the experiment began, that portion of its weight which affected the spring balance was 3lbs. [Description quoted.] Now, the specific gravity of mahogany, as ordinarily given in the tables, is 1060 (that of water being taken at 1000) and irrespective of that portion of the board which absolutely rested upon the table, we have in this case 342 cubic inches of mahogany suspended, one-half of the weight of which would, if the board were truly horizontal, have rested upon the balance. A cubic foot of water weighs rather more than 997ozs. avoirdupois, hence 342 cubic inches of mahogany, at the specific gravity just stated, weigh rather more than 209ozs., or 13lbs. 1oz. It is strange that a trained man of science should not have noticed this discrepancy. At the very least we might have expected that he would have assured himself of the absence of all suspicious circumstances by weighing the whole board before adjustment, since it was the effect of the so-called Psychic Force upon its apparent weight, which he had set himself to observe. It may be answered that mahoganies vary much in specific gravity, and that a light timber would naturally be chosen for the experiment. The discrepancy appears to me to be far too large to admit of such an explanation. Had the board been of ordinary Scotch pine, the indicator ought to have shown more than 3lbs. 4ozs. pressure on the balance, and even had the common Canadian yellow pine been used it could hardly have shown less than 3lbs. Moreover, it is evident from the context

* For a full report of this paper see "Otago Daily Times," November, 1871. The article by Mr. Crookes referred to appeared in the "Quart. Journ. of Science" for July, 1871.

that the weight of the cord, or whatever else was used to suspend one end of the board from the balance, is included in 3lbs. indicated, although, with that want of precision on which I have already commented, Mr. Crookes omits to tell us so. This makes the matter slightly worse, and I cannot avoid the conclusion that the circumstances under which this experiment was made are highly suspicious."

In conclusion, the author remarked that could as accurate a measure of the mental temperament of the observers be taken as was made of the temperature of the apartment in which the experiments were conducted, we should know better what to think of the affair.

Mr. Brent said that Mr. Crookes had not made himself so sure that no trick was being practised as he ought to have done.

Mr. Stout, in answer to Mr. Webb's objection that sufficient experiments had not been made to verify the conclusions come to, said that Mr. Crookes had stated in his article that his conclusions were not arrived at hastily, or on insufficient evidence, but that space would only allow him to give the details of one trial. If Mr. Crookes was duped, other scientific men of character had likewise been deceived, of whom Professor Varley had made far more decided assertions regarding this new force than Mr. Crookes had ventured on.

Mr. Webb briefly replied to some of Mr. Stout's remarks.

3. Some Fossils from the Caversham tunnel were exhibited by Mr. Blair.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

FIRST MEETING. *4th January*, 1871.

Sir D. Monro, President, in the chair.

New members.—John Avery, J. A. Packer, J. C. Moutray, T. C. Batchelor.

Resolved, that in compliance with the request of His Honour the Superintendent of Auckland, two of the Society's specimens of the rare land snail, *Helix hochstetteri*, be presented to H.R.H. the Duke of Edinburgh.

1. "On a Means of Detecting Incipient Combustion of Flax or Wool in Ships at Sea," by F. W. Irvine. The plan was proposed to be carried out by means of a simple and ingenious application of a galvanic battery and galvanometer.

A discussion ensued on the merits of the invention, and the feasibility of working it in a closely packed ship's hold.

SECOND MEETING. *1st March*, 1871.

Hon. Dr. Renwick in the chair.

New members.—Hon. E. W. Stafford, Alexander Brown.

Several contributions were reported, and some discussion took place as to the purchase of periodicals.

THIRD MEETING. *5th April*, 1871.

F. W. Irvine, M.D., in the chair.

New member.—J. B. Sadd.

Several new books were laid on the table.

1. Mr. Mackay exhibited a Brown Trout (*Salmo fario*) taken out of the Maitai River, which measured 13 inches in length, 11¾ inches in girth, and weighed 3½lbs.

2. "Sketch of the History of Astronomical Science, third paper, 'Newton and his Times'," by R. Lee. The author gave a description of that philosopher's principal inventions, and illustrated his remarks by means of diagrams.

3. The Chairman gave an interesting account of a visit to an ice manufactory in Auckland, with a description of the apparatus employed, and the mode of using it.

FOURTH MEETING. *3rd May*, 1871.

The Bishop of Nelson, Vice-President, in the chair.

The receipt of new books was reported by the Honorary Secretary.

The Chairman presented to the Association some fossil plants from the coal-bearing strata at Pakawau, and a leg-bone of a Moa from the Fairfield Downs, Awatere; a femur of a Moa, from the Slate River Cave near Collingwood, was also presented by Mr. Austin.

