TRANSACTIONS

AND

PROCEEDINGS

OF THE

Royal Society of New Zealand, Wellington

NEW ZEALAND INSTITUTE,

1875.

VOL. VIII.

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ERRATA.

PAGE

13, line 19 from the top, *for* and and *read* and.

22, ,, 14 from the bottom, *for* similiarity *read* similarity.

23, ,, 5 from the top, *for* Marqesans *read* Marquesan.

25, ,, 1, *for* Marqunesan *read* Marquesan.

34, for reference to note against canoes, see page 33 at the foot.

38, line 8 from the bottom, *for* sefula *read* safulu.

56, ,, 17 from the top, *for* having *read* has.

70, ,, 5 from the top, *for* their *read* the.

106, ,, 2 from the bottom, *for* as high as low water *read* as low as high water.

107, ,, 15 from the bottom, *dele* . and *insert* ,

117, ,, 10 from the bottom, *for* hand *read* hands.

118, ,, 2 from the bottom, *for* pnt *read* put

123, ,, 14, *for* hair *read* hairs.

140, ,, 11 from the top, *for* Kauroo *read* Kauru.

176, ,, 7 from the top, *for* me ta *read* met a.

184, ,, 9 from the bottom, *for* Eperia *read* Epeira.

186, ,, 9 from the top, *for* peats *read* bents.

189, ,, 23 from the top, *for* other *read* outer.

193, ,, 20 from the bottom, *for* these *read* there.

195, ,, 11 from the bottom, *for* reference *read* preference.

196, ,, 2 from the top, *for* oblosignata *read* albosignata.

198, ,, 3 and 10 from the bottom, and 199, line 2 from the top, *for* albosiquata *read* albosignata.

204, art. 25, *for* auctirostris *read* acutirostris.

209, *for* D $\frac{11}{12}$ *read* D $\frac{12}{11}$.

213, line 6 from the bottom, *for* larger *read* longer.

227, ,, 14 from the bottom, *for* as *read* us.

235, ,, 23 from the bottom, *for* referencet o *read* reference to.

254, ,, 18 from the bottom, *for* natualists *read* naturalists.

262, *et seq*. Art. XXXII, for Captain Brown *read* Captain Broun.

269, ,, 12 from the bottom, *for* Prionoplus reticulatis *read* Prionoplus reticularis.

271, No. 28, *for* Tetroreo *read* Tetrorea.

332, line 21 from the bottom, *for* fortunately *read* forthwith.

333, ,, 17 from the top, *after* retarded *insert* . *dele* , *after* chloride.

336, ,, 18 from the bottom, *for* which *read* while.

340, ,, 12 from the bottom, *for* both *read* water.

342, ,, 21 from the top, *dele* not.

346, ,, 19 from the bottom, *for* nitro-prussic *read* nitro-prusside.

350, ,, 11 from the bottom, *for* Mahutangi *read* Mahurangi.

386, ,, 17 from the top, *for* know *read* known.

439, ,, 7 from the bottom, *for* radiatian *read* radiation.

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

ABSTRACTS OF RULES AND STATUTES.

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

SECTION I.

Incorporation of Societies.

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

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

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

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

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

Regulations regarding Publications.

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

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

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

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

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

(*f*.) Extra copies will be issued to any of the Members of Incorporated Societies at the cost 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	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd October, 1868.
Otago Institute	18th October, 1869.
Nelson Association for the Promotion of Science and Industry	23rd Sept., 1870.
Westland Institute	21st Decem., 1874.
Hawke Bay Philosophical Institute	31st March, 1875.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1875.—*President*—W. L. Buller, D.Sc., F.L.S., F.G.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., and W. T. L. Travers, F.L.S.; *Council*—Hon. W. B. D. Mantell, F.G.S., T. Kirk, F.L.S., J. R. George, C.E., C. C. Graham, Captain Edwin, J. Marchant, H. F. Logan; *Auditor*—A. Baker; *Secretary and Treasurer*—R. B. Gore.

Office-bearers for 1876.—*President*—Dr. Buller, C.M.G., F.L.S., F.G.S.; *Vice-Presidents*—T. Kirk, F.L.S., and C. C. Graham; *Council*—W. T. L. Travers, F.L.S., J. C. Crawford, F.G.S., Dr. Hector, C.M.G., F.R.S., J. Carruthers, C.E., Hon. W. B. D. Mantell, F.G.S., J. R. George, C.E., J. Marchant; *Auditor*—A. Baker; *Secretary and Treasurer*—R. B. Gore.

Extracts from the Rules of the Wellington Philosophical Society.

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

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

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

11. The time and place of the general meetings of Members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1875.—*President*—J. C. Firth; *Council*—J. L. Campbell, M.D., J. M. Clark, W. Earl, G. F. Edmonstone, T. B. Gillies, J. Goodall, C.E., Hon. Colonel Haultain, T. Heale, Rev. J. Kinder, D.D., G. M. Mitford, J. Stewart, C.E.; *Secretary*—T. F. Cheeseman, F.L.S. *Auditor*—C. Tothill.

Office-bearers for 1876.—*President*—His Honor Mr. Justice Gillies; *Council*—R. C. Barstow, J. L. Campbell, M.D., J. C. Firth, J. Goodall, Hon. Colonel Haultain, T. Heale, Rev. J. Kinder, D.D., G. M. Mitford, Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., F. Whitaker; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.; *Auditor*—T. Macffarlane.

Extracts from the Rules of the Auckland Institute.

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

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

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

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

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OFFICE-BEARERS FOR 1875.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—R. W. Fereday, Rev. J. W. Stack; *Council*—Dr. J. S. Coward, H. J. Tancred, Ll. Powell, M.D., G. W. Hall, His Honour Mr. Justice Gresson, Professor A. W. Bickerton, F.C.S.; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—C. M. Wakefield.

OFFICE-BEARERS FOR 1876.—*President*—Ll. Powell, M.D.; *Vice-Presidents*—Dr. J. S. Coward and Professor A. W. Bickerton, F.C.S.; *Council*—Dr. Julius von Haast, Rev. J. W. Stack, Rev. Charles Fraser, G. W. Hall, H. J. Tancred, R. W. Fereday; *Treasurer*—J. Inglis; *Hon. Secretary*—J. S. Guthrie; *Auditors*—T. Palmer and C. R. Blackiston.

Extracts from the Rules of the Philosophical Institute of Canterbury.

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

25. 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.

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

OTAGO INSTITUTE.

OFFICE-BEARERS FOR 1875.—*President*—J. S. Webb; *Vice-Presidents*—J. T. Thomson, F.R.G.S., P. Thomson; *Council*—Professor Millen Coughtrey, Dr. Hocken, A. Bathgate, H. Skey, D. Brent, G. M. Thomson, J. McKerrow; *Hon. Treasurer*—R. Gillies; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

OFFICE-BEARERS FOR 1876.—*President*—R. Gillies; *Vice-Presidents*—H. Skey, and J. S. Webb; *Council*—Professor Millen Coughtrey, W. N. Blair, C.E., A. J. Bathgate, J. T. McKerrow, P. Thomson, G. M. Thomson, J. T. Thomson; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the Society may be elected by ballot, on being proposed

in writing at any meeting of the Council or Society by two members, on payment of the annual subscription of one guinea for the year then current.

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

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

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive, and General Meetings shall be held on the second Monday in each of those months, at 8 p.m.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

OFFICE-BEARERS FOR 1875.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Hon. Thos. Renwick, Joseph Shephard, George Williams, M.D.; *Hon. Treasurer and Secretary*—T. Mackay, C.E.

OFFICE-BEARERS FOR 1876.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—A. S. Atkinson, Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Joseph Shepherd, Geo. Williams, M.D.; *Hon. Treasurer*—Alexr. Kerr, F.R.G.S.; *Hon. Secretary*—T. Mackay, C.E.

Extracts from the Rules 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.

WESTLAND INSTITUTE.

OFFICE-BEARERS FOR 1875.—*President*—Judge Harvey; *Vice-Presidents*—Hon. J. A. Bonar, Ven. Archdeacon Harper; *Committee*—F. Dermott, M.D., H. W. Maunsell, M.D., W. C. Roberts, J. Crerar, W. Todd, Captain Turnbull, Rev. Mr. Kirkland, Rev. Mr. Rishworth, Rev. Mr. Martin, H. Meyer; *Treasurer*—W. Duncan; *Secretary*—R. C. Reid.

OFFICE-BEARERS FOR 1876.—*President*—Hon. James A. Bonar, M.L.C.; *Vice-President*—His Honour Judge Weston; *Council*—Thomas Turnbull, John Crerar, Hermann Meyer, Dr. Dermott, William Todd; *Hon. Treasurer*—William Duncan; *Hon. Secretary*—R. C. Reid.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist:—(1) Of life members, *i.e.*, persons who have at any one time made a donation to the Institute of £10 10s. or upwards; or persons who, in

reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting. (2) Of members who pay £2 2s. each year. (3) Of members paying smaller sums—not less than 10s.

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

HAWKE BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1875.—*President*—His Honour J. D. Ormond; *Vice-President*—The Bishop of Waiapu; *Council*—W. Colenso, J. M. Gibbes, H. R. Holder, S. Locke, J. A. Smith, W. I. Spencer, F. W. C. Sturm; *Hon. Secretary and Treasurer*—W. Colenso.

Office-bearers for 1876.—*President*—His Honour J. D. Ormond; *Vice-President*—The Bishop of Waiapu; *Council*—W. Colenso, J. M. Gibbes, H. R. Holder, S. Locke, J. A. Smith, W. I. Spencer, F. W. C. Sturm; *Hon. Secretary and Treasurer*—W. Colenso.

Extracts from the Rules of the Hawke Bay Philosophical Institute.

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

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

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

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1875.

I.—MISCELLANEOUS.

ART. I.—*On the probable origin of the Maori Races.** By W. S. W. VAUX, M.A., Baliol College, Oxford, and F.R.S.

[*Communicated to the Wellington Philosophical Society by* JAMES HECTOR, *M.D., C.M.G., F.R.S.*]

THE question of the origin of the MAORI or native race of New Zealand may, it appears to me, be conveniently considered under the three following heads.

I. *Their own Traditions:* which must, however, be accepted with some reservation, not that we have any right to suppose on their part, an intention to deceive, but because the reports given and published as unquestionable, especially by the Missionaries, are likely, in many instances, to represent rather the ideas of the individual persons who have been specially examined, than the assured judgment of the whole nation.

II. The *Ethnological Connexion and Affinities*, real or imaginary, between them and other peoples, as inferred on scientific principles, or from peculiar existing customs, by European scholars.

III. The relation, if any, between the Maori *language*, as traceable during the last hundred years, and those of the inhabitants of other islands in the Pacific Ocean, indicating, as such a connexion if proved, might be

* This paper is the substance of one read before the British Association at Bristol Aug. 31, 1875, with considerable additions.

expected to do, the probability that all the islanders were once one people, and possibly, also, derived at some very remote period, from the distant continents of Asia or America.

If these separate lines of research can be shewn to be convergent, it is hoped that some conclusions more or less definite, may be obtained as to the real ancestry of the native population of New Zealand.

To take, then,—

(1.) Their own Traditions.

Now, here, it is interesting to see that a very general uniformity prevails among the legends of all the tribes, the testimony they offer, being, for the most part, that their ancestors found their way to New Zealand from the North or North-East, in certain canoes, the names of which have been preserved; there being also, in the island still existing families, who assert of themselves, that they are lineal descendents of the first immigrants. Some of the natives, I should add, however, believe that they came from the Chatham Islands, the land, geographically, the nearest to New Zealand; but, by far the most prevailing tradition is, that their original ancestral home was Hawaiki, a name, the real or probable meaning of which, I shall fully consider in the later pages of this paper.

Now, if the genealogies of the chiefs can be trusted (and, certainly, *a priori*, there seems no reason for doubting their substantial accuracy), the existing population has occupied these islands but little more than 500 years; while, there would, also, at the same time, seem to be no reliable evidence, that there were any other people settled in them previously, although Mr. Colenso* and some other writers, have warmly advocated the view, that there had been an earlier race there, during a period no man can guess how many ages ago. I think it may be further conjectured that the whole number of original comers was not large, a fact, indeed, we should expect, as they had, in any case, to traverse a considerable breadth of ocean before they could reach these islands: moreover, their method of colonization, by separating into different tribes and families (so as to form distinct settlements, at considerable distances apart the one from the other), agreeing as this does with Captain Cook's account of them, 100 years ago, suggests, also, the probability, that occupation was by successive waves of immigrants, no one of these, most likely, having been very numerous.

There are many anecdotes in their various legends of their first advent to New Zealand, which seem to me to bear the stamp of truth upon them: thus, the story of their finding, at two different places, a sperm whale

* "N. Z. Inst.," Vol. I.

stranded, is just the sort of incident which would be remembered by an unlettered but observant people, while the further statement that one of the chiefs was so pleased with the beauty of the *rata*, then in full bloom, that he cast aside the red feathers he was wearing in his head-dress, to don, instead, a circlet of its flowers, is a perfectly natural act, but one, too, which would hardly have been thought of, for the purpose of record, had it not actually occurred. This legend has this further value, that it shows that the arrival of the *Maoris* must have been in the middle of summer, when the *rata* is in flower. I confess I don't see any reason why this story should not be accepted in favour of the Maori immigrants, just as readily as the notice, in the "Antiquitates Americanæ," of the number of hours the sun was above the horizon on the shortest day in "Vinland" (*i. e.* Narraganset) proving as this observation does, the latitude of the country discovered by the old Icelandic voyagers to the West.*

Indeed the long persistency of the Maori traditions and their striking similarity, naturally gives much support to our belief in their general truth; while, unless the conviction of their solid foundation had been fully present to the native mind, we could have hardly conceived the possibility of what is nevertheless literally true, that, only about twenty-five years ago, a family at Tauranga fitted out and provisioned a canoe for the purpose of visiting the homes of their ancestors;† and, more than this, that this is not the only instance in which similar schemes have been entertained and in part carried out. To have thought of such a thing at all, especially as they could have had no definite idea of the direction in which they ought to steer their vessel, proves the vitality of their belief in their traditions, and shows withal no little daring and love of adventure; for the smaller canoes, now or recently in use in New Zealand, could hardly have withstood the billows of the ocean, as did the great double canoes described by Tasman in 1642.

It is a popular idea that ignorance of writing tells with fatal effect against the preservation of early traditions: yet it is certain that there is scarcely any limit to the power of memory when exercised on one or a

* "Antiquitates Americanæ" (Rafn) Copenh. 1837, p. 32.

† Old traditions brought by the few Maoris who first landed in New Zealand would be preserved, and, perhaps, also, accounts of some of their early wars, but the daily incidents of the expanding population in the new country would not be preserved. As a rule, the histories we learn at school are better impressed on our memories, than the historical incidents during our own lifetime. Incidents occurring in savage or uncivilized states of society, must be surrounded by romance, and elaborated by a generalizing mind, before they pass into tradition or literature.

few subjects only. Everyone knows how an illiterate herdsman will recall at once every little peculiarity of each member of a large herd entrusted to his care, though, at first sight, scarcely anything would seem more difficult in individualizing than the ordinary sheep of a large flock. Again, in all the early and rude states of society, abundant songs and tales of the people are found to have been invariably preserved by the people, ages before any form of writing had been invented: while, we know that, in highly civilized India, where letters were, practically, unknown, even three centuries before the Christian era, the whole of the Sanskrit Vêdas, as well as many of the most important commentaries on them, were preserved in the memories of members of the different Brahmanic colleges, whose pride was enlisted in the accurate recollection of the most minute modifications of the sounds and letters of individual words. To maintain the absolute invariabity of these Hymns was the business of their life; and their memories were not distracted by attention to anything else.

In the case of the New Zealander, while the demands on his powers of memory were infinitely less, we have reason to believe that his *Tohungas*, or priests, continued constantly repeating these legends, one from the other, and, no doubt, generally, in the same words.* It is not necessary to take these tales for more than they are worth, nor do I wish to claim for them a solid historical basis; but I have as much confidence in them as in the early legends of Greece and Rome, some of which, especially in the case of Rome, are *now* seen to have had a far more real foundation, than the sceptical historians of the early part of this century were willing to admit. There is nothing, indeed, in the nature of the case, against the probability, that the Maori stories do rest on ultimate facts. Many circumstances, and not the least of these, the admitted fact that the New Zealand chiefs (as was the case, also, in other islands) were, even in life, held to have a *quasi*-superhuman character, have thrown their mythology into inextricable confusion; but, even, allowing the probability that, as suggested before, some local colourings may have been engrafted on the answers given to the first questions propounded to the Maoris by the missionaries or early settlers,† it does not follow that there was *no*

* It is mentioned, I think, by Mr. Ellis, that the native chiefs of the Sandwich Islands have preserved the names of their kings from father to son for a hundred successions—which is by no means improbable as it is the most important, if not the only thing they would care to record.