1. "On the Varieties of the Mulberry Tree as Food for the Silkworm," (Part I.), by T. C. Batchelor.

(ABSTRACT.)

It is a conceded point, that the food which agrees best with the Silkworm is the leaf either of the red or of the white mulberry tree. The quality, however, of the silk does not altogether depend on the food, but also on the degree of temperature in which the Silkworm has been reared. As there are mulberry trees of different qualities it might be imagined that these differences influence the state of the Silkworm. There are five different substances in the mulberry leaf: 1st, the solid or fibrous substance; 2nd, the colouring matter; 3rd, water; 4th, the saccharine matter; 5th, the resinous. The fibrous substance, the colouring matter, and the water, excepting that which in part composes the body of the Silkworm, cannot be said to be nutritive to it. The saccharine matter is that which nourishes the insect, that enlarges it, and forms its animal substance. The resinous is that which, separating itself gradually from the leaf, and attracted by the animal organisation, accumulates, clears itself, and insensibly fills the two reservoirs, or silk-vessels, which form the productive economy of the Silkworm. According to the different proportions of the elements which compose the leaf, it follows that cases may occur in which a greater weight of leaf may afford less that is useful to the Silkworm, either for its nourishment, or with respect to the quantity of silk it may yield. Thus the leaf of the black mulberry, though hard and tough, which is given to silkworms in some of the warm climates of Europe, produces abundant silk, the thread of which is strong, but coarse. The leaves of the red and white mulberry trees, planted in high lands and in light soils, and exposed to cold dry winds, produce large quantities of strong silk, of the purest and finest qualities. The leaves of the same kinds of trees, planted in damp situations, in low grounds, and in stiff soils, produce less silk, and of a quality less pure and fine.

The less nutritive substance the leaf contains, the more leaves must the Silkworm consume to complete its development. The result must therefore be, that the Silkworm which consumes a large quantity of leaves that are not nutritive must be more fatigued and more liable to disease than the Silkworm that eats a smaller proportion of more nutritive leaves. Notwithstanding all this, experience proves that, all things balanced, the quality of the soil produces but a very slight difference on the quality of the leaf; that which will appear most evident is, that the principal influential cause of the fineness of the silk is the degree of temperature in which the Silkworm is reared. There is another fact to be observed, that an old mulberry tree will always produce better leaves than the young tree, and as the tree grows older, of whatever quality it may be, the leaf diminishes in size, and improves so materially that it attains a very excellent quality.

Mr. Brady, the well-known sericulturist of New South Wales, writes to me that the *Morus multicaulis* is on the whole by far the best tree for its earliness, ready growth, and quantity of leaves. Count Dandolo gives a description of a tree called the Tuscan mulberry, which closely resembles the *Morus multicaulis*, and says that if the leaves are allowed to get matured on the tree, and those only given in the last stages of feeding, the Silkworms answer every purpose required. I received lately from a silk merchant in England specimens and circulars, giving names and descriptions of trees that are used in Europe, viz., *Morus japonica*, a large-leaved tree, Lombardy rose, and *Morus alpina*, suitable for cold and exposed situations. Some plants of *M. multicaulis* that I planted on a steep hill-side two years since have produced a smaller but much thicker leaf. As the growth of mulberry trees and the rearing of silkworms are two different branches of industry, and are often followed apart, there is no reason why this should not be done here, and there are many reasons why it should be the more preferable. In the early stage of the industry it would leave to the cottager the simple task of rearing the trees, which would largely recompense him for his labour. A few statistics will not be out of place here, to show what returns may be expected from growing mulberry trees. Assuming that an acre of land is planted with 400 mulberry trees one year old, at the first but few leaves can be taken, but the second year each tree should produce one shilling's worth of leaves, or at the rate of £20 to the acre, and increasing in value every year.

But it would be a mistake to suppose that the mulberry tree can be raised without cost or labour; at the present moment the cost of planting an acre of ground would be considerable, because the trees are scarce, and cannot be obtained in sufficient numbers; but the cost of trees will diminish yearly, as they can be grown readily from cuttings, so that commencing with a few trees the number can be increased at little cost. The cultivation of the tree requires attention, to grow luxuriantly and stand the waste it is made subject to by being stripped of its leaves. The mulberry tree must be well manured, but the cost of this would not equal that of cultivating crops of grain, while after the two first years the returns from ordinary farming would bear no proportion to those to be obtained from growing mulberry trees.

In a country like this, where land is cheap, and where, from the scantiness of labour so little is made of it, the sacrifice would be nominal were every small holder of land to plant only a few hundred trees on the sides of the hills; and on many spots where land is suffered to lie uncultivated the mulberry tree would thrive well.

In conclusion, I have to express my firm conviction that sericulture may be made one of the most valuable industries this colony can possess; and if I succeed in inducing small holders of land to cultivate mulberry trees, the object for which I have laboured will be attained.

2. "Traces of Ancient Glaciers in the Province of Nelson," by A. D. Dobson. (See *Transactions*, p. 336.)

Some discussion took place, and Mr. T. Mackay said that he could vouch for the accuracy of the author's description of the Mount Arthur and Mount Spencer districts, as he had himself observed the traces of glacial action in both, but he was not prepared to enter into the hypothesis which Mr. Dobson had raised regarding the origin of glaciers in New Zealand.

Fifth Meeting. *7th June*, 1871.

F. W. Irvine, M.D., in the chair.

1. The Chairman read a letter from His Honour the Superintendent, with an inclosure from Dr. Hector, respecting a proposed expedition to Cape York for the purpose of witnessing the total eclipse of the sun on 15th December.

2. "On the Varieties of Food for, and Management of the Silkworm," (Part II.), by T. C. Batchelor.

(abstract.)

The author gives extracts from various recent publications on the subject, to compare with the results of his own experiments, which show:—

(1.) That the leaves of *Morus alba* are inferior in size and quality to those of *M. multicaulis*.

(2.) That the leaves of the latter when grown on hill-sides are thicker and, though smaller, more valuable than those from trees grown on level ground.

(3.) That *Morus alba* grows as freely from cuttings as *M. multicaulis.*

(4.) That the seeds from four successions will produce cocoons of equal quality with the original, therefore disproving any necessity of degeneration—an hypothesis that has been put forth to account for the low price of the silk grown in Australia.

(5.) That he has raised successfully the Lombardy Buff and Japanese cocoons, both of which are highly esteemed.

(6.) That he can successfully delay the hatching so as to produce two broods in the year, the latest commencing in November.

(7.) That the silk he has produced can be wound, and equals in quality that produced elsewhere.

He is of opinion that the *Morus japonica* should be introduced.

In answer to questions, the author explained more fully some portions of his system, and offered to present members of the Association with Silkworm eggs.

Annual General Meeting. 19*th July*, 1871.

The Bishop of Nelson, Vice-President, in the chair.

The report for the past year, being the second annual report, was read and adopted.

(abstract.)

Notwithstanding that the subscription had been doubled, in order to allow of the Association becoming affiliated to the New Zealand Institute, the number of members had increased. One-third of the total amount of subscriptions received was given to a local library and museum (the Nelson Institute), in accordance with the rules of the New Zealand Institute, and the selection of books to be purchased had been placed in the hands of a Joint Committee. Arrangements had also been made that the collections of the Association should be deposited in the Nelson Museum. His Lordship the Bishop of Nelson had been chosen in October last to vote in the election of Governors of the New Zealand Institute. There had been ten meetings since the last annual meeting, and the average attendance of members was fifteen. A nomination for the election of Honorary Members of the New Zealand Institute had been made in accordance with Statute IV.

In conclusion, the Committee urged upon every member the necessity of contributing to the general stock of knowledge, and proposed the establishment of a course of scientific lectures, the funds from which might be made available for the purchase of scientific instruments.

A vote of thanks to the officers for the past year was carried unanimously.

Election of Officers: *President*—Sir D. Monro; *Vice-President*—The Bishop of Nelson; *Treasurer*—J. Holloway; *Secretary and Curator*—T. Mackay; *Council*—R. Lee, J. Shepherd, F. W. Irvine, M.D., Hon. Dr. Renwick, G. Williams.

On the motion of Mr. Lee, seconded by Mr. Hunter-Brown, it was resolved, "That any member may make a requisition in writing to the Secretary for obtaining any scientific publication, or any piece of scientific apparatus, and that such suggestions be considered by the Council at its first sitting."

It was also resolved, "That a book be kept for the purpose of receiving such suggestions as are referred to in the previous resolution," and "That the Council be requested to make arrangements whereby the Association may have a room for its meetings and the reception of its property."

On the motion of Mr. Hunter-Brown, seconded by Mr. Huddlestone, it was resolved, "That a complete copy of the *Transactions* and *Proceedings* for the last year be reserved for the President, Vice-President, and for each member who has supplied a paper or specimen to the Association, and that the remaining copies be supplied one to each member as applied for."