† There is a constant tendency, especially, among uneducated but shrewd savages to give that answer to any question which they think the enquirer would like to have. An Eastern or an Irish peasant illustrates, as well as any one else, this remark. Arch-

truth at all at the bottom of the system recorded, or that the natives did not really believe in a Chief God or Creator, *Tangaroa* or *Tane*, with so much of religion, as consists in the recognition of the dependency of the human mind on some presumed higher or more powerful Being.*

I have mentioned the traditions current with respect to the first arrival of the Maoris; but they have also others scarcely less important: for instance, the tribes state, universally, that they were once one people, a statement apparently well confirmed by what can even now be seen; moreover, language, in this instance, may be trusted as a faithful witness. The speech of these Islanders is clearly one and the same; and, though some differences of dialect occur (Mr. Colenso makes ten such varieties; Mr. Shortland six), it is certain the differences between the dialects of the North and South Island are not so great as between Yorkshire and Somersetshire at the present time. Nor, does there seem to me, the slightest ground for supposing them *autochthones*; the more so, that the only plants they originally cultivated are exotics and their only domestic animal not indigenous. These, therefore, if as we suppose, they found these Islands uninhabited, they must have brought with them whencesoever they came. Another argument in favour of the great antiquity in New Zealand of the present people has been urged on the ground of the presumed long time it must have taken the Maoris to manufacture their most valuable ornaments, hatchets, adzes, spear-heads, etc., in Jade, or other hard and costly materials: and, in this argument there certainly would have been some force, were it certain that either these instruments, themselves, or the substances of which they are made, are found only in New Zealand: on the contrary, however, it is now certain that plenty of highly wrought ornaments of a similar character may be met with in other islands of the Pacific; the presumption being, as well as the strong and natural probability, that if the execution of such works be as difficult, or of the ancient date pretended, the Maoris brought them with them when they first settled in New Zealand. I believe, however, as a matter of fact that these implements do not require for their manufacture, anything like the time suggested by Mr. Colenso. Again,

deacon Maunsell has further shown that, in Maori, this practice is, as it were, reduced to a system. "In answering a question," he says, "the answer will always be regulated by the way in which the question is put, *i.e.* '*Kahore i pai?*' *&c.* 'Was he not willing? Yes,'—*i.e.* 'Yes. He was not willing.' If the answer was intended to be affirmative, the speaker would have said, '*I pai ano.*'" (Maunsell, N.Z. Gr. p. 167.)

* For interesting details on these matters, see Rev. J. F. H. Wohler's Mythology and Traditions of the Maoris, "Trans., N.Z. Inst.," Vol. VII., pp. 3—53.

though there is no doubt that the Middle Island is rich in a kind of Jade, or greenstone, which the Maoris prize highly, it is, by no means, the only place where this mineral is found.* Nor, indeed, do I see, in the writings of any of those persons, who, disbelieving the traditions of the natives, consider them of remote antiquity,† if not, *autochthones*, any proof, whatever, that the present people differ, in any essential respect, whether of manners or habits, from what has been discovered about the presumed elder races. Yet this would seem to be a matter it is incumbent on these theorists to prove.‡ Nor, and this is a more important point, in that it connects the Maoris more or less with their famous extinct bird, the Moa, can I say I have any more faith, in the arguments adduced to show that the Moa-hunters, the population that is, who were the chief agents in the destruction of the *Dinornis*, were themselves of a period so ancient as to have been contemporary, as has been suggested, with the great European mammals of the Post-Pleiocene period ; still less that they dwelt in these Islands so long ago that it may well be doubted whether they have any connection with the present people. It is right, however, to add that, on this particular subject, there is no actual agreement among the holders of these extreme views, as some maintain, like Dr. Haast, that the existing Maoris are descendants of these supposed most ancient Moa-hunters, while others deny this.|| Now it has, of late years, been held, with tolerable unanimity, by European ethnologists, that the time of man's existence on the earth admits of division into four principal periods, called, respectively, the Palæolithic, Neolithic, Bronze and Iron Ages, and that the two first periods are marked, definitely, by the use, in the first, of rudely chipped flints and stone implements, and, in the second, by that of materials of the same kind, but, generally exhibiting considerable polish and much skilful and elaborate workmanship,—At the same time, it is tolerably certain that these divisions cannot be drawn with a hard and sharp line, the two classes

* I notice that the South or Middle Island is called by the Maoris *Te wahi pounamu*, which means, I believe, "the country of Jade." So far as it goes, I should infer from this name, that Jade was found there abundantly by the first comers from the North Island, and that the name was really given as a reply to enquiries addressed to the natives by the first surveyors.

† Mr. Colenso's argument from what he thinks the remains of hill forts now covered with *humus*, can only be answered *on the spot* by practised antiquaries or geologists.

‡ Mr. A. Thomson's idea that the present Maoris are a "cross" will be noticed presently.

|| For various interesting suggestions, see Mr. Colenso's summary, "Trans. N.Z. Inst.," Vol. I., pp. 404—7.

having, in many instances, overlapped: thus, rude and finely worked specimens have been, occasionally, found even in Europe so placed as to imply their use by the same population simultaneously. On the supposition, however, that the Palæolithic and Neolithic periods are sufficiently well marked for ordinary purposes of comparison, and bearing in mind that rude as well as polished instruments of stone have been abundantly found in New Zealand, it has been assumed that the people who made and used the former and rudest of them must have belonged to those remote periods; in other words, that there must have been here, as it seems most likely there was once in Europe, a race of men contemporary with the Post-Pleiocene or Mammoth Period. The main argument in favour of this theory rests on the further *supposition* that all the Moa bones are those of birds extinct for ages, a large number of these remains having been met with in close connection with the flint weapons whereby they were probably slain or cut up. Now, if this be so, it has been further not unreasonably urged that the hunters of the birds must have been contemporaneous with the weapons they used. I ought to add that, with the bones, have been also found a great quantity of the shells of their eggs, as well as the ovens in which they were cooked.

Now, no doubt, this theory had a certain consistency so long as it was supposed that most of the bones of the Moas had been found at a depth of many feet under the surface soil, implying, as this circumstance, naturally did, a long lapse of time, since the birds themselves were actually alive on the plains of New Zealand: it was, moreover, asserted that the present people have no traditions of the existence of the bird, which they could not possibly have forgotten. On this point, however, it would seem quite sufficient to remark that the absence of any direct allusion to the Moa in the songs or traditions of the Maoris may just as well have arisen from the probable fact that they were really so familiar with the existence of it, that it would naturally have no place in their traditional lore; while, for the same reason, it would have had none of that peculiar fame among the natives, which the discovery of its remains has aroused among European philosophers. While it lived, the abundant relics of it recently met with shew clearly enough that it could not have been at all rare; and when it perished, perhaps, not very long before the present generation, it simply ceased to be talked about. In making this statement, however, I must not be supposed to deny that Moa bones of considerable antiquity do, from time to time, turn up; I only affirm that that they have not remained long enough in the soil to lose all their albumen and to have been thus converted into true fossils.

A

Two other views have been put forth, each of which has had its adherents and must, therefore, be noticed here: according to the first, it has been suggested that, had any Moas existed in what may be called "Modern" times, some of the earlier European navigators, as for instance, Captain Cook,* who, during his several visits to these islands, spent over 350 days here, must certainly have heard of or recorded them; according to the second, that, if any of them had died in the open plains, all traces of them would have disappeared in a space of time comparatively short, as the bones of even horses or of other large cattle are known not to resist exposure to the weather for more than 20 or 30 years; the inference being, that all the remains which have been discovered, owe their preservation to the silt and mud in which they have been very generally found embedded. It was, besides this, averred by some that so ancient, indeed, was the period of the final disappearance of the Moa, that its life probably preceded more than one great geological change, such as that which created Cook Strait; while the occurrence of many species of Struthia as well of the *Dinornis* suggested, at least to these reasoners, the probability of a former vast Antarctic continent,† connecting Australia, through New Zealand, with America and perhaps, even with Africa; the whole of this continent, with the exception of Madagascar, Australia, and New Zealand having been since submerged for countless ages. The smaller groups, more strictly known as Polynesia, were not, I believe, included in this grand conception, as being when not volcanic for the most part of coralline formation. But, apart from other considerations, it is clear that such a speculation requires an enormous amount of evidence to render it at all probable; nor, indeed, am I aware that it has been in any way confirmed by competent geologists; moreover, so far as the present enquiry goes, by simplifying, it may be, but, in a very doubtful manner, the problem to be discussed, it looks to me very much like cutting the knot, we ought rather to attempt untying. Of course, if there were any real evidence (such as we see in channels so narrow as that between England and France) that, within a tolerably recent period, New Zealand had formed part of a continent, connected with Madagascar and Australia on the one side, and with India, *via* the Malay Peninsula, &c., on the other, we should have the chance of solving many difficulties, which now beset the enquiry into the origin of many races, whose languages, so far as they can be trusted, certainly shew considerable signs of affinity. Late researches have, however, shewn, conclusively, that the idea

* Haast. Dr., Moas and Moa-hunters, "Trans. N. Z. Inst.," Vol. IV., p. 77.

† Admiral Dumont D'Urville in the "Voyage of the *Astrolabe*" has held this view.

of the extraordinary antiquity of the last living Moa cannot be maintained; indeed, considering the vehemence with which the antiquarian theory has been urged, it is not a little remarkable that the first to discover its remains (Bishop Williams and the late Rev. R. Taylor in 1839) stated their beliefs at the time that the actual extinction of the bird was quite recent; a view, in which they were subsequently energetically supported by Mr. Walter Mantell (the son of the well-known geologist), himself, at once, by far the greatest collector of Moa remains, and the person to whom, more than to any one else, all the Museums in Europe have been indebted for the specimens they now possess. Elaborate examinations of the districts or individual spots either where bones have been accidentally discovered or theoretically guessed at, as those most likely to prove rich in such relics,* have since been carried out and discovered by Drs. Haast, Hector, Captain Hutton, Messrs. Murison, Booth, and others, the result being, the discovery of many portions of these birds, with not only their skin and muscles adhering to their bones, but even their feathers, a combination which could not have been preserved, had not the destruction of these individual birds, at least, been quite modern. In the course of these researches, I may add,

* See the following papers:—

Mantell, W. B. D., "Quar. Jour. Geo. Soc.," and "Trans. N. Z. Inst.," Vol. I.

Haast, Julius, F.R.S., On Moa Hunters and Moas, "Trans. N. Z. Inst.," Vol. I., p. 80; Vol. IV., p. 66 and p. 102; Vol. VI., p. 62 and p. 419; Vol. VII., p. 54.

Hector, Dr. J., F.R.S., Discoveries of Moa Remains, "Zool. Proc.," 1867; "Trans. N. Z. Inst.," Vol. IV., p. 110; Vol. V., p. 407; Vol. VI., p. 76 and p. 370.

Murison, W. D., On Moa Remains, "Trans. N. Z. Inst.," Vol. IV., pp. 120-1.

Williams, W. L., On Footprints of a Large Bird, "Trans. N. Z. Inst.," Vol. IV., pp. 124-7.

Mantell, W. B. D., On Moa Beds, "Trans. N. Z. Inst.," Vol. V., pp. 94-97.

Grey, Sir Geo., On the Hokioi, "Trans. N. Z. Inst.," Vol. V., p. 435.

Taylor, Rev. J. R., On the First Discovery of Moa Remains, "Trans. N. Z. Inst.," Vol. V., pp. 97-101.

Fraser, Captain, On Earnscleugh Cave Remains, "Trans. N. Z. Inst.," Vol. V., pp. 102-105.

Hutton, Captain, F.G.S., "Trans. N. Z. Inst.," Vol. V., p. 138 and p. 266.

M'Kay, Alex., On Moa Hunters, "Trans. N. Z. Inst.," Vol. VII., p. 98.

Booth, J., Moa Swamps, "Trans. N. Z. Inst.," Vol. VII., p. 123.

Hamilton, J. W., Traditions of Moas, "Trans. N. Z. Inst.," Vol. VII., p. 121.

Goodall, J.,—he thinks, quoting Hochstetter, p. 210, that there was an antecedent population—"Trans. N. Z. Inst.," Vol. VII., p. 144.

Stack, Rev. J. W., who holds that there is no evidence of Moa in the N. Z. poems collected by Sir G. Grey in his article, "Trans. N. Z. Inst.," Vol. IV., No. 5; Append. XXVIII.-IX., Vol. VII.

Roberts, W. H. S., Evidence of Modern Arts, "Trans. N. Z. Inst.," Vol. VII., p. 548.

extensive and long occupied camping grounds of the Moa-hunters have been explored, and many essential points relative to their mode of life have been ascertained. By these means it has been shewn, that the argument for their remote antiquity, derived from the discovery of rude as well as highly finished stone implements, falls to the ground. Clearly they are found thus intermixed, as having been in use at *one and the same time* by *the same people*. As both these classes, together with a large quantity of flakes of flint and chert have been discovered in these camping grounds, it is reasonable to suppose that each type of implement was used just as might be required for the matter in hand. If, for instance, the Moa-hunters wished to grub up fern roots, they would use, as the Maoris do *now*, the hard and often highly polished adzes; if they were desirous of stripping the flesh off the tough neck of the bird, they would make use of the sharp flakes of flint; if, lastly, they were anxious to break the thick bones of the *tibia*, to get at the marrow, they would use the rough and massive *kapus*, as suggested by Dr. Hector. The fact is, no satisfactory reasons can be deduced for the age of those, who used these weapons, merely from the circumstances under which they have been found; but, at the same time, there is clearly no proof of their remote antiquity: moreover, what may be called a manufactory of flint flakes is constantly associated with the Moa bones where most abundant. Again, recurring to the idea of the ignorance of the natives, as inferred from the want of traditions about this bird, it is certain from more careful enquiry, that so little ignorant were the natives, as a matter of fact, that, so early as the first discoveries of 1839, they joined readily with the English settlers in their further search for them, at the same time making no mistakes or blunders about the objects they were looking for, as is distinctly affirmed by Sir George Grey in a letter to the Zoological Society, himself, from having mixed as much as any one with the people, being a very competent witness on this subject.

Indeed, in a subsequent letter to Mr. Mantell, Sir George Grey states definitely that when he first came to New Zealand, the natives told him that the Moas were fast disappearing, but that they thought one might, perhaps, be found—and Mr. Mantell has, incidentally, pointed out that the corroded state in which the egg-shells of the Moas are often found is no test of their antiquity, nor caused, as was at first supposed in Europe, by the long continued action of water; it is rather due to the wearing influence of drift sand, especially at Waingongoro where Bishop Williams procured his first specimen, a place, by the way, which the natives, then resident there, asserted was the spot where their ancestors had first landed.

Nor are we, indeed, now without direct testimony on this head; for the natives asserted to Governor Weld that the Moa, like the Emu, defended itself by trampling on it adversary, and warned him not to go behind them as they kicked like horses;* two facts, which it is scarcely possible to suppose were purely inventions of their imaginations. Again, we are told by Mr. Hamilton that he spoke with an old Maori in 1844, who remembered Captain Cook, and who said he had seen the last Moa, describing it as having a long neck like a horse. Mr. Pollock, too, in an early account of New Zealand, affirms the same thing, and states that the natives told him that when food was scarce, the birds were easily entrapped, an assertion then more probable, from the remark of the old man just mentioned, that the plan usually adopted for catching the Moas, was to drive a post into the ground before the caves they frequented, with a stout noose attached to it. Lastly, Dr. Hector himself noticed, in the neighbourhood of Jackson Bay, well-worn tracks through the high scrub about sixteen inches wide, and such, too, as could not have been made by any animal or bird now existing in the Southern part of the Island. It has also been stated, I believe on good authority, that dogs have been known to suck the Moa bones, shewing clearly that *these* specimens, as would also have been the case with the skin and and muscles of the neck recently found, must have retained in them some nutritious matter.

Putting, then, all these statements together, I confess I do not see how any conclusion can be arrived at, but that the final extinction of the Moas is quite recent. Professor Owen has, I believe, supposed that the Dodo and the Moa passed away together, probably about two centuries ago: but there seem now, fair grounds for thinking, that some specimens of the latter were really alive, at least in the most Southern parts of the Middle Island, as lately as the commencement of the present century.† It has been stated by Dr. Hector, that the character of the plains and of the brushwood in the recesses of the province of Otago, are peculiarly favourable to its habits.

In concluding, then, this portion of my paper, I think I am entitled to say, that, so far as the story of the Moa goes, the credit of the natives, as a truthful race, is unimpaired: and that their not having preserved in their traditions any special references to it, nowise affects the truth of their further assertions of having first colonized the Northern Island about 500 years ago.‡

(2.) ETHNOLOGICAL.

I take next, the connexion and affinities real or imaginary, between the

* Hector, l. c.

† Hutton, "Trans., N. Z. Inst.," Vol. VII., p. 138.

‡ *Vide* post, Art. II.—[Ed.]

Maoris and other peoples, as inferred by European Scholars, on Ethnological principles or from peculiar existing customs: in other words, I propose to examine the questions "Are there any populations in the Pacific Islands with whom there is reason to suppose that the Maoris have blood relations, either by parallel descent from a common ancestor or by a more immediate and traceable pedigree, or do they stand alone and with no apparent affinities with any one else? As my object is, chiefly to place before those, who may look into the Transactions of the N. Z. Institute, the evidence about the Maoris which seems to me reliable, I have not thought it necessary to quote at length the various views that have been held on this subject by scholars in Europe, such for instance, as W. von Humboldt, Crawfurd and others. I have thought that it would be more useful to consider, chiefly, the theories of those writers who, like Mr. Thompson, have placed their opinions on record in the pages of this work.*

Now before I proceed to make such observations as seem necessary on this part of my general subject, it is necessary that I should state that ethnologists are, generally, agreed in dividing the inhabitants of the Pacific Islands (meaning by this term those portions of land which lie between the two great continents of Asia and America), into certain leading groups; though I must add, in my judgment, not unfrequently, with very inadequate designations. On the whole, I think the division into five such groups, now usually accepted on the continent of Europe, is the clearest and best, though not wholly free from objections: I shall, therefore, adopt this here; though it is not an exhaustive division and many instances occur, as might naturally be expected, of the overlapping of the lines of partition, and of the intermingling of distinct but adjoining populations.