Seventh Meeting. 13*th September*, 1871.

F. W. Irvine, M.D., in the chair.

New member.—W. Davis.

Several new members were proposed for election, and other business was transacted.

Eighth Meeting. 11*th October*, 1871.

The Bishop of Nelson, Vice-President, in the chair.

New members.—A. D. Dobson, C.E., W. B. Sealy, R. P. Bain, T. M. Wright, L. Boor, M.R.C.S.

Dr. Irvine reported that Mr. T. Mackay and himself had waited on the Committee of the Nelson Institute, with whom they had arranged for the use of a room in the building of the Institute for a period of six months, for which a rent of £5 was to be paid, to be expended on books on the same terms and conditions as those on which the Association's contribution of one-third income was carried out.

1. "On the American Blight on Apple Trees," by T. Mackay, C.E.

(ABSTRACT.)

In the spring of the year a slight hoariness is observed upon the branches of many of our apple trees. As the season advances this hoariness increases, and towards the end of the summer the undersides of some of the branches are invested with a thick downy substance, so long as at times to be sensibly agitated by the air. Upon examining this substance, it will be found that it conceals a multitude of small wingless creatures which exude it from their bodies, while at the same time they are busily employed in preying upon the limb of the tree. This they are well enabled to do by means of a long beak, or proboscis, terminating in a fine tubular bristle, which, being insinuated through the bark and the sappy part of the wood, enables the creature to extract, as with a syringe, the sweet vital liquor that circulates in the plant. The sap-wood, being thus wounded, rises up in excrescences all over the branch and deforms it; the limb, deprived of its nutriment, grows sickly; the leaves turn yellow, and the tree perishes. The insect which is productive of so much mischief is a species of the Coccidæ—order *Homoptera*—*Coccus* (or *Pseudo-coccus*) *adonidum*, otherwise the *Aphis lanigera*, or woolly plant louse, popularly called the American Blight. It was first observed in England in 1787, but it is uncertain if it was, as has been supposed, accidentally imported there from America. Some entomologists say it came from France. At all events, there is little doubt its original habitat was a warmer climate than that of Britain. It has, however, found its way hence from the latter country.

The wonderfully rapid development of the *Aphis* has thus been described by a popular writer:—

"It produces in the course of a season *eleven* broods of young. The first ten are viviparous, or brought forth alive, and consist entirely of females. These never attain their full development as perfect insects; but being only in the larval state (the larvæ are active and resemble the perfect insect, but are wingless) bring forth young, and the virgin aphides thus produced are endowed with singular fecundity. But at the tenth brood this power ceases. The eleventh does not consist of active female larvæ alone, but of males and females. These acquire wings, rise into the air, sometimes migrate in countless myriads, and produce eggs, which, glued to twigs and leaf-stalks, retain their vitality through the winter. When the advance of spring again clothes the plants with verdure the eggs are hatched, and the larva, without having to wait for the acquisition of its mature and winged form, as in other insects, forthwith begins to produce a brood as hungry, as insatiable, and as fertile as itself. Supposing that one aphis produced 100 at each brood she would at the tenth brood be the progenitor of one quintillion (1,000,000,000,000,000,000) of descendants."—Paterson, "Science Gossip," 1865.

It will thus be seen what very formidable foes these insignificant-looking little pests are to our orchards, and two questions naturally arise—first, what is the cause of their being so? and, second, where can a thoroughly radical remedy be found against their ravages?

There are some particular kinds of apple trees more attractive to these insects than others. Whether this may be attributed to the particular colour of the bark, a deficiency of lime, the presence or absence of certain juices in the sap, or to over-cultivation or climatic influences creating an abnormal condition of the tree, and consequently rendering it more susceptible to parasitical disease, it is hard to say; but the blight now treated of is evidently more destructive in semi-tropical climates, such as Australia and New Zealand, than in Britain, owing in a great measure to the effect which the frequent hot sunny days succeeded by the cold frosty nights of early spring have upon the circulation of the juices of the tree, unduly stimulating their flow in the day time and abruptly checking their current at night, by which they burst their vessels and become the food of such insects as have been already described, the insects being often mistaken for the cause of the disease, while they are really the effect of it.

That the action of the American Blight, the Scale Blight, and the Cicadæ on our apple trees is to a great extent the effect of the last described condition, there cannot be much doubt.

Assuming, therefore, such an hypothesis to be correct, it is clear that, in place of the various nostrums or specifics—such as the preparations of carbolic acid, corrosive sublimate, kerosene, lime, or sulphur, which are recommended for washing the diseased trees, or the plastering of the infested parts with moistened clay, all of which are very transient in their effects—a non-liable stock to disease should be selected on which to graft any liable species the grower may desire to cultivate. That there are such stocks proof against blight, there are several authorities for stating, and, moreover, there is a member of this Association, Mr. Lightband, senior, living in our midst, who has succsssfully treated the disease by grafting an anti-blight tree, using a species of winter apple, on diseased ones.

In Darwin's book, "Animals and Plants under Domestication," Vol. II., chapter xxi., "On Natural Selection," he says:—

"From some unknown cause the Winter Majetin apple enjoys the great advantage of not being infested by the coccus.

"On the other hand, a particular case has been recorded in which aphides confined themselves to the Winter Nelis pear, and touched no other kind in an extensive orchard. * * Liability to the attacks of parasites is also connected with colour."

Considerable controversy has lately been carried on in the pages of the

"Australasian" on remedies for the American Blight, and much has been said in favour of using stocks of the Majetin apple as a sure prevention of the disease. A Mr. Wade, of Pomona Place, Launceston, Tasmania, in a communication on the subject to the same paper, says:—

"That on his arrival in Tasmania he devoted especial attention to the check and prevention of apple blight, and one of his first ideas was to raise stocks from the seeds of those sorts not affected by blight. He chose the seeds of the Siberian Bitter Sweet, and the result was success far beyond his most sanguine expectations, for barely one per cent. of stocks raised from those seeds were in the least affected by blight, while some alongside, raised from promiscuous seeds, were destroyed by it; and that he has continued the system for several years with the same unvarying success."

Mr. Lightband's operations, above referred to, have been most successful. The juices of the fresh graft after a while permeate the whole of the diseased tree, infusing as it were a new life and fresh vigour into it. The aphides avoid infesting it, the leprous bark exfoliates, and a clean sound bark takes its place; the tree continuing to bear two kinds of fruit—that of its original stock as well as of the anti-blight graft. These, however, will no doubt in time merge their respective types or qualities, the one with the other.

From these circumstances it is not too much to say, there are good grounds for assuming that, in the first place, as a prevention of the disease the selection of an anti-blight stock on which to graft the particular kind of apple desired to be grown, will be the best means of insuring a healthy fruit-bearing tree; and in the second, as a cure for trees already affected with the blight, the inoculation process of Mr. Lightband is the most rational plan that can be adopted.

It is not the apple tree alone, however, that such parasites persecute. The pear, the peach, the apricot, and the nectarine, as well as the smaller fruits, also the grape vine and the hop plant, are all, more or less, infested by a species of one or other of them; and those who desire to derive both pleasure and profit from their fruit-gardens or hop-grounds, should not fail to seek for and apply proper remedies in good time.

In conclusion, it may not be out of place to advance a few words on the bearing which the theory of *natural selection, or the survival of the fittest,* has upon the subject now under consideration. It is obvious that without an operating cause—one, doubtless, amongst many, such as the parasitical influence of aphides on fruit trees in enforcing, as regards the latter, the necessary process of renewal by stimulating horticulturists to adopt improved methods of cultivation, as well as, instinctively as it were, to select such stocks as will prove the fittest against the destructiveness of these pests—with little exception, many fruit-bearing trees would be left untended, and, as a natural consequence, would inevitably degenerate, and eventually dwindle away. In this will be recognized one, perhaps, of the many purposes designed for these tiny insects by that Providence who hath numbered the very hairs of our heads, and without whose knowledge a sparrow doth not even fall to the ground.

The Vice-President having placed his microscope at the service of the meeting, the author was enabled to illustrate very clearly the peculiar nature of the American Blight, as well as the Scale Blight. He also exhibited several branches of apple trees from Mr. Lightband's garden, showing the curative effect of that gentleman's anti-blight grafting treatment.

A discussion ensued, in which several members took part.

Mr. Elliott mentioned that when on a visit at the Hon. W. Robinson's in the Amuri three years since, while walking through the orchard one morning he discovered a tree affected with the American Blight, much to the disgust of the gardener. The trees in this orchard were at the time ten years old. No fresh tree or graft had been imported into it for at least seven years, and the nearest fruit garden was twelve miles distant.

Ninth (Special) Meeting. 31*st October*, 1871.

Sir D. Monro, President, in the chair.

New member.—Walter Ladley.

Dr. Irvine proposed, and Mr. Huddlestone seconded, the nomination of the Lord Bishop of Nelson to vote at the election of Governors of the New Zealand Institute, in conformity with clause 7 of the Act.