The names of these divisions are:

I. *Malaisia.* Comprehending Sumatra, Java, Borneo, Celebes, Moluccas, Sooloo, Philippine Islands, and a considerable part of Malacca and Formosa. The characteristic of this people is that they have brownish-yellow skins and lank black hair.

II. *Melanesia.* Comprising New Guinea, Arra, Mysol, Waygeon, New Britain, New Ireland, New Caledonia, New Hebrides and the Solomon Islands. These people are dark (nearly black) as regards their skins, with woolly and frizzly hair. The western

* I have made one exception in the case of Baschmann, "Iles Marquises," Berl., S. 1843, to whom I have referred constantly in the latter portion of this paper for views of the Analogies between the Tahitian and Hawaian dialects.

portion of this population is often known by the name of *Papuans*, and their abode as *Papuanesia*.

III. *Australia*. With dark-skinned but rarely black population, with hair, however, not frizzly but lank and soft.

IV. *Micronesia*. Consisting of several small groups of islands, many of them coral reefs enclosing lagunes, as the Ladrone or Marianne Islands, the Ludack Chain, Kingsmill, etc. The people who inhabit them are much mixed, and, in many of the islands nearly connected with the Melanesians.

V. *Polynesia*. Comprising by far the most numerous groups, and extending from the Navigators' Islands on the west, to Easter Island in the extreme east, with those of New Zealand, the Friendly, the Society, the Austral, Hervey and Gambier groups, the Low or Saumatoa, and the Sandwich Islands.

As distinguished from Melanesia or Micronesia, the inhabitants of these Islands have more resemblance to those of Malaisia, with light or dusky brown skins, often with a tinge of yellow, the New Zealanders and Sandwich Islanders (or Hawaiians) being the darkest, with black and curly as distinguished from woolly or frizzly hair. One other considerable group I have omitted, purposely, that of the Fiji (or Viti) people, as it would seem they are a very mixed race, with many affinities to *Melanesia*, though their grammar is more like the Tongan. I have not been able, at present, to meet with any very satisfactory account of them, but, as they have now placed themselves under the sovereignty of England, we shall soon I presume know whatever there is to be known about them. It is clear that a great many Polynesian words are incorporated in the few specimens of their language I have met with; indeed, in the name of their principal island *Vanua-leva* (the high land) I recognize at once, the Maori *whenua*. One marked distinction between the Viti and the dialects of the adjacent islands, which I have noticed, is the common occurence of two consonants at the beginning of their words, without an intervening vowel. The Fiji chieftains are said, too, to be devoted to the adornment and dressing of their hair, and to exhibit on their heads the circular mop-like masses of hair, so characteristic of the Papuans.

It is probable, that the darker hue noticed as I understand chiefly in the case of the Maoris who are now found in the Southern Island is mainly due to their out of door life, exposure to the weather, and laborious occupations, The climate of New Zealand, especially southward of the middle of the North Island, does not differ very much from that of the South of England and France; requires, therefore, warm clothing and gives ample scope for bodily energies; but the reverse of this must be the case with Saumatoa, Marquesas, Society and Navigators' Islands; while the climate of the Sandwich Islands must approach much more nearly to that of the latter, than to that of New Zealand.

So far, then, I think it may be taken as a matter of general agreement that the native race of New Zealand have, on the whole, much more marked resemblance to those populations grouped under the name of Polynesia, than they have to the Negrito or Papuan peoples. It remains, however, to be shewn whether they have any nearer connexion with these Islands than may be fairly assumed from the broad differences between the black Negro and the yellow Malay; and, further, whether, admitting this one physical resemblance between them and the Malays, there is any reason to suppose them the descendants of a Malay colony, who might have found their way to New Zealand six or seven centuries ago.

It is right that I should state, *in limine*, that some writers, as Dr. Dieffenbach, and, to some extent, Mr. Thomson* also, have maintained that there are two distinct races in New Zealand, the yellow-brown and by far the most numerous, but, besides these, a much darker skinned people; and have assumed that these two classes are descendants of two original stocks, the darker being the original. Later examination has not, however, as it seems to me, confirmed this view; besides it is scarcely probable that had there been, at any time, a considerable infusion of a Negrito population, they would not have left behind them some other traces of their former presence, than merely a certain number of darker skinned people, with hair differing in quality from that found among the majority of the population. I shall recur to this theory, presently.

Now there are various ways in which such an inquiry as I am proposing might be carried out, independently of what are called "Race-characteristics," such as the recognition of a similarity or peculiarity of customs, manners, etc., prevailing through all or most of the leading Polynesian groups, but which are found less universally, or not at all, elsewhere;—or, the unity or difference of dialects among the islanders. To each of these, especially the latter, I shall refer at some length hereafter. But I must notice first, a new view of the "whence" of the Maoris, which has been advocated with much ability in the Fourth Volume of the "Trans. of the N. Z. Inst." by Mr. J. T. Thomson; because, if his theory can be maintained, the Maori can, hardly, be any longer considered as a

* Mr. Colenso, I observe, asserts that the Maoris are not Polynesians, but I do not see that he has given any very strong reasons for this opinion.

leading member of the Polynesian groups; at least, I do not understand that Mr. Thomson applies his theory to the whole of the Pacific Islanders, or perhaps, I am more accurate in saying, to the same extent, as in the New Zealanders.

In this theory, Mr. Thomson, following, often in the same words, the very learned, but, to my mind, unsatisfactory views, of the late Mr. Logan, in the "Journal of the Indian Archipelago"* has assumed, that, in remote ages, a much wider range of country was occupied by the dark skinned and woolly haired races; in fact that they ranged over the whole of the plains of Hindostan, as well as over Africa, Madagascar, the Andaman Islands, New Holland, and New Guinea, etc., indeed, as far as 170° E. long. Closely, on the northern flank of these dark men, were the energetic *Aryans*, who, at some time or other, forced their way so far west and north-west as Ireland and Scandinavia, and the *Tibetans*—that is, the *White* and the *Yellow* races—both of whom, ultimately, though, probably, with an interval of many centuries between them, descended into India, the one by the Punjaub, Jumna, and Ganges, the other by the Brahmaputra. The result of these invasions was (though chiefly through the agency of the Tibetans, for the Aryans have never much influenced Southern India), the expulsion or, more probably, the enslavement of the dark races, so far, at least, as India was concerned. I may add that it was a further view of Mr. Logan, that some of the castes in the South of India shew in their physiognomies a strongly marked African character, a proof, to his mind, that they are remnants of an Archaic formation of a still more decidedly African type. Thus, he says, the black Doms of Kamdon have hair much resembling wool. But how, one naturally asks, did they get to India? So far as we know, the genuine Negro of Africa has never been a navigating race: and the same thing may, I believe, be predicated of the Papuans and of most of the other *Negritos*: and though there *may* have been conquerors from India, who, reversing the fables of Sesostris and Semiramis, *may* have brought from Africa an entire slave population and settled them in India; as history is

* The elaborate papers of Mr. Logan on this subject are in the fourth, fifth, and sixth volumes of that work (for 1850, 1, 2). I do not see that, except in his researches in the Appendix to "Trans. N. Z. Inst.," Vol. VI., Mr. Thomson has added much to what Mr. Logan gave to the world, 20 years ago—soon after which time, I remember reading them—while, he has, in many instances, adopted the exact words and phrases of Mr. Logan. Coming as they did from a man of such linguistic eminence as Mr. Logan, they, naturally, attracted much attention; it was, however, very generally thought, that his data were not sufficient for the very wide generalization he deduced from them.

wholly silent on this point, I cannot go the length of accepting, still less of proposing, so wild an hypothesis. Not the least objection I have always felt to most of Mr. Logan's theories—as distinguished from his extraordinary linguistic knowledge, is the prodigious length of time required for working them out. It is true, that if the Logan-Thomson views could be proved, some of the difficulties of the "whence" of the Negrito Island races would be got rid of—for, in such a case, one might suppose the "Melanesian" occupation of Timor, Gilolo, etc., due to their expulsion by the *Yellow man* from India; and, further, that the Yellow tribes, now, generically, called Malays, may be descendents of those Tibetans (to call them so *ex hypothesi*) who, coming down from Central Asia into India, drove the dark skinned people before them. I am not called on here to discuss this question; nor, indeed, would it be possible to do so, within the limits of any one paper; but it is worthy of remark, that, though, in some of the islands, the wild dwellers in the inmost fastnesses are as fair as the Malay coast-men, in other islands the dark people have been evidently forced back into the interior, while the yellow races have secured the sea shores and, with these, all the trade of the neighbourhood. Hence, there is no improbability in the idea, that the *Yellow* men did effect certain conquests over the Negroes, though it does not follow that India itself was ever populated by a purely Negro race.*

With regard to the Maoris, Mr. Thomson thinks (as judged by their features) that they are "clearly a cross," with affinities to the Dravidian or oldest inhabitants of the South of India. But this view is, obviously, at variance with the Negro theory—for the Dravidians are certainly descendents of a Yellow race,† who, according to it, drove the Negro people out of

* I may as well notice here, that the presumed Negro occupation of India could not have been called the "Barata Kingdom" (more correctly Bhárata) as Mr. Thomson at least implies, in his subsequent paper on the "Barata Numerals" ("Trans. N. Z. Inst.," Vol. V.) Bhárata-varsha. ("Bhárata Kingdom") is a title essentially and purely Sanskrit, and could not have been applied to any Negro dominion. Bhárata was the son of Dushyanta, and India was, hence, called his kingdom.

† Professor Max Müller long since in "Bunsen's Philosophy of Universal History," Vol. I., London. 1854, demonstrated the close connexion between the Dravidian or Nishada races and the so-called Turanian population of Central Asia; and his views have been completely confirmed by Dr. Caldwell's admirable Dravidian Grammar (2nd Edition, 1875). Though possibly connected with the Finns, the Lapps, and Samoiedes of the North or with the Basques of the South, they have, assuredly, no Negro affinities. Nor, without much more information about the "Tamil books" that Logan has referred to, should I venture to conclude, that the people with "tufted hair" said to be mentioned in them, were what we understand by 'Negroes.

the country; and have, except accidentally, nothing in common with the Negroes. No doubt some of the Tamil population are dark enough, much darker than the ordinary Malay; but their hair is as a rule of a soft glossy black, the very opposite to that of the crisp and woolly Negro. Far more probable, is a further suggestion of Mr. Thomson, that the Maoris are, in part, offsprings of the Tibetan and Ultra-Gangetic races—which Mr. Logan has, I think, also proposed, a race, perhaps, now represented by the Bajow or *Oranglaut*:—("Men of the Sea") the more so, that these tribes are, in an especial manner, "Sea-nomads" and frequent to this day all the waters and islands of the Indian Archipelago. In this way, no doubt, it will be quite possible for New Zealand to have been peopled—only, that unless this took place at a very remote period we should unquestionably find much more modern Malay in the Maori language, than either Mr. Crawfurd or Mr. Thomson have been able to point out.* Moreover this theory does not account for the supposed "cross" unless we imagine the invading Bajows to have brought with them a handsome supply of Papuan slave girls. With Mr. Thomson's further *dictum*, that the obliteration of an intervening race does not destroy the Ethnological links between two distant regions, I should, of course, agree—only that I do not perceive, in this case, any need for such an obliteration: he has not, I think, shewn that the actually occurring cases of this "cross" are very numerous; while, so far as I can learn from other sources of information, it would appear to be generally considered that the Maoris are one in race as well as in language.

Mr. Thomson in his next paper "On Barata Numerals" ("Trans. N. Z. Inst.," Vol. V.) endeavours to support his view of "Barata expansion" by an elaborate comparison of the numerals of 34 islands and districts with those now in use in New Zealand, drawn up with great care from the works of Logan, Earle, Wallace, and others, and maintains that the remarkable similarity he has, in many cases, succeeded in showing, is due to these places having all, at some time or other, been either colonized directly, or greatly influenced by the so-called "Bhārata" population. Now, as I have said

* I should add that Mr. Thomson has given a very interesting account of the people whom he has met with in India—illustrated by his own sketches—with certain inferences from their physiognomies. With these views I do not presume to interfere—but I may be allowed to remark, that, with the exception of some very decidedly marked varieties, such as the Negro as compared with the pure Hindu or the pure Caucasian, *individual* examples from drawings or even photographs are not perfectly satisfactory. We want the presence of "numbers" before our conclusions can be safe. So in language—the occurrence of a good many individual words—*without grammar or syntax*—is nothing worth, as an evidence of the origin of the people among whom they may happen to be found.

before, I am not at all convinced by the mass of erudition in Mr. Logan's papers, which I have gone through more than once with as much care as possible; moreover I believe, that present physicists are, by no means satisfied with reference to any near connection between the Negritos of the Islands and the genuine Negroes of Africa, though their external resemblances are, at first sight, considerable. I feel therefore, inclined to suggest this further query—viz., Is it not quite as probable, on the whole, that what Mr. Thomson calls "Bhàrata numerals" are really those worked out, gradually, by the colonizing *Yellow man*, and that, if they are now found, also, in regions occupied by the dark races, they have been forced upon the latter by the power, or possibly, by the intelligence of the former? At any rate, this hypothesis does not require the extreme length of time demanded for the Logan-Thomson theory. Nor, indeed, is it without some confirmation from what may be seen in Mr. Thomson's own list of numerals ("Trans. N. Z. Inst.," Vol. V., p. 137)—for I observe, that, in New Caledonia and Arru, there are only two numerals the same as those of the Maori; in Kissa and Tenenbar, three; in Mallicolo and Tanna, and Vialo (Temir), four; all of these islands being essentially parts of Melanesia. Supposing, therefore, no sufficient evidence adduced to the contrary, the presumption would, I think, be that these Negritos had acquired such of their numerals, as are similar to those in Polynesia, either by compulsion on the part of their Yellow neighbours or conquerors, or, in the course of commercial intercourse. No one would, I think, assume from such proportions, that the Maori numerals, and those of the other islands, believed to be in many ways cognate with New Zealand, were derived from the ancestors of these Melanesians. Again, if Mr. Thomson's "Bhàrata" theory were true, we should naturally expect some resemblance—and a near one too—between these "Bhàrata" numerals and those of the languages connected more or less nearly with Tamil, the present representative language of the South of India—the Dravidian Tamils—having, agreeably with Mr. Thomson's view,—succeeded to the territorial possessions of the Negro race, they expelled—or, rather, being the actual Dravidian race (according to another of his suppositions) who have led to the "cross" he notices among the Maoris. All I can say, on this head, is that I have carefully examined the numerals in all the leading languages of Southern India, the Tamil, Canarese, Carnatiku, Telagu, etc. —and, that I have not been able to detect even a solitary resemblance with any of those in Mr. Thomson's list. If then, similarity of numerals be any real test of the connexion of races (which I do not at all assert to be the case) it is clear that Mr. Thomson's argument for the existing numerals cannot be sustained as any evidence of the "whence" of the Maoris. If the present Dravidians were nearly connected with the Maoris, their common numbers would have been nearly the same—if not identical.* But though I have thus freely criticised the views put forward by Mr. Thomson, and cannot admit I am a bit more convinced by his reasonings than I was, years since, by the still more elaborate papers of Mr. Logan, I recognise with pleasure the patient labour and study he has shewn in the papers he has contributed to this work, and the value of his independent researches in connection with Malagasi, Malay, Tongan, and Maori. I further think, that it would be a most valuable work, if any scholars, who have the time and the means, would subject the languages of Africa to the same exhaustive treatment, that has been applied with such remarkable success to the languages of Europe, by Grimm and to the Sanskritic dialects by Bopp. Were such a work to be effectually carried out, and were the result this, that the numerals of any reasonable number of these African languages or dialects were found to agree with those in Mr. Thomson's list, I would be first to recognise this fact, and to withdraw the objections I, at present urge. But I must confess I am not very hopeful of the proof of any such agreement between the numerals or, indeed, with any other linguistic system in Africa or in "Indonesia"—the more so, that a very intelligent Negro,—himself a native of the West Coast of Africa, and at present a student at Oxford, tells me that, though familiar with four or five languages on the West, he cannot understand one word of the Eastern language of Zanzibar.

On the other hand, I quite agree with Mr. Thomson, as to the principle of investigation to be pursued in tracing out cognate languages—and the primary words (as he aptly calls them, the "fossils" of language), in that they express the first wants of man, are more tenacious of existence than any others. No doubt, common nouns, pronouns and verbs, when found little changed in a long series of dialects, do go far to prove descent from some one common source. It is, on this very principle, that we speak, and speak truly, of the Celtic, Slavonic and Teutonic languages being akin with Sanskrit, not, indeed, as children to a mother, but as brothers and sisters, the offspring of a parent, at present nameless. As the Roman poet, said so long ago, they may be termed sisters with a strong family resemblance,—

"Facies non omnibus una nec diversa tamen, qualem decet esse sororum."