The Secretary reported the receipt of several valuable publications from Professor Agassiz, Harvard College, Massachusetts, U.S.A., Baron Ferdinand von Mueller, Melbourne, and Dr. Hector.

Tenth Meeting. 6*th December*, 1871.

Sir D. Monro, President, in the chair.

The nomination for the election of Honorary Members of the New Zealand Institute was made in accordance with Statute IV.

1. "On the Destruction of Land by Shingle-bearing Rivers, and Sugges-

tions for Protection and Prevention," by A. D. Dobson, C.E. (See *Transactions*, p. 153.) Considerable discussion ensued, and the opinions expressed were mostly in accordance with the author's views, both as to the preservation of the bush in the water-sheds, and the planting of suitable trees in proper situations as a protection from the destructive influences of floods in shingle-bearing rivers.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

The following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations, for 1871.

TABLE I.—Temperature of the Air, in shade, recorded at the Chief Towns in the North and South Islands of New Zealand, for the year 1871.

Place.	Mean Annual Temp.	Mean Temp. for (Spring) Sept., Oct., Nov.	Mean Temp. for (Summer) Dec., Jan., Feb.	Mean Temp. for (Autumn) Mar., Apl., May.	Mean Temp. for (Winter) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
North Island.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui . .	60·2	58·0	66·2	62·1	54·6	14·1	57·5
Auckland .	58·5	56·1	64·8	60·4	52·4	13·6	49·2
Taranaki . .	56·3	53·8	62·1	58·6	50·9	16·3	53·6
Napier . .	58·0	58·1	63·6	58·6	51·8	15·7	52·0
Wellington .	54·6	52·8	61·2	56·0	48·7	11·5	44·6
Means, etc., for North Island	57·5	55·7	63·5	59·1	51·6	14·2	57·5
South Island.							
Nelson . . .	55·1	53·9	63·7	56·4	46·5	20·5	56·0
Christchurch .	52·0	51·6	60·8	52·5	43·3	15·5	62·0
Hokitika . .	53·1	51·7	59·6	54·9	46·1	13·0	45·7
Dunedin . .	50·3	49·7	56·9	51·0	43·8	14·1	55·0
Southland . .	50·0	49·1	57·0	51·3	42·7	19·5	65·0
Means, etc., for South Island	52·1	51·2	59·6	53·2	44·5	16·5	65·0
Means for Nth. and Sth. Islands	54·8	53·4	61·5	56·1	48·0	15·3	—

TABLE II.—Barometrical Observations,—Rainfall, etc., recorded for the year 1871.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
North Island.	Inches.	Inches.	Inches.	Sat.–100.	Inches.	0 to 10.
Mongonui .	30·003	1·246	·434	82	57·640	5·9
Auckland .	29·987	1·433	·402	81	47·505	6·0
Taranaki .	29·948	1.410	.325	71	72·120	6·8
Napier .	29·883	1·610	·396	80	35·890	2·3
Wellington .	29·862	2·015	·332	77	64·057	5·9
Means for Nth. Island	29·936	1·542	·377	78	55·442	5·3
South Island.						
Nelson . .	29·867	1·663	·354	79	55·670	5·9
Christchurch	29·853	1·826	·322	81	27·935	5·4
Hokitika . .	26·905	1·766	·339	83	122·440	4·5
Dunedin .	29·821	1·812	·277	75	22·146	5·3
Southland .	29·800	2·014	·276	75	39·030	5·2
Means for Sth. Island	29·849	1·816	·313	78	53·444	5·2
Means for Nth. & Sth. Islands	29·892	1·679	·345	78	54·443	5·2

TABLE III.—Wind for 1871,—Force and Direction.

Place.	Average Daily Velocity, in miles.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
North Island.										*
Mongonui .	193	15	31	46	29	32	80	34	67	31
Auckland	331	28	52	32	18	43	116	30	26	20
Taranaki .	221	29	77	17	67	6	115	24	30	0
Napier .	250	27	111	5	16	60	61	51	31	3
Wellington	202	19	19	7	105	1	17	4	191	2
South Island.										
Nelson .	183	37	53	4	54	10	92	45	70	0
Christchurch	162	7	105	68	9	21	124	12	14	5
Bealey .	229	...	34	...	22	1	21	1	220	66
Hokitika	244	31	40	40	87	7	75	29	51	5
Dunedin .	191	38	33	29	20	36	40	83	17	69
Southland	158	36	4	41	71	...	19	124	69	1

* These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

Average daily horizontal movement in the North Island (five stations), 239 miles.
,, ,, ,, ,, ,, South Island (six stations), 194 ,,
,, ,, ,, ,, ,, New Zealand . . 216 ,,

TABLE IV.—Bealey,—Interior of Canterbury, at 2,104 feet above the sea.