But though, as I have said, I cannot accept Mr. Thomson's theory for the

* After all, I venture to doubt how far numbers are a safe test of race. The resemblance of numerical systems ascending to high numbers may be, as demanding considerable power of abstraction, but the simplest and smallest numbers up to 5, would seem to be within the reach of the most unlettered savage.

derivation of the Maoris, except so far as he has shewn in his able comparison of the Malagasi, Malay and Tongan languages, I think that there are certain customs prevalent among all or most of the Polynesian Islands, which peculiar to or characteristic of them, do tend decidedly to shew that they were once one people. Thus there is, or has been, in most of them, the worship of a Supreme Being, Tangaloa generally, in New Zealand, Maui, and what is remarkable an almost total absence of Temples, or of anything but the rudest form of Idols. At Tahiti, indeed, and in the Sandwich Islands, coarse wooden figures, which served for such, are noticed in the early missionary narratives. In the Ashmolean Museum at Oxford there is one in stone said to have been brought from Raiatea; and the curious Colossal figures from Easter Island, two of which have lately been set up in the British Museum, may, very probably, have been worshipped by the original population, a different race from the present inhabitants, and perhaps, as has been supposed, of Mexican origin. There seems, also, to have been in Tahiti certain sacred precincts not unlike the old Greek *Temenos*.* The majority of the Gods, however, were deified early chiefs: much as, in ancient Greece, the hero and the God were often nearly connected together. There is, also, much similiarity in the accounts given of the origin of the different islands; that of the Tongans, that they were fished up from the bottom of the sea being a likely story enough for people situated in a vast ocean like the Pacific. In several of the Islands, their Paradise is placed in the far west. Is this an indication of the traditional history of their emigration? Mr. Logan has also pointed out that the leading chiefs, generally bore a title, variously pronounced *Aliki*, *ali'i* or *ari'i*.† Thus in Maori, *ariki* or *whaka-ariki* means a man of high or ancient hereditary descent, and one, therefore, clothed with a peculiar sanctity. Mr. Mariner gives many interesting details of the Religion of the Tongans, before Christianity, and much similiar information may be gleaned from Ellis's Polynesian researches—such as the institution of what he calls the Areoi, a set of wandering players—who devoted themselves to every kind of debauchery—were hated by the agricultural people whom they plundered—but upheld by the chiefs—and, generally, looked up

* There are several words in Hawaian for image as Tü (in the Dictionary *Kü*) as *Kü akua* (*Tü atua*) *He kü*, etc. The last is, probably the same as the Maori *Heitiki*—a charm worn round the neck. In the sacred precincts, animals constantly, and human beings, occasionally, were sacrificed, to please the good or to appease the evil Spirits.

† But to suppose as Mr. Logan further does ("Journ. Ind. Arch.," Vol. IV., p. 355, and note) that Aliki, etc. is the same as the Indo-European "Aryans" seems to me something like Philology run mad. On such a principle any thing may be derived from any thing as *poaka* from the English "pig," or "pork," or "*kuri*" from "cur."

to by the populace at large, as being something Divine, or rather Diabolical. This institution was directly connected with the very prevalent practice of infanticide, especially with the destruction of female children. It would seem that, by some fortunate accident, the customs incident to this institution were not accepted by the Marqesans. Human sacrifice was universal, and Suttee (Sati) not uncommon. Again, there is the institution (probably sanitary), of Tapu (anglice, *Taboo*),* which, extending to all the Islands of Polynesia, is, in an eminent degree, characteristic of them—though not absolutely unknown elsewhere. Mr. Crawfurd used to say that the name and the practice were of Indian origin†—but this may, I think, well be doubted. It is not, however, easy from the very various accounts of it, to decide,—what may have been its most probable origin: its universality, however, proves its antiquity. The Hindu *tapa* (penance) is far from being comprehensive enough; I should rather have supposed its origin in the will of some great potentate or chieftain, who united in himself, as was so often the case in former times, not only in Polynesia, but in classical lands, the double office of King and Priest. Obviously, no institution could tend more fully to foster and support the tyranny of the leading men. While the quite recent, if not still prevailing custom, of disusing certain words or syllables, which, occurring in the names of great chiefs, might be supposed disagreeable to their ears, is, I believe, but one further instance of the power of "tapu." It must be remembered that the usual Maori word for a priest "Tohunga" does not necessarily, bear the title now assumed for it—but is strictly the "*skilled artisan*"‡—the clever fellow, who can turn his

* There is no doubt that the Tapu was a wise provision (made a religious ceremony in order to enforce it more completely) for the purpose of preventing the spread of infection etc., particularly, leprosy. (See Hector, "Trans., N.Z. Inst.," Vol. VI., p. 370).

† It is true that there is a Hindu word of common use (tapas) in the sense of "penance," "ascetic devotion," "self-torture," etc., the like—and that, from it, we get such derived forms, as *Tapaswi*, a devotee; *Tapasya*, austere devotion; *Tapasani*, a female devotee; *Tapodhana*, one rich in devotion—who leads a life of penance; and, in Guzerati, the same word is used for the servant and minister of a Temple—but, I confess I cannot see much connexion between these meanings and that universally given to the Polynesian *Tapu*.—I don't know what word, if there be one, corresponds with the Hindu *Sati*. But the burning the widow in honour of her deceased husband was not an universal custom in Polynesia, moreover, is, in India, an atrocity invented since the laws of Manu.

‡ I suspect the greater number of Tohungas belong to the only tribe which is skilled in wood-carving. They live near the East Cape, and are, frequently, yellow-skinned. Individuals of this tribe are sent for by the other Maoris all over the Islands to do wood-carving for their houses and halls. See "Trans. N.Z. Inst.," Vol. I., p. 446.—J.H.

hand to any thing.* This is clearly seen in Tongan, where *tufunga* means any kind of workman as *tufunga ta maka*, a mason; *tufunga fei cara*, a barber. In an early stage of society, such men naturally take the place of leaders, and if they could add a little superstition to their other abilities, this would help them all the more to keep down the common people. Another custom very prevalent in the Polynesian Islands, though not strictly confined to them, was that of cannibalism. It is true that, in Australia, with a population quite as savage as can be found anywhere else, as also in Micronesia, man-eating was not practised,—moreover, that it was less frequent in the Navigator's Friendly Society and Sandwich islands than in New Zealand, the Marquesas, etc. Still, there can be no question that the practice was occasional everywhere and involved no loss of caste or character on the part of those addicted to it. In some places, too, it would seem that the victims, generally slaves or captives were fattened previously to being killed. Much has been written on this subject, and it has been held up to view as the most atrocious act that man can commit: it seems, however, to me to be, but one more instance of the entire disregard of anything sacred in the human body or in human life, which the stories in the works of Mr. Mariner and Mr. Ellis show to have been so generally prevalent in the Pacific Islands. It is not pleasant to call hard names, but there can be no doubt that, till very recently, murder daily and under every form, was the characteristic practice of all these Island populations. To eat portions of a body so slain—especially, if slain with the view of propitiating some evil spirit, is not unnatural, and has been done in modern times and by people calling themselves Christians.† Another custom, like most of those I have mentioned, very universal among these Islands, though, not absolutely restricted to them was that of Tattoo;—the carving on the outward surface of their bodies,—and, especially of their faces, certain patterns, generally curves, and forcing into the skin thus incised, various pigments most frequently of a blue colour. This custom, though partially practised by some of the Tribes now living in the Eastern outskirts of India, cannot, I believe, be traced to India itself. The word used for it is nearly the same in most of the dialects. Thus, Tahit., *tatau*; (with two special words given by Monkhouse and Cook for tattooing in different

* The oldest English name is believed to be Pratt (the family name of Lord Camden). This is "praet," the "ready" man.

† So lately as in the insurrection of 1848, in the public streets of Palermo, and, during Garibaldi's war of independence, at Messina. A Sicilian Brigand just slain, is stated to have eaten the hearts of the people he murdered (Daily News, October 18, 1865.)

parts of the body, viz., *Tamoraho* and *Tamorau*) Marquesan, *tatu* and *patu*; Nukuhivan, *pikipatu*: Tongan, *Tattu*: Hawaiian, *Kakau*: but, curiously enough, though as much practised there as anywhere else, there seems to be no similar word in the New Zealand language, except the doubtful *Tamoko*, or lizard, is the *Maori* word, possibly from the curved lines they rejoiced in tracing, in parallel lines, on both sides of the face. As to the origin of this curious practice, there is great diversity of opinion, some writers fancying that it arose from a sense of decency; but it seems hardly probable, that a people accustomed, in many of the islands, to wear scarcely any dress, should have adopted, for this reason only, a custom so extremly painful in its operation.*

A more likely reason would seem to be that of striking terror into their enemies; while, if it be true, as Mr. Ellis asserts, that the attendants of the different chiefs were usually tattooed like their masters, only less elaborately, this plan would answer well as a means of identification.

Another curious custom is that of *Cava-drinking*, the nauseous mode of preparing which *Cava*, in the Tonga Islands, is minutely described by Mr. Mariner. I do not know whether this custom is universal, but the word is found in most of the dialects, for a species of the pepper plant.

I think I have now said enough on the subject of some of the principal customs, which, if not all peculiar to Polynesia, certainly prevailed in these Islands more than anywhere else. They are, as it seems to me, essentially such, as would be handed down from family to family, and from tribe to tribe. They are, hardly, such as would be invented by two or three separate sets of peoples, but point, almost as surely as the colour of the skin or the texture of the hair, to a period, when the inhabitants of these widely scattered islands were one people dwelling together. I venture, therefore, to hope that in drawing to a conclusion, this, the Ethnological portion of my Essay, I shall be deemed to have shown some reasonable grounds for believing the Maoris, Tahitians and, generally, the dwellers in Polynesia, with the partial exception of the Fijeeans, One Race, physically, united under one group, with clear and definite lines of demarcation, which separate them from the Dark-skinned people on the one hand, and from the White races on the other.

* I do not know whether Polynesian skins are less sensitive to pain than those of Europeans; but if not, such tattooing as appears in the portrait given by Ellis of the N. Z. chief, Hongi, must have entailed years of suffering. Mr. Logan (I think) mentions a kind of tattoo, in some parts of Melanesia, which must be more hideous to look at, if not more painful in execution, than that of Polynesia. It consists in making great and permanent wales all over the body.

(3). Philology, &c.

In the *Third* portion of this paper, I propose to examine, so far as I can with the limited materials within my reach, the relation, if any between the Maori language as traceable during the last hundred years, and those of the other principal islands of Polynesia; to do, in short, on a somewhat more extended scale, what Mr. Thomson has so well done recently ("Trans. N.Z. Inst.," Vol. VI., p. xxv. Appendix, 1873), in the careful comparison he has made between the Malagasi and Malay, Maori and Malay, Tongan and Malay. In this important paper, he has most successfully demonstrated, and, I believe for the first time with sufficient fulness, the connexion subsisting between these languages; an affinity, which has, indeed, been pointed out before by W. v. Humboldt, Buschmann, Chamisso and others, but, as resolutely denied by other competent scholars, such as the late Mr. Crawfurd.

And I am the more induced to undertake this work, because, beyond what Mr. Thomson has accomplished, and a few remarks by Mr. Colenso in a paper not specially devoted to this subject ("Trans. N. Z. Inst." Vol. I.), I do not perceive that this question has been taken up by anyone else in New Zealand, or, at least, has been discussed as fully as it deserves. I can, of course, only hope, in a very small degree, to supplement Mr. Thomson's researches, especially, as for one or two important branches of the whole subject, I have failed to procure either in London or in Oxford, the necessary books.* Yet, I am in hopes, that this work, though, avowedly, so imperfect, may yet be so far useful, that it will place within a small compass, what seem to be the most striking varieties, at least as regards their *litteral* system, between many of these dialects, and may thus enable

* I had better state, here, the only books I have been able to see with reference to the present enquiry, are Kendal (or Lee's) "New Zealand Grammar, etc." 1820; Williams' "Dictionary of New Zealand and Grammar," 1852; Duff's new ed. 1874; "English Common Prayer in Maori;" Maunsell's "New Zealand Grammar," 2nd edit., 1862; W. L. Williams' "First Lessons in Maori," 1872;" Mariner's "Tonga Islands' Gram. and Dict.," 1827; Andrews' "Dictionary of the Hawaian Language," Honolulu, 1865; Buschmann's "Aperçu de la langue des Iles Marqueses," with notes on the Tahitian language by Baron W. v. Humboldt, 1837; A. V. Chamisso's "Uber die Hawaischen Sprachen," 4to, 1837; Mosblech's "Vocabulaire Oceanesia-Française," 1843, with various papers published by J. R. Logan, in the "Journ. of Ind. Archæology." I should have been most glad to have obtained more information about the Samoan, Low, and other dialects but could not. When I have referred to these, I must be supposed to be quoting (whether or not I specify the page) from the invaluable papers of J. A. Logan.—I have of course, had before me, many if not most of the Navigators of the South Seas, as Cook, Vancouver, D'Entrecasteaux, Dupont, D'Urville, with some other works on the subject, as Ellis' "Polynesian Researches," etc., etc.

other students, on the spot, to follow up these matters, in greater detail,—and, as certainly, to correct many errors into which I have myself surely fallen, in my desire to call attention to those things, which seem to me of most interest and importance in the languages I have been able to examine. The general result, I am convinced will be, a complete and satisfactory proof to all who have time or patience to follow up the steps of the argument, that over a wide range of the Pacific Ocean, including the Sandwich Islands on the extreme north, and New Zealand and Madagascar to the south and south-west, are still to be found ample remains—the "disjecta membra"—of one original language. It may, perhaps, also tend to the solution of the ultimate and still more interesting question, whence, at a remote period, the forefathers of the present occupants of these islands, themselves, emigrated, I venture to add *must* have emigrated—for, in point of fact, Crawfurd's "autochthones" theory is far more difficult of comprehension. Given sufficient time, and, here, I have no evidence against me, even though I am not able to produce evidence in my favour which will convince other people; there is no difficulty, whatever, in conceiving a continued emigration from the East (if Mr. Ellis' theory be preferred), or from the West, which I hope, hereafter, to show is of the two the more probable.

I think it highly probable that the researches of Mr. Thomson combined with the few matters I have, myself, been able to note down in the following pages, may, if more fully carried out by individual scholars at Rarotonga, Manganevu, etc., and, at perhaps, other less known islands, form a useful manual for future and more advanced study; or, at all events, a tolerably accurate record of our present knowledge of these islands, so far, at least, as their languages are concerned. It is, I think, a work that ought not to be delayed, as contact with European civilization—with its languages—together with the natural influence of trade, must every year modify, considerably, the native tongues. Mr. Logan ("Ind. Arch.," Vol. IV., p. 272) says "I saw, lately, some Honolulu youths at Singapore for the first time. Their thoroughly English dress, manners, and speech, were calculated to make a strong impression, after a perusal of the account of Cook's reception and death at Hawaii in 1779." I feel myself certain, that, not many centuries will elapse, ere Tahitian, Fiji (or Viti), and Maori, will be as much things of the past, as Cornish is now in England. With the extinction of these languages, it is not too much to say, that though "race characteristics may best go down in blood" (Whitney, "Life and Growth of Language,") we shall lose an invaluable aid in our endeavours to trace out the "whence" of the Maoris.

I propose, therefore, now, as I believe this is, on the whole, the simplest plan, to take the different parts of speech, separately, in the order usually presented in European grammars, and, in this instance, to adhere to that given by Dr. Williams, as, perhaps, the clearest, though, by no means, the fullest. Dr. Maunsell's work is invaluable for the Syntax; but, with this portion, I do not feel myself at present competent to deal; nor is it, indeed, essential that I should for the object I have here in view. I ought, perhaps, to add here, that Dr. Maunsell and some other writers have objected to the use of the names, *cases*, *moods*, etc., in Maori grammar, because, in it, strictly speaking, as in other Polynesian dialects, we do not find those modifications of the root-stems of the words which occur in Sanskrit, Greek, etc., and which constitute the peculiarity of what are, therefore called Inflectional languages. I venture, however, to think that these names may be usefully retained as conveying, at least, to European eyes and ears, certain definite senses which are in the main true. As a matter of fact, such names might as easily be dispensed with in most modern languages, and are, indeed, only kept for the sake of convenience.

Before, however, I proceed to discuss in detail the various parts of the Grammar, it is necessary to note the principal and constant variations in the consonantal systems of these Oceanic languages and to establish for them so far as it is possible, the common laws of their permutation, after the fashion so successfully applied by Jacob Grimm in the case of the European tongues. There is, indeed, a remarkable regularity in these changes; but I am not, at present, prepared to state that the reason for this is, that any one of them stands to any other exactly in the relation of parent to children. This point I must reserve till the conclusion of my paper. Now many writers have called attention to a larger or smaller number of these variations. Thus, Mr. Thomson, in the article to which I have already referred more than once ("Trans. N. Z. Inst.," Vol. VI., p. 53), has pointed out that, in Tongan, the Maori *p*, *t*, *k*, *r*, and *w*, find equivalents in *b*, *b*, *g*, *l*, and *r*: as, in the following instances,—

Maori ...	*Potiki*	Tongan ...	*Bibigi* (child).
	kuri		*guli* (dog).
	wera		*vela* (hot).

so, too, *h* and *p* similarly interchange, as,

Maori ...	*hua*	Tongan ...	*pua* (fruit).
	huru		*pula* (hair).

Again, Mr. Logan has shewn that *k* is very generally omitted in Samoan, Tahitian, and Hawaian, though present in other dialects, and, in the same way, *l* in Tongan; that *h* appears as *s*, in the dialects of the Samoans and

Fakaafo; *f* as *w* or *h* in Maori, and *h* in Hawaian; that the *v* of the others, is generally *w*, in Maori, Hawaian, and Saumatoan, and that the Maori *r*, is replaced by *l*, in the Fakaafo, Samoan, and Hawaian.