Mean Annual Temp.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degrees.	Degrees.	Degrees.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
46·8	15·8	62·2	29·757*	1·390	·269	84	106·801	5·1

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1871.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Mongonui .	...	...	...	...	...	...	...	...	...	...	...	...	...
Auckland	...	...	...	...	...	...	...	...	...	...	...	...	...
Bay of Plenty	...	...	...	...	...	4*, 5*	...	...	...	...	...	...	2
Tauranga .	...	...	...	...	...	...	...	16	...	...	...	...	1
Maketu .	...	...	...	...	...	...	...	22	...	...	...	...	1
Waikato .	...	...	...	19	...	...	...	...	...	...	...	...	1
Te Teko .	...	...	...	...	...	...	...	15** 16**	...	...	...	...	2
Taupo .	...	...	...	...	...	...	25*	...	...	...	...	...	1
Taranaki	...	14	...	...	...	...	...	...	...	...	...	...	1
Patea . .	...	...	...	...	...	...	...	...	...	...	25	...	1
Napier .	...	...	13	19	...	...	25	...	...	...	...	...	3
Wanganui .	...	...	...	...	...	...	...	...	26*	...	23, 25	...	3
Foxton .	...	...	...	...	...	...	...	...	26*	...	23, 25**	...	3
Otaki . .	...	...	...	...	...	...	...	...	...	...	25*	...	1
Featherston	...	...	...	...	...	...	...	...	...	...	25*	5	2
Masterton .	...	...	...	...	...	...	...	...	...	...	23	...	1
Hutt .	...	...	...	...	...	...	...	...	...	...	25	...	1
Wellington .	1,20,30	...	16	...	...	28	...	31	26	1	10, 25	4	11
Havelock	1	...	...	...	...	...	...	...	...	...	...	...	1
Picton .	1	...	...	...	...	...	...	...	...	...	25*	...	2
Blenheim	...	...	...	...	...	...	...	...	...	...	25	...	1
White's Bay	1	...	...	...	...	...	...	31*	26**	...	25*	...	4
Nelson .	1	...	...	...	...	...	...	...	...	...	26	...	2
Kaikoura	...	...	...	...	...	...	...	31**	...	...	...	...	1
Greymouth .	8	...	...	...	...	...	...	...	...	...	...	...	1
Hokitika	1	...	...	20	...	...	...	...	1	...	...	...	3
Bealey .	...	...	19*	...	...	22*	...	...	...	...	...	...	2
Cheviot .	...	...	...	...	...	...	...	31*	...	...	...	...	1
Kaiapoi .	...	...	...	...	...	...	...	31*	...	...	...	...	1
Lyttelton	...	...	...	...	...	...	...	27	...	...	...	...	1
Christchurch	...	...	28	...	...	...	...	...	...	...	10	...	2
Queenstown	...	...	...	19**	...	...	...	...	...	...	...	5	2
Clyde . .	...	...	...	19*	...	...	...	...	...	...	...	...	1
Cromwell	...	...	...	19*	...	...	...	1	...	...	...	...	2
Dunedin .	...	...	...	19*20	...	...	...	...	...	...	...	...	2
Southland	...	...	...	19*20	...	...	...	...	...	...	...	...	2
Long Bush .	...	...	...	19*	...	...	...	...	...	...	...	...	1
Bluff .	...	...	...	19*	...	...	...	...	...	...	...	...	1

The figures denote the days of the month on which one or more shocks were felt. Those with one asterisk affixed were described as *smart* ; those with two as *severe shocks*. The remainder were very slight, and may have escaped record at some stations, there being no instrumental means employed for their detection.

Notes on the Weather during 1871.

January.—Northerly weather prevailed throughout the month, attended with excessive rainfall at the north extremity of the Islands, and small amount of rain with average humidity and high atmospheric pressure in the south. Average of pressure for all stations, 0·162 above that usual for this month, and temperature 0·4 above the usual average. A meteor on the 1st was observed over an area of 630 miles from N. to S. and 250 miles in width, passing through the zenith at Picton; altitude less than 30 miles; form pear-shaped; apparent length 1°, and diameter of head 10′; detonation heard within a radius of 80 miles from Picton. Meteor of 27th crossed North Island from N.E. to S.W., almost as brilliant as the above. Auroras in south.