Other changes I have noticed (and I doubt not more are to be found by learned scholars in the islands themselves), such as the double one, in the case of the Maori *wahine* (woman) as compared with the Tongan (*fafine*); the absence in Tahitian of the Maori *ng*;* and, further, the change of the *ng* into *n* in Hawaian, and into *k* in Nukuhivan. The general inference to be drawn from these modifications would seem to be, that the Polynesian dialects (at least so far as we can judge of them from their present forms) do not sharply distinguish between *v* and *w*, *d* and *t*, *l* and *r*, *d* and *r*, *b* and *p*, *g* and *k*; that *t* and *k* are sometimes confounded; and, that one island has an affection for one set of sounds, another for another. In these changes and modifications of sound, the classical scholar is reminded, at every step, of the dialectical changes of ancient Greek, dependent as both the Classical and Oceanic dialects alike have been on the greater or the less education of the ear in different localities.† I should add that Mr. Thomson gives the following proportion of the number of consonants in different dialects to which he has called attention; and this list is certainly curious, as shewing an apparent diminution in the powers of vocal expression, as you proceed from West to East. Thus he states that, while Malay has 18 consonants, Mindanao has 16; Wagi of Celebes, 15; Tanna, 13; Malagasi, 12; Mallicolo, 12; Awaiya of Ceram, 10; Tahiti, 9; Maori, 8; Marquesas, 7; Sandwich, 6: but it should be remembered, that some of these, as Mindanao, Mallicolo, and Ceram, do not fall within what is usually termed Polynesia; moreover, I am not satisfied (not that I doubt that Mr. Thomson has taken his lists from books correctly), that the numbers given above do really represent *all* the consonantal sounds—which accurate ears, combined with sound philological knowledge, would detect in even the existing languages. Mr. J. E. Alexander, who has written an excellent preface to Mr. Lorrin Andrews' valuable Dictionary of the Hawaian language, remarks

* Two-thirds of the Maoris use k for ng.—J. H.

† It is not easy to find words sufficiently distinct to avoid tedious repetition, or the ever-recurring tendency to fancy similar words in one dialect are *derived*, the one from the other. It would be tedious to say invariably "found in" or "occur in," instead of calling what we observe simply a change. According to my view, it would be more *accurate* to say (for instance) that the Maori word *wahine* takes the form in Tongan of *fafine*; rather than to say that *w* and *h* respectively are changed into *f*: all, however, I *mean* to urge is, that if, for argument's sake, a single original Polynesian language be imagined, then, Maori, as a rule adopts one set of consonants, Hawaian or Tahitian another.

as general laws prevailing throughout the Polynesian dialects, that every word and syllable ought to end in a vowel; that most of the radical words are of two syllables; that the accent is usually on the Penultimate; and that the islanders have, as a rule, sharp ears for the distinguishing of vowels, but dull ones for consonants. He, also, points out as characteristic of Hawaiau, and of one or two other of the dialects, that where the *k* (found elsewhere) is omitted, there is, in the middle of the word "a peculiar guttural catch or break." It would be a very interesting subject for research, if missionaries or others, dwelling in the separate islands, and well acquainted therefore, with their marked geographical features, would notice whether any (and what) differences exist between the dialects of the mountaineers and of the low country people, and what are the laws governing the differing pronunciations of languages, presumably the same *radically*. Supposing, for instance, there was still a numerous race of natives living in the Canterbury Plains, these people would almost certainly speak in Maori, dialectically diverse in many ways, from the Maori of the North Island, or even of the west of the Alpine ranges of the Middle Island. Languages in narrow valleys between lofty mountains are often strangely different the one from the other, though, unquestionably, those of one family.

As it is of great importance to keep clearly in view the nature of these changes, I submit, here, a list of them from the Preface to the Hawaiian Dictionary, drawn up I presume by Mr. Alexander, as it very clearly shows what we may expect to find in each case. This list differs, in some slight matters, from the opinions quoted by me from Mr. Logan, but, having been drawn up on the spot, may, I have no doubt, be quite depended on.

Fakaafo.	Samoan.	Tongan.	Maori.	Rarot.	Tahitian.	Hawaiian.	Marquesan.
F	F	F	W or H	Wanting	F or H	H	F or H
K	'*	K	K	K	'	'	K
L	L	L	R	R	R	L	Wanting
M	M	M	M	M	M	M	M
N	N	N	N	N	N	N	N
NG	NG	NG	NG	NG	Dropped	N	NG, N, or K
P	P	P or B	P	P	P	P	P
S	S	H	H	Wanting	H	H	H
T	T	T	T	T	T	T or K	T
V	V	V	W	V	V	W	V

The meaning of this is, that when a word in one dialect begins with a certain letter, it will probably be found (if, indeed, it occurs at all, which is by

* The apostrophe is to shew the omission of the K mentioned before as producing "a guttural catch or break."

no means always the case) under the corresponding letter in the preceding list. The following list of words, taken from the same preface, illustrates this matter even more clearly,—

Fakaafo.	Samoan.	Tongan.	Maori.	Rarot.	Tahitian.	Hawaian.	Marquesan.
Foe	Foe	Foe	Hoe	Oe	Hoe	Hoe	Hoe
Tonga	Tonga	Tonga	Tonga	Tonga	Toa	Kona	{ Tonga Tona
Sina	Sina	Hina	Hina	Ina	Hina	Hina	Hina
Ika	I'a	Ika	Ika	Ika	I'a	I'a	Ika
Vaka	Va'a	Vaka	Waka	Vaka	Va'a	Wa'a	Vaka
Songi	Songi	Hongi	Hongi	Ongi	Hoi	Honi	Hongi
Tufunga	Tufunga	Tufunga	Tohanga	Taunga	Tahua	Kahuna	Tuhuna
Kupenga	'Upenga	Kupenga	Kupenga	Kupenga	'Upe'a	Upena	Kupeka

In the same preface, it is further remarked that *r* and *d* are often hardly distinguishable from one another, a fact, which I notice has been preserved in Lee's (or rather Kendal's) "New Zealand Grammar," where *dua*, *todu*, *dima*, and *wadu* are found instead of the present spelling of, *rua*, *toru*, *rima*, and *waru*; that, in writing Hawai, *k* has been "erroneously"* adopted in the place of *t*; and that, throughout the dialects, there are comparatively few changes of vowels, and, when these occur, they are usually owing to consonantal influences. Thus, in Hawaian, *hohu*, *honua*, *maia'*, and *maika'i* represent the *feta*, *fenua*, and *maitaki* of other dialects. Mr. Alexander, also, thinks that, in the consonantal sounds, the Hawaian is one of the softest and most attenuated of the dialects, being surpassed in that respect only by the effeminate Marquesan.

I proceed now to take the different parts of the Grammar in the order set forth in Dr. Williams' "Grammar," noticing—

I. The *Articles*; and, here, I at once observe a very general agreement, such modifications as there are, applying usually only to the initial letters. Generally, with the exception of the Tongan, each dialect has a Definite and Indefinite Article. Thus Maori has *te* and *he*: Tahitian, Rarotongan, and Mangarevan, *te* and *e*: Hawaian, *ke* (for *te*) and, sometimes, it would seem from Buschmann, *he*; in Tongan, *he* is the only article, but *ko* is often used in answering a question, as, *koa tangata*, a man. When several things come together, *ko* is generally used and *he* omitted, and so before proper names—as, *ko Tuo*, *ko Koumete*, *ko Finow*. Dr. Maunsell has further, I think, rightly considered that the indicator of the Plural in Maori (*nga*)

* If this adoption of the *k* for the *t* be really an *universal* error, as implied in this statement, it cannot be too soon corrected, as it may gravely mislead those students, especially in England, who are attempting to trace the inter-connexion of the different dialects of Polynesia. But this must be done, if at all, at Honolulu, and by authority.

partakes of the nature of an article as do, also, *te tahi* (literally *the one*) and its plural *etahi*.* The latter, he thinks, corresponds very nearly with the use of the French *des*, or the adjectival "some" of English. Thus—

Te tahi maripi, a knife ; *maku etahi ika*, give me some fish.

He shews, also, that *te* is used

1. Where no article is required in English, as, *he kino te tutu*, disobedience is sinful.
2. In the place of the English *a*, as, *he mea kaha te hoiho*, a horse is a strong thing.
3. Sometimes for the pronoun "some," as, *kei tahaetia e te tangata*, lest it should be stolen by some one.
4. Before proper names, as, *Te Puriri*, etc.

Somewhat similar variations may be noticed in the case of *he*, which, like *te*, is often used where no article is required in English, in the sense of "some," and, before nouns in the plural number, as, *kawea he wai*, fetch some water ; *he tini oku kainga*, my farms are many.†

I must mention here that Mr. Logan, to whom all students of "Oceanic" Philology are so much indebted, has pointed out ‡the curious fact that, in what he calls *W. Indonesia*, *i. e.*, Sumatra, Java, etc., the definite article is *si* : this *si*, he thinks, is nearly connected with the Polynesian *tahi*, *tasi*,—and, probably, with the modified forms *se* and *he*. In like manner, other forms such as *iti*, *ti* and *te*, resemble closely the Polynesian *te* and *ta*. Again, *an* and *ang*, which occur frequently in an appellative sense, have a striking similarity to the Polynesian *na*, *nga* : while the *ka*, *kua*, and *koe* of Maori, Tongan and Saumatoan, would seem to be connected with similar forms in the dialects of *W. Indonesia*. In a former essay, || the same distinguished scholar has shown, that there are many characteristic features in Polynesian, which have not been preserved, either in Sanskrit or in any of its modern derived dialects, but, which are, at the same time,

* The forms corresponding with *etahi* in the different dialects have a strong family resemblance. Thus—

Rarotongoan has	*tetai, etai.*
Mangarevan	*mai.*
Hawaiian	*tahi* and *tetahi* (and *wahi*) which is also found in New Zealand.
Samoan	*sa, setasi, letasi, etasi.*

The Tongan (like the Mangarevan) is different—viz., *na*, *foenihi* (compare here the Samoan, *nisi*), and *etaha*.

† Buschmann (p. 168) points out that, in Tahitian, *taoua* . . . . *ra* sometimes occurs for the Definite Article ; and *te hoe*, *maa*, *te maa*, and *te hoe maa* for the Indefinite.

‡ "Journ. Ind. Arch.," Vol. VI., 1852.

|| "Journ. Ind. Arch.," Vol. IV., 1850.

found in Greek and other western Indo-European languages. Thus, this very definite article, lost in Sanskrit or Malay, but common in Greek, has remained in full use in Polynesia and, what is more curious, in even the mountain dialects of the rude *Khasias* of *Assam*.

II. *Substantives*. Are distinguished according to their gender, number, whether singular or plural, and case. Of these, the first, in most of the dialects, is shown by attaching to the word, another one signifying male or female.

Thus Maoris use *tane* and *wahine* when applied to human beings, *tourawhi* and *uwha* when applied to the brute creation or inanimate objects—as, *He matua tane*—*He matua wahine*—*He kararehe tourawhi* (a male beast)—*He kararehe uwha* (a female beast). Maori has, also, according to Dr. Maunsell (p. 19), several distinct words for specially related men and women as *Tuahine*, a man's sister—to which it is not necessary to refer to more fully here. The words and their use in the other dialects are nearly the same. Thus—

In Tongan and Samoan, *tane*, *fafine*.

,, Rarotongan, *tane*, *vaine*.

,, Tahitian, *tane*, *vahine*.

and for animals, *oni* and *ufa* (Buschm., 168.)

,, Hawaiian *kane*, *vahine*.

The Plural is shown in several ways, but most simply in Maori and Rarotongan by the prefix of *nga*, as, *tangata*, a man, *nga tangata*, men. There are, however, in Maori other methods of expressing plurality such as placing before the noun some of the plural or dual pronouns, as, *aku tupuna*, my forefathers.* Sometimes *o* is used as, *kei o Hone matua*, with John's uncles; sometimes the ground form is altered—as, *tamaiti*, a son, *tamariki*, children. Occasionally *ma* is added, with, as Dr. Maunsell suggests, the Greek sense οἱ ἀμφι, οἱ περι (viz., a person and his company) —as, *kei a Kukutai ma*, with Kukutai and his party; while a constant repetition of the same act may be designated by a reduplication of one or more syllables, as, *kimo*, to wink, *kimokimo*, to wink frequently.

* The singular may also be denoted by a singular pronoun as *toku paraikete*—my blanket.

† When a special stress is needed to show that only one object is meant, Tongan inserts the particle *be* (only), as, *togi be taha*, axe only one.

In Tongan the plural, in the case of things inanimate, is mostly denoted by the particle *e*, combined with a numeral, as, *toji e ua*, axes two; *falle e tolu*, houses three, etc., or, when an indefinite number is required, by *lahi*, many or several; as, *lahi e vaka*, many canoes.† In animate objects, a distinction is made, as to whether they are rational or irrational beings, the particle *toko* being used with a numeral, in the former case; as, for instance, *tangata te tokotahi*, one man only; *fafine toko toru*, three women; *tokotahi e tangata*, many men. Two other words (probably old collective nouns) sometimes occur, viz., *kau* and *tunga*, as, *kau* or *tunga tangata*, a body of men; *kau tangata tokoterau*, a body of men, a hundred. In Hawaiian, the Plural is shown by *na*, *pue*, *mau*, with article *te*, *hui*, *feia* according to Buschmann, and, in Marquesan, by *mau*. There are, no doubt, many other modifications—as the Rarotongan *au* and *kau* both in Tongan and Hawaiian (Buschmann), *tau* in Nukuhivan (Mosblech); but these are sufficient to show the resemblances between the Dialects in this particular.

The cases in Polynesian (if, indeed, there be any, which Dr. Maunsell, I think rather unnecessarily, calls in question) are clearly indicated by prefixing various particles, generally prepositions. Thus the *Nominative* is denoted in Maori, Tongan, Rarotongan by *ko*, and, in Tahitian, Hawaiian and Nukuhivan, by *o*. This particle is found before the article *te*,* and the possessive pronouns, as well as before Plural particles, which precede the substantive. According to Buschmann, *o* occurs sometimes in Nukuhivan texts to mark the Accusative. The *Genitive* is, usually, shewn by the prefixes of *no*, *na*, *o* and *a*. Of these, *o* is the most common; while *a* is used, in a restricted sense, before living things. *To* and *ta*, also occur, and, in Hawaiian, *ko*, *ka*. The same pairs of prepositions serve to form the possessive pronouns by union with the personal. M. Buschmann remarks that those with *a* generally indicate a dependent, those with *o* an independent relation, and, further, that the genitival form in *a*, *o*, *na*, *no* follows the governing word, while *ta* and *to* precede it.

In all the Polynesian languages, when two nouns come together without any particle between them, the second is considered to be in the genitive case.

The *Dative* is very regular. Thus, in Maori, Tongan, Rarotongan, and Mangarevan it is shewn by the prefix of *ki*: and, in Hawaiian and

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* The older form of the Island names Otaheite, Owhyhee, illustrate this; being O Tahiti, O Hawaii—so, also, the native name of the island Dominica—Hivaoa—which is written by Marchsand. Ohivaroa (O Hivaroa), and by Krusenstern. Ohivaoua (O Hivaoua).

Tahitian by that of *i* only. Before Proper names of Persons, and before the Personal pronouns, *ki* becomes *kia* in Maori and Rarotongan, as, in Tongan, *gui*, becomes *guia*. M. Buschmann points out that, after the verb *to give*, the Dative of the person is expressed by the preposition *na* and *no* in Rarotongan, Tahitian, and Hawaiian, and that he has also detected *na* in Marquesan, as, *a tuu mai na matuu*, give us our bread.

The *Accusative*, when marked at all, is, generally, shewn by a preceding *i*, in, at least, Maori, Tahitian, Hawaiian, and Rarotongan—and this *i* likewise becomes *ia* before proper names. In a great many cases, the substantive alone after the verb is sufficient, as, in the instance, from the Nukuhivan given by M. Buschmann, *aperau te nata*, call the man. The *Vocative* is marked in Maori, Rarotongan, Tahitian, Hawaiian, and Marquesan by *e*, preceding the noun. Occasionally in Tahitian and Hawaiian, *e* is found after, as well as before the substantive.

The *Ablative* is indicated by *i* or *e*, the first being used to express means, cause or manner, while *e* is more usual after a passive verb.

Taking next—

III. *The Adjective.* The most general of all rules relating to the Adjective is that it follows the substantive and has not of itself, any distinctions of gender or number. It is usual to prefix *ka* when the adjective is alone, as *ka roa*, long; *ka poto*, short; but, when with, that is, after a substantive, the *ka* is omitted, as, *he rakau roa*, a long tree. Comparatives and Superlatives are formed by particles; by one or more words prefixed or post fixed; or by a repetition of the adjective itself, as, *he waka nui, he waka nui atu, he mea nui nui*. In some cases, the comparison is shewn by the insertion of the particle i, as, *nui atu tenei waka i tera*. This canoe is bigger than that—or without the *i*, as *pai rawa te hanga a te tangata nei*, this man's performance is best; in both of which latter instances, the adjective precedes the noun. The Plural is, being generally, made by a reduplication of the first syllable of the adjective—thus, *he rakau pai*, a good tree; *he rakau papai*, good trees: Archdeacon Williams however, remarks that these changes or modifications are not invariable, and that the simple form is often used in the plural. The reduplicated one, however, is *restricted* to the Plural. He adds, that the result of doubling *both* syllables of the roots is to diminish the intensity of the meaning of the root; as, *wera*, hot; *werawera*, warm (Dict., 1871, p. 8). In Tongan, there are some modifications. Thus, *fu*, great, very; *foe*, whole, entire, etc.; *fu lahi*, very many;—come before the substantive,—indeed, are used to a great extent, adverbially—hence, we find, *fu ita*, great anger (*i.e.* very angry);

Fa ulu, a single head—or the whole head; *Fa ufi*, a single yam, or an entire yam. Again, an interchange not unfrequently occurs—substantives being used as adjectives or *vice versâ*, as, *he vaka Fiji*, a Fiji Canoe. In some cases, adjectives are derived from substantives by adding *ia* or *ea*—as, *mafanna*. heat; *mafannaia*, hot. In degrees of comparison, Tongan is nearly the same as Maori—but, the substantive verb would seem always to come first, as, *gua lille ange he mea koeni gi he mea koia*—is, better this than that thing (Mariner, p. 12). The superlative is, generally, made by the addition of the word *obito* most, very—as, this axe is the best, *koe togi koeni gua lille obito*. Dr. Maunsell observes that in Maori, adjectives, generally, take the *form* of the noun with which they are connected—*i.e.* if the noun be verbal, so is also the adjective—as, *oranga tonutanga*, Eternal life; that, when there are several qualities, the noun must be repeated with each quality; as, *he tangata nui, he tangata pai*, etc., that a common mode of denoting inferiority of degree is to associate together two contrary qualities as, *pai kino*, good—bad, *i.e.*, indifferently good; *Roa poto*, long—short, *i.e.*, of moderate length, etc., and, lastly, that, to represent the superlative degree, the definite article is sometimes prefixed with or without some word of intensity, as, *ko au te kaumatua*, I am the eldest son; *ko te nui tenei o nga rakau katoa*, this the large one (*i.e.*, the largest of all the trees).