February.—S.W. gales on 2nd and 9th, but atmospheric pressure tolerably uniform during the early part of the month, the maximum occurring after new moon on the 20th; it then declined one inch to the minimum on the 28th, when a southerly storm was felt throughout the whole islands, but most severely in the middle portions. The wind, followed by heavy rain, blighted the vegetation on the coast in a very unusual manner. This storm made the rainfall for the month excessive, especially in the North Island and on the East Coast of the South Island. The temperature was 1·9° below the usual average for the month. Frequent auroras in south.

March.—Very wet and stormy throughout, except in Southland, where it was unusually dry and calm. A heavy storm from 24th to 27th from N.E., changing to W., was felt generally throughout the colony, but at Auckland it assumed the character of a cyclone; about same date a violent hurricane took place at Fiji, when 20·03 inches of rain fell during 19th and 20th, and from 19th to 24th 29·35 inches was recorded. The S.W. gale at Wellington on 5th and 6th appears to have been local. Rainfall excessive throughout. Aurora general on 23rd.

April.—Fine weather in the south-western districts, but stormy and wet elsewhere, with frequent thunder storms, especially at Mongonui, where 3·74 in. fell in 24 hours on 4th, with N.E. wind. Auroras frequent in extreme south.

May.—Frequent thunder storms and much unsettled weather, prevailing S.W. wind. Atmospheric pressure during the month only slightly above the average, but marked by great steadiness, the only disturbance being on the 3rd and 4th, when a dip of $\frac{8}{10}$, lasting for twenty-four hours, was recorded at most stations. Prevalent westerly weather, with excessive rainfall on the western slopes of the Southern Alps. At Bealey, on 4th, 5·56 inches fell in 24 hours.

June.—A marked excess of rainfall in the north, with thunder storms, the temperature and pressure being rather above the average. In the south and west the rainfall was deficient and the weather more seasonable, with sharp frosts, S.E. winds predominating over the whole colony. Aurora on 18th at Southland. Weather severe and unsettled, S.W. storm with very low barometer and thunder generally felt on 16th and 17th.

July.—Month characterized by an abnormal depression of the atmospheric pressure, and constant electric disturbance, especially in the southern part of the colony, and by the prevalence of N.W. winds; the rainfall at Hokitika and Bealey, which are influenced by the Southern Alps, being from this cause greatly in excess of the usual average; while at Christchurch and Dunedin it was below the average. Aurora seen from Wellington on 22nd.

August.—Season more than usually severe at the western stations, with excessive rainfall on the West Coast. Fine in S. and E., except towards end of month, when stormy weather was general, commencing with thunder. Severe S.W. gale at Auckland on 30th, with heavy rain, also at Wellington from S.E. Strong gale in Southland, with thunder, hail, snow, and rain, on 24th from W. Auroras in south on 18th and 25th.

September.—Stormy at opening and close of month, with heavy snow fall in south. Chiefly remarkable for the high atmospheric pressure that prevailed towards the middle of the month, the maximum throughout the colony on 19th, being the highest on record, 30·6, and following a continuance of fine southerly weather. Temperature below the average. Auroras in south on 4th, 7th and 8th.

October.—Weather throughout generally wet and stormy, with prevailing N.W. wind; rainfall on the whole in excess of average for previous years, especially on West Coast. Temperature and pressure below average. Thunder storms in S.W.

November—Weather excessively dry in extreme north; otherwise rainfall has been generally in excess of average for this month. A very severe S.W. gale occurred at Auckland on 12th and 13th, doing considerable damage; also at Wellington from S.E. on 11th and 12th with very heavy sea; and at Dunedin on 19th, from W.; but winds, on the whole, have been moderate. Aurora at Hokitika on 16th and 20th; at Dunedin and Bealey on 19th; and at Southland on 4th and 7th. Thunder storms in S.W.

December.—Prevailing N.W. weather, with great drought (except on the West Coast of the South Island), damaging the crops. A gale at Wellington on 13th and 14th, though violent, did not affect the pressure, and was local. A remarkable N.W. gale on the 23rd was most severely felt in the south, where it did much damage, during which the pressure was diminished by one inch, but without rainfall or thunder storms. In Southland the maximum force of the wind reached to 52lbs. on the square foot; in Canterbury it was felt as a hot wind, and at Wellington as a strong dry north-wester, also with sudden fall of barometer. Auroras—Wellington, 9th; Dunedin, 1st and 13th; and Southland on 9th, 11th, 14th, 15th, 16th, and 17th.

James Hector,
Inspector of Meteorological Stations.

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