M. Buschmann remarks that, while the determining adjective comes after the substantive, an adjective preceding, it acts as its attribute, in connexion with the verb "to be." Thus, in Tahitian, *te mauna roa* is, the high mountain, while *e roa te mauna* means, the mountain is high (p. 173). Again, in Tahitian the comparative is made by the particles *aê* (*ange* in Tongan) and *atu* (so in Maori) placed after the Adjective.

Mr. Logan has suggested ("Journ. Ind. Arch.," Vol. V., p. 219), that the system of reduplication so prevalent in the Polynesian dialects is due to a love of "euphonic echo," and that, by this means, plurality, intensity, repetition and reciprocity, are very effectively expressed. The same system prevails in Malay, and, occasionally, in Javanese, but it is far more extensively used in the Polynesian dialects than elsewhere. Thus, in Samoan, *lau utele*, is, a great tree; *lau utetele*, large trees. Rarotongan, *Maki*, sick; *maki maki*, sick persons. Javanese, *homa gede*, large house, *homa gede gede*, large houses. Again the Superlative in Viti (Fiji) is made of the reduplication of the Adverb, thus *levu sara sara* means, very very great. In Javanese, the same effect is produced by doubling the adjective—as *duwor duworre*, the highest. So, too, adverbs may be doubled, as *genti genti*, by turns. For intensity of action, we find in Tongan, *tete*, to tremble; *tete tete*, to tremble much. So Rarotongan, *kati*, to bite; *kati kati*, to bite much. Hawaiian, *lawe*, to take; *lawe lawe*, to handle. Again, for repetition, plurality and reciprocity, we have in Maori, *inu*, to drink; *iinu*, to drink frequently. Tahitian, *amaha*, to split, *amahamaha*, to split repeatedly. Hawaiian, *lele*, to jump; *lelelele*, to forsake, repeatedly, (as a man his wife.) Nukuhivan, *pepi*, to strike; *pepehi*, *pehipehi*, to strike hard and often. Samoan, *fefe*, to fear; *na fefefe i latau*, they were afraid; *moe*, to sleep; *momoe*, to sleep together. Tongan, *nofo*, to dwell; *ke mau nonofo*, to dwell together. Rarotongan, *tae*, to come; *e tatae atu ra raua*, and they two arrived. Tahitian, *Taoto*, to sleep; *taotooto*, to sleep together. In Javanese, *hambedil bedil*, means, continuing to shoot; *bali*, to return; *bali bali*, always returning. Vitian, *ravu*, to kill; *sa vei raravui*, they are killing one another. So, again, in Vitian, *kamba*, to climb; *kamba kamba*, a ladder. Tongan, *lolo*, oil; *lolo lolo*, oily. Rarotongan, *paka*, a stone; *paka paka*, stony.

IV. *Numerals.*—In dealing with these, I am in great measure relieved from further labour, by Mr. Thomson's learned and admirable paper on the "Barata Numerals"; and though, as I have stated, I cannot accept the special view which he advocates, I, at once, bear most willing testimony to the great ability shewn, not only in this paper ("Trans. N. Z. Inst.," Vol. V., p. 131), and, in his two other papers "On the 'Whence' of the Maori," which I have also noticed previously. Both these papers I have read three or four times over. I am, however, afraid, that, within the limits of my present paper, I shall not have space for any further examination of the questions Mr. Thomson has brought forward and discussed, but I may do so, hereafter, if I am able to procure the necessary addition to my at present, very limited supply of materials: meantime if I differ from him now, and may do so still more, if I ever have time, as I hope I may, to examine all his arguments as fully as I am sure they deserve to be examined, I rejoice to recognize in him a man, who has done, in the branch of Philology to which he has given his attention, first-rate work. I purpose, therefore, here, merely to point out what seem to me the chief characterictics of the Polynesian system of numeration, reserving for the present, any further discussion of Mr. Thomson's "Bharata" Theory. With reference to the spelling of the Numerals, I have, in the case of the Maori, taken the forms given in Dr. Williams' most recent dictionary (1871); and, for the other dialects, that I have found most common in the books I have before me.

The following table gives the leading forms:—for those of the Marquesas, Gambier and Hawaiian, I am indebted to M. Mosblech; for the Tahitian and Hawaiian to M. Buschmann compared with Mr. Andrews, and Adalbert von Chamisso; and for the Tongan, to Mr. Mariner—

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Maori	tahi	rua	toru	wa	rima	ono	witu	waru	iwa	ngahuru
Tongan	taha	ua	tolu	fa	rima	ono	fitu	valu	hiva	hongofulu or ulu
Rarotongan	tai	rua	toru	a	rima	ono	itu	varu	iva	ngauru
Samoan	tasi	lua	tolu	fa	lima	ono	fitu	valu	iva	safulu,ngafulu
Mangarevan	tai	rua	toru	a	rima	ono	itu	varu	iva	ngauru
Tahitian	tahi	rua or piti	toru	éha ha maha	rima or pae	ono or fea	hitu	varu or vau	iva	ahuru
Hawaiian	tahi	lua	tolu	ha tauna	lima	ono	hitu	valu	iwa	umi

I shall, therefore, only remark here that it is usual to place before the numeral, certain particles; of these, *ko*, *ka*, *e*, and *a* vary least in their several uses. Thus, in Maori, *ko* is invariably used before *tahi* and *pu* or *topu* for one pair;—thus, *ko tahi pu*, is the usual form for one pair. *Ko tahi*, *ka rua*, etc., answer the question, how many, as here, one, two, etc. When necessary, the individualization *taki taki* is made use of, as, *ka waru taki taki nga kete*, there were eight baskets once told. Again, for distribution, *tá taki* is prefixed to the numeral, as, *kia tátaki rua pu nga utu i te tangata*, let each man have four payments. So, *taki whitu*, means, by sevens. *Toko* is used when speaking of persons only, up to nine; *hoko* for multiples of ten. *E* occurs before all the numerals except *tahi*, but is not so definite as *ka*. The ordinals are generally expressed by *tua* or *whaka*, as, *tua iwa*, *whaka tekau*, or by a cardinal with a definite article, as, *ko te wha tenei*, etc.

In the other dialects, the arrangements of particles, etc. is nearly the same. Thus Hawaiian often puts *hoo* before *tahi*—and *ma* is, generally, used to connect the different numerals as, in—

Rarotongan—*ngauru ma tai*	Each meaning 10 + 1=11.
Maori—*ngahuru ma tahi*	
Samoan—*sefula ma tasi*	
Tongan—*hongofulu ma taha*	

In fact, as I have said in the case of Maori, so, in other dialects, we find *toa too*, *toka*, used for numbering persons—as, Hawaiian *too piti*. Tongan, *toka hongofulu*. Samoan, *toa safulu*, etc.

The ordinals are arranged on the same principle, as in Maori. Thus we find *ko te wa* for fourth; so in Tahitian, we have, *o ta ha* (or *éha* or *maha*); and in Samoan, *o te fa*. Lastly, as Maori has *tua ngahuru* for the tenth, so Rarotongan, has *tu rua*. Hawaiian, *tua lua* and *tua tolu*; and Tongan, *tuo ua* or *tuo tolu*.*

V. *The Pronouns*, of which there are five Classes, Personal, Possessive, Demonstrative, Relative, and Interrogative, are somewhat complicated, but, chiefly so, from the number of words, many of which, in English, we should consider had only a *quasi* pronominal value. As a rule, they exhibit, throughout all the dialects I have been able to compare, a remarkable similarity, moreover are mostly found in all the three numbers of the Singular, Dual and Plural.

It will be simplest to refer to each class separately, so I take *first* the Personal Pronouns :†

The following scheme gives the First Persons of *Personal Pronouns* in the different Dialects :

—	Singular.	Dual.	Plural.
Maori ..	hau, koe, ia	maua, taua, korua, raua	matou, tatou, koutou, ratou
Rarotongan	au	same	..
Mangarevan	au	same	..
Tahitian ..	au, oe, oia	maua, taua, 'orua, raua	matou, tatou, 'outou, ratou
Hawaiian ..	au, oe, ia	maua, taua, olua, laua	matou, tatou, 'outou, latou
Samoan ..	au, ou, oe, ia	maua, taua, olua, laua ma, ta, lua, la	matou, tatou, outou, latou
‡Tongan ..	te or oa, ger-ia	mau, tau	mo, rau.

The chief point to notice here is that the Dual and Plural are formed by the addition of the numbers, two and three, to the radical of the pronouns; but the roots differ from the singular and the numeral is somewhat contracted. Thus—

We two (inclusive) is in Maori, Rarotongan, Tahitian, Marquesan, *taua;* Tongan, *guita uua*; Hawaiian, *kaua*.

We two (exclusive) in Maori, Rarotongan, Tahitian, Hawaiian, is *maua;* Tongan, *gui ma uua*.

You two—korua, Maori, Rarotongan; *orua*, Tahitian; *olua*, Hawaiian; *guimoua*, Tongan.

In these we see the respective additions, of *rua*, *lua*, *ua* (two).

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* I ought to add that Forster (in his notes on Capt. Cook's Voyages), puts before all his Numerals *ebo*, as, *ebo dahai*, 1; *Ebo houa*, 2. But, as *bo* or *po* is the usual word for *night*, this evidently refers to the habits of the natives, who count by nights, as we by days. In Tahitian, *rui* is often used for night.

† I am indebted for this list partly to the Maori Grammars of Kendal, Williams, and Maunsell, and partly to the works of the Abbé Mosblech and M. Buschmann.

‡ I do not feel sure that the above is quite correct. Any how Tongan differs a good deal from the others

The two (i.e., one and the other)—*raua,* Maori, Rarotongan, Tahitian; *laua,* Hawaiian; *guinaua,* Tongan.

In the *Plural*—

We (inclusive)—Maori, *tatou;* Rarotongan, Tahitian, and Marquesan, *tatoou;* Hawaiian, *kakoou;* Tongan, *guitautolu.*

We (exclusive)—Maori, *matou;* Rarotongan, Tahitian, Marquesan, *matoou;* Hawaiian, *makoou;* Tongan, *guimautolu.*

You—Maori, *koutou;* Rarotongan, *kotou;* Tahitian, Marquesan, *outou* Hawaiian, *oukou;* Tongan, *guimotolu.*

They (masculine and feminine)—Maori, *ratou;* Rarotongan, Tahitian, *ratoou;* Hawaiian, *eakoou;* Tongan, *guinautolu.*

M. Buschmann points out certain peculiarities in the above Tongan words, as, for instance, the use of *gui,* the preposition of the Dative, and *mo.* The Tongan also uses the pure form for *three,* namely *tolu* (Maori, Rarotongan, and Tahitian, *toru;* Hawaiian, *kolu).* The Rarotongan, Tahitian, and Hawaiian drop the consonant of the numeral, and the Maori makes a further contraction of the vowels. In Tahitian, *aou* of the Pronoun of the First Person Singular is abridged into *ou,* after the prepositions *a, o, na, no, ta, to, ia* (Buschmann, p. 181), the elision being denoted by an apostrophe; and the pronoun *ia,* both in Tahitian and Marquesan, generally combines with the *o* of the Nominative and Accusative, making *oia;* and, also, after the above preposition, takes the form *na,* preceded by an apostrophe, as, *to ia* becomes *to'na,* of him, his; *ia'na,* to him, etc., for *ia ia.** But the most remarkable thing in the Polynesian personal pronoun is the existence of two distinct forms in the Dual and the Plural, distinguishing those persons who are really subordinate to the speaker from those who are not. Thus *Maua,* we two, means, I and my associate, not you. *Taua,* we, that is, I and you. So *Matou,* we (not you); *tatou,* we (with you). Mr. Logan points out ("Journ. Ind. Arch.," Vol. V., p. 231) that this remarkable idiom is found, also, in the Malay and Philippine languages. The speaker is considered as the centre of being and action, and, in agreement with this, the present and future tenses are, as a rule, indicated in the Polynesian dialects by the definite article. Mr. Logan also thinks, that, to the idea of personality, which has a great influence in crude national minds and languages, is due, also, the double form of the possessive; viz.,

* It is a pity that more care has not been taken in the printing different Polynesian dialects. M. Buschmann observes that sometimes the pronoun of the second person is contracted in such a manner that you cannot tell whether it is for I or you, my or yours. The American missionaries, on the other hand, he adds, distinguish in Hawaiian thus; writing *a'ou, na'ou* for of me, mine, and *aou, naou,* of thee, thine.

that which is mine attributively—or to possess merely, being indicated by the vowel *o*, while, that which is mine, objectively, or instrumentally, to act on or with, takes the stronger vowel *a*. M. Buschmann considers the peculiarity of the *Mo*, in the Tongan second person Dual and Plural, is also due to Western Malay influence; *Mou*, in Malay and Javanese, signifying you, yours, as *Mo* does in Tagala.

I ought to add, that Dr. Maunsell considers some of the *Possessive* pronouns in Maori, are declensions of the Personal pronouns, as

Naku / *Noku* } mine.	*Nau* / *Nou* } thine.	*Nona* / *Nana.* } his or hers,

and, so, also, *Ia*, as *I a ia*, from him, her; and *Mona* or *Mana*, for him or her.

Mr. Williams further thinks, that, with the exception of *taku*, *tau*, and *taua*, they have been formed from the genitive cases of the Dual and Plural numbers of the Personal pronouns. Thus he considers, *to taua kainga*—the abode of us two—is properly, *te kainga o taua*, the article *te* and preposition *o* having coalesced.

The *Possessives* in Maori are—

Pers.	Sing.	Plur.
1st	*Taku, toku.* *Ta matou, to matou.*	*Aku, oku.* *A matou, o matou.*
2nd	*Tau, tou, to.* *Ta korua, to korua.* *Ta koutou, to koutou.*	*Au, ou, o.* *A korua, o korua.* *A koutou, o koutou.*
3rd	*Tana, tona.* *Ta raua, to raua.* *Ta ratou, to ratou.*	*Ana, ona.* *A raua, o raua.* *A ratou, o ratou.*

Generally, but, not invariably, *taku*, *tau*, *tana* are used, when speaking of any thing done by or proceeding from a person, while *toku*, *tou*, *to*, and *tona* apply to something suffered by, or, in the possession of a person. Thus, *taku kakahu*, means, the garment I am making: *toku kakahu*, that belonging to me, or which I am wearing.

The resemblances between Maori and the other dialects are, here, well marked. Thus, the Rarotongan is almost identical with the Maori, while the Mangarevan has *takoe*, *tokoe*, and the rest the same. Some, like the Tahitian and Samoan, have a contracted as well as a longer form, as Tahitian, *tau*, *tou*, *nau*, *nou*, *au*, *oe*, etc.; Samoan, *leau*, *loau*, *lau*, *lou*, *aau*, *oou*, *au*, *ou*, etc. Generally, M. Buschmann's view holds good, that the genitives of the Personal pronouns, formed with the three pair of prepositions, *a*, *o*; *na*, *no*; *ta*, *to*; (in Hawaiian, ka, ko) expresses fairly, the possessive pronouns in the Polynesian dialects. The selection between those six forms by each separate dialect takes place on the same principles which regulate the formation of the genitive; the pronouns formed by the prepositions *ta* and *to* being placed before the substantive, and taking the case sign *o*; those formed by *na*, *no*, *a*, or *o*, following the substantive. M. Buschmann adds, that, in his Marquesan texts, he finds *tou* (for my) and *to* (they), the latter also occurring in Tahitian.

The *Demonstrative* Pronouns are preserved most completely in Maori, as,

Singular.		Plural.	
tenei	this.	*enei*	these.
tena	that.	*ena*	these.
tera	that (further off).	*era*	those.
tana	that.	*au*	those.
	(referring rather to objects.)		

Rarotongan is nearly the same—

teia or *eie* *teianei reienei*,

and modified forms, such as *te reira*, *taua nei*, *aua nei*, *taua ra*, *aua ra*.

Dr. Maunsell points out that *tenei* (and its branches) are derived from *te* and *nei*, and are resoluble, as,

ho mai te mea na
or } Give me that thing.
ho mai tena mea

and, that *ia* is also sometimes used demonstratively, as, *tona wenua kai ha ia*, this is the very land of food.

The Samoan has—

lenei	this.	*nei*	these.
lena	that.	*na*	those.
lela / *lea*	that.	*ia* / *lae*	those.

The Tongan is more defective, and has only, *heni*, this or these; *hena*, that or those, wanting, therefore, the adverb and pronoun of the third person, with the usual prefix of *ko* or *a*; but Mr. Mariner observes that there is very little distinction between *koheni aheni* and *kohena ahena*, here, as in Maori, and, elsewhere, the particles may be separated, as, *hé tangata na*, that man there.

M. Buschmann observes that the Tahitian *tëi*, *téie*, *éië*, correspond, in meaning, with the French *ceci*, or *celui-ci*, that is, the person nearest the speaker; while *tena* agrees with *celui-là*, the person or thing furthest off. He states, too, that, besides *tera*, there is also a form *vera*, used only in the

Plural. *I* or *ëi* is clearly part of *nei*, as is obvious in the Rarotongan, *teiënëi*. In Marquesan (Nukuhiva) he mentions, *i tëië nee*, to-day.

tëei } ce, celui-ci
tëië nëi }

The local relations are formed by the connecting the substantive with one of the three adverbs of locality, *nei*, *na*, or *ra*, as, *taua*, *taata*, *na* or *ra*, this man. Malay and Tagala, especially, preserve similar local relations.

Relative pronouns, as distinct from others, do not appear to be used in the Polynesian dialects, generally they are, in fact, supplied by the sense of the passage, or parts of other pronouns are used for them. Thus, in Maori, the personal pronoun is used for the genitive. as *ko te tamaiti tenei nona te ringaringa i wera i te ahi*, this is the child whose hand was burnt in the fire (Williams, p. xxii.); or by *ai* after the verb, as, *kei hea te pukapuka i tuhi-tuhi ai koe*, where is the letter that you wrote? *Ai* is sometimes similarly used, as, *nana ahau i ora ai*, his (was the effort) by which I was saved. In the other dialects, similar devices are adopted. Thus, in Hawaian, *te*; Tahitian, *tei* and *otei*; Rarotongan *tei* and *ko tei* are met with.

In the case of the *Interrogative* Pronouns, it seems to me that it is difficult, in many instances, to decide whether some of them are not more properly adverbs. Those, however, usually given in the Maori grammars are:—

Wai }
Kowai } Who? Restricted to persons, as, *Ko wai tera tangata*, who is that man?
K' wai }

Aha. What? Restricted to everything meaning kind.

Tehea }
Hehea } Which? With reference to things.

Besides these, Dr. Maunsell notes *kohea* and *pehea*, and adds that plurality is sometimes obtained by using *ma* (as we have seen before), as, *Ko wai ma ena*, who are they?

The use of *tehea* is seen in the sentence, *Ko tehea o nga waka i pakaru?* which of the canoes was broken? *Ko ehea tangata au e ki nei?* which men did you speak of?

In Tongan, Mr. Mariner gives—

Kohai, Ahai?	Who?	With the same distinction as in Maori, between—
Koeha	Which?	
Koehe heha	What?	(1) Men.
Ahai	Whose?	(2) Inanimate objects or brutes.

As, *Kohai tangata ko hena*

Koe tangata kohena ahai ?

But, *Koe togi ko ena heha ?* What axe is that ?

In the same way, *ki heha* means, to which ?

i he ha ,, by what ?

fi ha (for *fi he ha*). How many ?

M. Buschmann (p. 184) points out that, in Tahitian, the forms are :—

Aha (possibly, the Malay *apa*, and Javanese *hapa*) answering to the the French *quoi ? pourquoi ?*

é aha (in Rarotongan, *éaa*)

tëi hëa (derived from *hëa*, when, which is used in Hawaiian adverbially as well as pronominally)

rai }
orai } the sign of the Nom. with reference to persons.

ëhia, in the sense of "combien," "how many ?" (possibly the Javanese *pira*), as, *ëhia fare ?* How many houses ?

At Nukuhiva—he finds

orai

orai aïoa—quel est le nom ?

ëha tëëi—qui est celui-ci ?

As, *ëha te méa nëi ?* Who is it ? What is it ?

ëha ta oe—What are you doing ?

The Samoan shows the greatest simplicity of forms, and has rejected even more consonants than Hawaiian or Tahitian. Thus, I find—

ai ?—who ? As, *ko ai tou ingoa ?* What is thy name ?

i ai—to whom ?

a—what ?

fea—which ?

o le fea—which, of more than one ?

fia—how many ?

ė fia fale—how many houses ?

So grammarians, as Dr. Maunsell, make further divisions of the Pronouns into Distributive and Indefinite : but these seem to depend more on their position in the sentence than on any thing else, moreover, are also used for other purposes. Thus, he expresses *each*, and *every*, by the Demonstrative or possesive pronoun, or by the noun twice or thrice repeated—as, *I tenei ra, i tenei ra*, each day ; *ia tangata, ia tangata*, each man. In the same way, he states that *some other*, or *any*, are, generally, denoted by *tetahi*, *etahi*, etc.

In Tahitian, M. Buschmann points out the existence of nearly the same forms, as *e.g.*, *etahi*, or *vetahi*, *e fanu*, *tu fanu*: we find, also, *atoa* (Maori *Katoa*) as *tana mau mea atoa*, all these things. *Tu fanu*, which he renders "*quelques uns*," he thinks corresponds with the Malay *ano* and the *Javanese hanou*. *E* occurs also, he adds, in the sense of "*autre*," and is compared by him with the Maori and Rarotongan *ke*, and the Tongan *guihe*: he notes, further, that *ke* means *strange* in the Maori and Hawaiian and *different* in Tongan; he believes, therefore, that it may be compared with the Javanese *zedje*, which bears the three meanings of *strange*, *different*, *another*. In the Tongan, I notice *kotoa* with the sense of *all*, which is clearly the same word as *katoa*; and, yet another form in Hawaiian, with the same meaning, *a pau* or *a pau loa*. These, however, can hardly be modifications of the former.

In considering the question of the *Verbs* M. Buschmann states that it is the weakest part of the Polynesian system of languages, and that, though there are abundant particles more or less connected with it, they fail to determine with accuracy even the principal times; while there is, also, no sufficient distinction between many of the particles employed to denote the separate moods. In this, he agrees, mainly, with Dr. Maunsell, who considers, truly enough, that there are comparatively few verbs in Maori, in the sense in which we speak of those parts of speech in Classical, or even European languages, as the same word may very often be a verb, a substantive, an adjective or an adverb.

At the same time, as Dr. Maunsell further remarks, there are, no doubt, certain verbs, which may be considered as primitive, and certain others which are as clearly derivatives, comprehending under the latter head the reduplicated and compound ones. Since, therefore, as a rule, there is no variation of the ground form to denote, respectively, number, person, gender, mood, or tense; the simplest plan will be to consider separately each of the formations, whether by prefixes or postfixes, which are usually held to denote such changes, although it may be quite true as Dr. Maunsell urges, "that there are but few absolute forms for determining tenses." As, in the comparison of the various dialects I have as yet been able to examine, the Maori is generally the best preserved, I propose to take the Maori verb first, and then to shew as far as I can, wherein the other dialects agree or disagree with it. Now, it is generally accepted (Williams', p. 24), that the Maori verb may be divided into Active, Neuter, and Causative, each of these divisions having its own passive. Thus, (1), the active and simplest form is clearly seen in the sentence, *e kite ana ahau te tangata*, I see the man; (2), The *Neuter*, (as expressing, generally, quality or circumstance), *e moe ana te tamaiti*, the child is sleeping; (3), The *Causative*, made by prefixing *waka* (generally to Neuter, though sometimes to Active, verbs), as, *pono*, to be true; *wakapono*, to believe; *mate*, sick; *wakamate*, to make sick. The *Passive* verb expresses the action of some agent, as, *e kitea ana te tangata e au*, the man is seen by me; and is formed, by the addition to the active base or ground-form of one of the following particles:—*Ia*, *ngia*, *a*, *kia*, *hia*, *ina*, *tia*, *kina*, *na*, *ngia*, *mia*, *ria* and *whira*; the particle selected for this purpose, being, chiefly, determined by the termination of the verb, though many of these passival endings are quite arbitrary in their use. Frequentatives (as we saw before, in the case of the Adjectives), are expressed by reduplications, as, *kokoti*, to cut; *kotikoti*, to cut into many pieces. *Tense*, is shewn by the use of verbal particles—adverbs, prepositions, pronouns, and the articles *he* and *te* placed in connection with the verbs. These verbal particles (which have no meaning in themselves), are *e*, *ana*, *ha*, *kua*, *i*, *kia*, *hei*, *me*, *kaua*, *ana*, and *kei*.

Thus the *Present* is formed by *ka* preceding the verb, or by *e* before and *ana* after it; as, *kia rere te kaipuke ki Tauranga*, the ship sails to Tauranga, etc.

The *Imperfect* by *e* and *ana*, and some word or words to show that the action was incomplete when referred to; as, *kai penei inanahi e haere ana*, at this time yesterday I was going.

The *future Imperfect* by *ka* or *e* before the verb, by *ka* before the verb and *ai* after it, or by *ai* alone after the verb; as, *ka tere te waka aianei*, the canoe will be adrift presently. *Akuanei ano riro ai te kaipuke*, to-day the ship will be gone.

The *present* and *future*, when formed by *ka*, are generally to be distinguished by the sense.

The *Perfect* has *kua* and *i* before the verb; as, *kua ara mai te Karaiti i te mate*, Christ has risen from death.

The *Pluperfect*, with *kua* before the verb, must be distinguished by the construction; as, *ka penei inanahi kua tae matou ki Puketona*, at this time yesterday we had arrived at Puketona.

The *second Future*, also indicated by *kua*, must, in like manner, be ascertained from the construction; as, *e kore e po akuanei kua tae ahau ki Hokianga*, before night I shall have arrived at Hokianga. The tenses of the subjunctive moods are indicated by help of conjunctions and adverbs; as, *kua kite pea ahau i tana tangata otira e wareware ana ahau*, perhaps I may have seen that man, but I forget.

The *Moods* are shewn—the *Indicative* by *e*; as, *e ngaki ana ia te whenua*, he is cultivating the land. The *Subjunctive* by *me*; as, *me kaua te marangai*, etc., if there had not been bad weather, etc.

The *Infinitive* by *kia* and *kei*, and the *Imperative* by a great number of different modifications, the chief of which are the employment of *kia*, the absence of any particles whatever, or the prefixing of *e* to the future. Generally a passive form is used for the Imperative, as, *karangatia e koe te tamaiti*, let the child be called by you. The Imperative is also further indicated by the use of *maku*, *mau*, *manu*, *me*, etc., in which, though the verb retains its active form, it is clearly used in a passive sense; as, *me karanga e koe te tamaiti*, the child must be called by you.

Dr. Maunsell thinks that the verbal particles have some correspondence with the auxiliary verbs in English; at the same time they clearly do not admit of the same varieties of application, while they cannot claim the rank of the *verb substantive*. He thinks, too, with M. Buschmann, that no tenses can be accurately defined except the *Present*, *Past*, and *Future*. The distinctions he shews between simple and compound tenses are much to the point, and his analysis of the Imperative in Maori is valuable for the accurate study of the language, but is too detailed for the purpose I have here in hand. In connection, however, with the verb, I ought to add that there are a considerable number of what are called *Verbal Nouns*—their general object being to secure nicetics and distinctions of meaning. Thus, *wanaunga* is, relative; *wanautanga*, a birth; *kiteanga*, the opportunity of seeing a thing; *kitenga*, the act of seeing; *wahanga*, the carrying on a back; *wahinga*, a breaking, etc.

But, condensed, though my notice has necessarily been, I believe I have said enough to shew the general character of the verb in *Maori*: I proceed, therefore, now, to compare with it the verb in other dialects. The *Tongan* verb is characterised by its simplicity and regularity. It has but three tenses—past, present, and future—denoted by the signs, *gooa*, *na*, and *me* respectively, and three moods—the indicative, imperative, and potential. The first has no modal sign, the second neither modal nor temporal. The Subjunctive is marked by the modal sign *ger*. The order of construction in the Indicative, is first, the sign of the *tense*, then the pronoun, and lastly the verb; except in the third person singular of each tense, where the pronoun is placed last. In the Dual and Plural, the pronouns *ua* and *tolu* follow the verb. Thus, the *Present* is denoted by *gua*, as, *gua te alu*, I go; the *Past* by *na*, prefixed to all persons, except the first, where it is changed to *ne* and joined to the personal pronoun *u*, as, *ne u alu*, I went. (The second persons, all through, are shewn by the form *ger*, as, *gu ger alu*, thou goest, etc.) The *Future* is indicated by *te*, except in the third person, where it is changed to *e* and sometimes to *teune*, the pronoun being omitted; as *e alu ia* or *teune alu*, he will go. In the *Imperative*, in the second person, either the pronoun *koi* or the subject of the verb comes after it, but, in the first and second persons of the dual and plural, the pronouns *tau* and *mo* come before the verb and those, which distinguish the numbers, follow it, as, *alu koi*, go thou; *tau alu*, *mo alu*, etc., let us go (you and I), go ye (ye two). The *Subjunctive* is shewn by *ger* applied to any tense, as, *ger te alu*, *ger ger alu*, etc. In Tongan verbs, it would seem that the dual and plural are not carefully distinguished, the indefinite Plural (without *ua* and *tolu*) being constantly used. The Infinitive in Tongan is hardly distinguishable from an ordinary noun. Three words, *my*, *atu*, and *angi* are in constant use, with the general sense of "give" when verbs, and of "to" or "towards" when prepositions; hence, they are to be used, accordingly, as the first, second, or third person may follow, as, *my ia giate au*, give it to me; *teu atu ia giate koi*, I will give it to thee; *angi ia giate ia*, give it to him or her. Clearly, their chief object is to imply *direction*. Thus, *ofa* is, to love; but "I love you" must be rendered not by *gua te ofa koi*, but by *gua te ofa atu giate koi*. They also form parts of compound words, *tálamy*, *talatu*, *talangi*. It is a very general characteristic of all the Polynesian dialects that they love to use passive forms where we use the active for correct translation, and we have seen how fully supplied Maori is for the purpose of indicating the passive. Nearly similar forms (but much fewer in number) may be found in the other dialects. Thus, the Samoan has, *a*, *ina*, *ia*, *fia*, *ngia*, and *tia*: the Rarotongan, *a*, *ia*: the Mangarevan, *ia*: Tahitian, *hia*; and the Hawaiian, *a*, *ia*, *hia*, *tia*. M. Buschmann observes, that the use of the passive is equally characteristic of all the Malay languages, and he thinks he can detect the *hia* of the passive in the Marquesan *kuhia*. He adds his belief, that the character of the particle *ua* in Tahitian and Hawaiian (*kaua* in Rarotongan, *kua* in Maori, and *gua* in Tongan) marks a direct connexion between these tongues and the Malay and Kawi; holding that it is the same as the *djoua* of Malay, *hunga* of Javanese, and the *djouga* of Malay and Kawi, in all of which it is an adverb, with the heterogeneous meanings, of "also," "only," "thus," "already," "again," etc. To this variety of meanings, he thinks, with William von Humboldt, is due the indiscriminating fashion in which it has come to be employed in the Polynesian idioms as the temporal particle of the verb, alike for the present, the imperfect, the perfect, and the pluperfect, the general definitions of which are anything but clear. It seems, indeed, to act as an auxiliary, in all the tenses, even in the future. Thus, in Marquesan, *ua* marks the present and perfect. Again, M. Buschmann further points out, the peculiar use of *auanei* for the future in Tahitian and Hawaiian, and shews that *te* (the article before substantive nouns) and one of the local adverbs *néi* (here) or *ra* (there) seem, as it were, to embrace the Polynesian verb, so as to make it resemble a substantive accompanied by a demonstrative pronoun. The *te* before, and *néi* after the verb, makes the present in Tahitian, and *te* and *ra*, similarly placed, makes the imperfect. Occasionally, too, the adverbs are combined together, as, *te* first, then the verb, and then *néi ra*. The particles *é* and *i* are the most frequent auxiliaries to the Polynesian conjugation ; they are found with all the tenses, excepting that *i* is not used with the future : they are found alone, or, joined with an adverb of time or place, are attached to the verb. In Tahitian, he gives the following uses—

é—verb—*ai*—forming the future (in Maori, perfect and future ; in Hawaiian, imperfect and future ; in Rarotongan, *é......éi).*

i......ai—present and perfect (same in Maori and Hawaiian ; in Rarotongan *i......éi).*

é......néi—present (in Hawaiian, present and future ; Rarotongan, present).

i......néi—present (in Rarotongan, imperfect).

i......na—perfect.

é......ra—imperfect and perfect (Hawaiian, *é......la*, present).

i......ra—perfect.

ua....ra—present and past.

ra (alone after the verb), the past (so, *la* in Hawaiian).

The particles *e* and *i*, exhibit a peculiar construction throughout all the Polynesian dialects, with the exception of the Tongan, viz., that the subject, when it precedes the verb, is combined with one of the three prepositions, marking the genitive, and terminating in *a* : as, *a*, *na*, or *ta*. When the subject is represented by a personal pronoun (see, before the forms, *a*, *o* : *na*, *no* : *ta*, *to* :) it takes the form of the possessive. But this construction is not found in negative or interrogative phrases.

The imperative is indicated in Tahitian by *e* (as in Maori and Hawaiian), *a* (the *ka* of Maori and Rarotongan), *ia* (the *kia* of Maori), or *ei* placed before the verb ; the last two particles being, in fact, the conjunction "that," and the preposition indicative of motion. *A* joins itself with *na* after the verb. In Tahitian, as in Maori and Tongan, the verb, without any special sign, serves for the imperative. The Marquesan has the same simplicity of mood, with the use of *é*, as, *noho oé*, sit down (you, singular) ; *noho*, sit down (you, plural). The conjunction *ia* expresses the third person, as, *ia tapu to oéinoa*, hallowed be thy name (Maori, *kia tapu tou ingoa*). The prohibitory particles of the imperative, are, in Tahitian, *auaa (aua* in

Tongan, *kaua* and *aua* in Maori) and *éiaha*; in Marquesan *moï* is used for the same purpose, and *mai* in Hawaiian.

The *Infinitive* is denoted in Tahitian and Hawaiian by *é* before the verb; and the past participle of the Passive is shewn by *i*, preceding the passive form of the verb itself, as in *iritihia*, "translated," (v. Tahitian Bible of the British and Foreign Bible Society). The English substantive verb, which is not generally rendered in the Polynesian dialects, is, in some degree, represented by the Tahitian temporal particle *ua* (the *ua* of Hawaiian and *gua* of Tongan), and by the pronoun of the third person, *ia*.

M. Buschmann further shews that the Maori *whaka* (Tongan, *faka*; Rarotongan, *aka*; Tahitian, *faa* or *haa*; Marquesan, *haka* or *haa*; Hawaiian, *hoo*, sometimes *haa*) is, by no means, *only*, the sign of the *Causative* verbs, but is found, not only with transitive and intransitive verbs, but, also, with substantives, adjectives, and adverbs.* There seems no sufficient principle for the employment of this prefix, and, possibly, all that can be said about it is, that it partakes the vague indeterminate character of a large number of other Polynesian particles. But, besides the particles connected with the verbs, to which I have already called attention, there are some others to be noticed, which M. Buschmann calls "particules de direction," and which are variously employed. Thus, in Tahitian, two of these particles are directly opposed; *mai* (found in all the dialects in the same sense), "this way," "towards me," and *atu* (the same in Tongan and Maori, *adu* in Rarotongan, and *aku* in Hawaiian), "that way," "towards you," etc. There are two other particles *aë* (the same in Hawaiian, *ake* in Rarotongan, *angi* in Tongan) in the sense of "towards a third person," and *iho* (the same in Hawaiian, *io* in Rarotongan, *hifo* in Tongan) in the sense of "downwards." "Particles of direction" are employed after certain adverbs, whether simple or formed by a preposition, but their principal business is to accompany the verb, before the temporal adverbs, *néi* and *ra*, which are attached to it. Some other adverbs, however, which determine the character of the verb, as that of the passive *hia*, and the termination of the substantive *raa*, occupy the first place after the verb, and are, therefore, themselves, followed by the particle of direction. In the Marquesan, *mai* and *atu* are similarly used. Maori does not use *ange*. As *mai* essentially

* Thus, in Tongan, *faka* (mode or manner), and *ange* (like or similar to), are joined to adverbs, etc., the former to verbs and adjectives, the latter more strictly to adjectives. The first is, as in the other dialects, always a prefix, the latter always a postfix. As, *toa*, brave; *faka-toa*, bravely; *mamafa*, heavy; *mamafa-ange*, heavily.

belongs to the first person, we are prepared to find it constantly joined to the oblique cases, as, in Marquesan, *ua tuu maï Jesu Mesia*, Jesus gave it to us. In Nukuhivan, *apéa maï oé*, answer me; *tuku mai*, give me; *mammi maï*, follow me (Buschmann), in which latter case, it is equivalent to "here." The simplest conception of *atu*, on the other hand, is that it belongs to the second person, as, in Marquesan, *é nonoï atu au ia oé*, I pray you.

It is hardly necessary that I should prolong this paper by any detailed examination of the many other Particles in general use, whether as Adverbs or Prepositions, the more so that I could not presume to write a disquisition on Polynesian Grammar, and have no object in view but to point out sufficient similarities or diversities among the different dialects to enable me to draw some conclusions as to the supposed or real connexion between the existing inhabitants of these islands. For the same reason I abstain, altogether, from any discussion of questions of Syntax, which could not, indeed, be examined with any advantage without far more data than I at present possess. I may hope to do so some day. With regard to both adverbs and prepositions, I may, however, observe, that many of the most important have been incidentally noticed in earlier parts of the present essay. Generally, it may be said of the adverbs, that almost any word may become such, by the mere fact of being placed after the verb, but that a large number of them, as Dr. Maunsell has remarked, require some preposition to exhibit their application; many, also, are derived from words belonging to other parts of speech, while some are scarcely adverbs at all, in our sense of the word, but, rather, *periphrases*. Dr. Maunsell exhaustively groups them under the several heads of adverbs of time, place, order, quantity, quality, affirmation, negation, comparison, interrogation, and intensity, thus shewing that in these, as in other matters relating to grammar, Maori is much more rich than any of the other dialects. Perhaps, however, we are led to think so, in some degree, from the fact that the language of New Zealand has been more minutely and carefully studied than even Tahitian or Hawaiian. The latter, in its vocabulary, is considerably fuller. M. Buschmann points out that there are a considerable number of Polynesian words, which, by the use of prepositions, vibrate, as it were, between the substantive and the adverb; thus, preceded by prepositions, they express adverbs, but are, in fact, local and temporal prepositions; sometimes, also, they have another preposition also following them. Thus, in Tahitian, *roto* (same in Maori; Tongan, *loto*; Hawaiian, *loko*), as, *i roko*, within; *i roto i*, *ei roto ia* before a personal pronoun; *tei roto i*, in; *maï roto mai*, out of; *i roto pu i* or *ia*, within. Again, *ore*—(not *kore*, in Maori and Rarotongan; *kurang*, in Malay; *kourang*, in Javanese; *kolang* in Tagala)—is treated as a Verb in Tahitian and preceded by the particles *é* or *a*.

The Adjective *roa* (same in Maori; *loa*, in Tongan and Hawaiian; *dhava*, in Javanese; *lava*, in Malagasi). "Long" is used in Tahitian for "very" and placed before the Adjective; so, also, *ino*, bad; and in Hawaiian and Marquesan, *nui*, great, as, *ea nua*, very high. On the subject of the Prepositions, I will only add that the following seem to be the simplest forms of them in Maori:—*E, i, ki, hei, no, na, mo, ma, hei, o, a, ko, to*, and that most of them may be recognised in the other dialects; as, in Tongan and Rarotongan—*a, e, ki, i, o; mo, na, no*, in Mangarevan, etc. M. Buschmann shows that in Tahitian *i* is employed in many and various ways—the same relations being found also in Marquesan. He considers it represents the *i* of the Hawaiian, the *ki* of the Maori and Rarotongan, and the *hing* of Javanese; it is applied in Tahitian to all times, while *e* and *ei* have also a general similarity of sense; on the other hand, *a* is restricted to times future, and *na* and *i na* to times past, as is the case also with *ne* and *ine* in Hawaiian.

I here bring to a close the few observations I have thought it worth while to make on certain forms occurring in different Polynesian dialects, and, while I am sure that they admit of almost unlimited expansion, I venture to hope that these will be considered sufficient to determine the question that the leading Oceanic dialects—the Maori, Tongan, Tahitian, and Hawaiian—are the remains of one original and wide-spread language. It now only remains that I should attempt to draw some conclusions from the evidence adduced in the previous pages, so far at least as this seems to point to the ultimate origin of the Polynesian population. Now, I think it will be admitted that, whenever I have found in such books as I have had the opportunity of examining, any apparent connexion between the Polynesian and other peoples, I have, in all cases, endeavoured to notice them. Thus I have repeatedly called attention to similarities existing between the Malay languages and one or more of the Polynesian dialects, with this principal object, that I might confirm, as far as I could, the evidence brought forward by Mr. Thomson, in the Appendix to "Trans. N. Z. Inst.," Vol. VI., before referred to. That there is some connexion, I do not suppose any one can doubt who will take the trouble of fairly considering Mr. Thomson's arguments. The question is, how has this arisen? Have we, in short, any further reasons to support this connexion, and is what Mr. Thomson has urged, sufficient to enable us to say, unhesitatingly, that the Polynesians are Malays? I hardly think so; for what we are sure of amounts to scarcely more than this—that in certain Malay, or so-called Malay languages, some grammatical forms, and also a certain number of individual words are found, both of which are also met with in Polynesian, though, in most instances, under considerable modifications of form. Clearly if we cannot say that languages so near akin the one to the other as Greek and Sanskrit can be placed under the category of *derived* languages, still less can we assert this in the case of Polynesian as compared with Malay. I am rather inclined to think that all that can at present be reasonably affirmed on the subject is, that there must have been a time when these two populations (the Malay and the Polynesian) were living near together, probably in intimate connection, and, further, that a long interval of time has elapsed since this occurred, during which there has been—almost certainly—an intervention of other races wholly diverse from both. Taking into consideration all the available facts, I think we are justified in believing that Malay and Polynesian, alike, ultimately came from some part of Central Asia, though, even here, I must admit that we have hardly anything that can be called evidence, and that it is only guess work as to the line or lines they may have taken from Mongolia to the Western Pacific. As an *hypothesis* I would suggest it is likely that, as we know was the case with the great waves of emigration, which at a period probably more recent, proceeded westwards across Asia into Europe, there were several routes eastward also, distinct the one from the other, but all, in the end, reaching the ocean. The originally one people, thus divided, might, perhaps, never again have met till long after they had occupied the island abodes where we now find them. Such a separation would be amply sufficient—on the analogy of what we know has happened in the progress of the Aryan (or Indo-European) races—for all the modifications of speech now noticeable in the dialects to which I have referred. There is nothing unreasonable in the supposition that what we can trace in the instance of the wanderings westward of the races of Central Asia should be equally true of other wanderings, in this instance, to the East and the Pacific, even though we cannot trace back these migrations with the same clearness that we can those to the West. The same reasons that led to migrations in the one would avail to produce the other; the most probable of these being over-population, and scant provision of food and of other necessaries of life. On this *hypothesis* it seems to me probable that there might have been two principal waves of emigration Eastwards, one finding its course along the great river highway of the mighty Yang tze Kiang, and thus reaching the ocean in the latitude of 32° N., with, possibly, a smaller branch by the southern stream of the *Si Kiang*, or river of Canton, reaching in 23° N.

latitude. The upper and main division would thence have found a nearly connected chain of islands, as the Ladrones, Carolina, and Radach Chain, etc., and might thus ultimately have attained even the extreme distance of the Sandwich Islands. In the same way those of the smaller branch, by the river of Canton, might have reached Luzon and the other Philippine Islands, and, possibly, by the same Caroline Islands have passed on to the more Southern as well as Easterly groups of Polynesia, such as the Fiji, Tonga, New Zealand, Society, and Paumatoa groups. Of course, this view partakes altogether of the nature of a guess; but, so far as we know at present, I do not think there is any thing in it unreasonable.

The second main wave of emigration Eastwards, or rather South Eastwards, I suppose to have passed from Central Asia by the lines of the great rivers Brahmapootra, Irawaddy and Menam, thus impinging on the ocean at the South-east end of the Bay of Bengal and Gulf of Siam. These emigrants would, thence, naturally spread themselves in the direction of Tenasserim, the Malay Peninsula, Sumatra, Java, Borneo, etc., thus forming the ancestors of the present Malay races, though, as it seems most probable to me, at a period long antecedent to the 2,000 years, to which we are able, historically, to trace up the existing Malays. Now, if this theory of two or more lines of emigration has any consistency, and it be true that both Malays and Polynesians did come—it matters not how many years ago —from one original Asiatic source, some certain forms of speech, once correct in their ancestral homes, would be preserved by each wave as portions of a common heritage. The occurrence of similar grammatical forms, though perhaps few in number, would prove contact, if not relationship, at some period or other, while the absence of a large vocabulary of similar words would prove, also, a long and entire separation. We see the reverse of this in cases where the vocabulary is rich, but the grammatical words few or none. Thus, modern Turkish and Persian are loaded with Arabic words, but the one has not altered its Tatar or the other its Indo-European Grammar; on the other hand, France, which we know was once wholly Celtic, at the present moment, though still largely Celtic in race, has, with the exception of a few names of places, retained not one Celtic word in its spoken language. I am further induced to think that this view is confirmed by even the little we know of the Fiji and Tonga dialects, for which their grammar is sufficiently cognate with those of the other islands for their people to be generally included under the generic head of Polynesia. There are a great many words not Polynesian, and other words Polynesian originally but now altered (like *tambu* for *tapu*) to suit their organs of pronunciation.* Tongan has been clearly shown by Mr. Thomson to have many remarkable resemblances to Malay, and may some day prove to be an intermediate link by way of the Marianne and Caroline Islands, at least, this I take to be the drift of M. Freycinet's researches. We have no historical, or even traditional, records on this subject; but a glance at the map suggests the probability that Melanesians from New Caledonia (the nearest Negro islands) may have found their way to Fiji, if not to Tonga. As both these populations were equally illiterate, the success of one over the other, if not the result of trade between them, must have been due simply to brute force: it would not have been like that of the letter-less Franks over the comparatively civilized and refined Gallo-Romans. I may add that the existence, both in Viti and Tongan, of many consonantal sounds, unpronounceable by any pure Polynesian, but at the same time not averse to the genius of other languages, point, necessarily, to such an intermixture as I have suggested; but when or how this came about, I doubt if we shall ever be able to determine.

To recur to the native traditions: I have already stated the prevalent beliefs in New Zealand that the ancestors of the existing Maoris came from Hawaiki, and in all, or almost all, the islands a somewhat similar tradition is prevalent; in the Marquesas, indeed, the same name occurs unaltered. In general, however, this word has been slightly altered according to the consonantal system of each island, the varieties, according to Mr. Logan, being as follows:—

In Samoa............	Savaii.
,, Tahiti	Havaii.
,, Sandwich	Hawaii.
,, Rarotonga	Avaiki.
,, Nukuhiva	Havaiki.
,, New Zealand ...	Hawaiki.

Captain Cook (Vol. III. p. 69) evidently refers to the same place in the name he writes, *Heawige*. Generally, it may be stated, that the popular idea is that this *Hawaiki* was somewhere *under* the islands—a sort of *Inferno*, confirmed

* There is another hypothesis which, I think, ought not to be wholly discarded, and this is, that there has, at some period, been an emigration from America, westwards. If, as has been suggested, the idols on Easter Island have a considerable resemblance to those found in Mexico, it is not at all impossible that some of the earlier peoplers of Easter Island, or their kinsmen, may have reached Tahiti or even Tongatabu. Mr. Colenso, too, I see, thinks that the carving of the New Zealanders may be, perhaps, derived originally from America.

by the Tongan myth (prevalent also in New Zealand) I have already noticed—that their Chief God fished them up from the bottom of the sea.* The general inference from the universal occurrence of this word so little changed in form, and with nearly the same meaning, affords a strong argument in favour of the unity of the Polynesian race, though I am not sure that we can accept Mr. Logan's arguments for the order in which the different islands were peopled, because we find the name of Hawaii in both Society and Sandwich Islands, as well as in the most Western Samoan group. It seems almost hopeless, with such data as we have, to attempt any conclusion as to which island first used the word or the name; but if, as I think is certain, the migration was from West to East, it is reasonable to believe that the Navigator Islands might have had it centuries before it reached Tahiti or the Sandwich Islands, provided the migration took the course which I have called the Southern-eastern line. With regard to the great distances of water that the migrating canoes would, in any case, have had to pass over, there is certainly not the difficulty at first apparent, for Williams, in his "Missionary Enterprize," having also clearly shown that there is not much more difficulty on the score of adverse winds. No doubt, over a considerable belt of the Pacific, East winds may be considered as the most prevailing; but not so as altogether to exclude the North and North-west, which often blow for days together. Kotzebue, in his voyage (Vol. II., p. 122) met with a native who had been driven 1,500 miles, with three companions from Ulea in the Caroline Islands, and who, as he had started from the East, still maintained that he had continued in that course; and, quite recently, a canoe was found 1,800 miles from its home; but the people in it were not starving, having caught fish enough for their support; moreover we know that, to this day, the Illanau people make annual voyages of more than 2,000 miles in quest of slaves and other plunder.

I have before noticed that Tasman speaks of large double canoes as existing in his day on the coasts of New Zealand. Vessels of this

* I think I have seen it mentioned that, on some of the islands the tradition has died out or been forgotten; but that the word *havaiki* or *avaiki* has been retained with the simple meaning of "below," "underneath." It appears, further, that most of the islands place the residence of their Chief God in an island in the far West, called variously, Balotu, Salotou, and Purota. There is no island now to be found in that direction with any similar name, unless it be that of Bouro, a little to the East of Ceram. I have no means of telling whether Bouro contains any vestiges of Polynesian occupation; but, from its position, one would fancy it more likely that it would prove to be chiefly occupied by Negritoes. On the other hand, if it should turn out to be Polynesian, on the hypothesis of a descent from Central Asia, it would be well placed as a stepping-stone for further advance into the Pacific.

capacity seem to have gone out of fashion, at all events they are rarely now seen at any of the islands. Moerenhout, however, in his interesting voyage, states that he found such canoes in use among the people of the Paumatoa group, and with this unusual facility of construction, that they could be sailed whichever way their owners pleased by shifting their sails and rudder. Such vessels would, doubtless, have been quite fit to traverse very great distances. I believe that boats similar to these may be occasionally seen in the Fiji and Caroline Islands.

I have already noticed that as you proceed from West to East it is a peculiarity of the Polynesian languages that they have fewer consonants, till at the Marquesas those are reduced to six, and it has been very generally asserted that this loss is a striking sign of degeneracy. But I am not so sure that this is a true view to take.

Many of these changes, or rather modifications, are, I suspect due to climate, and certainly this is the case in well-known European examples. We may have a great, a natural respect for Highlanders; they may be, as they often are in our minds, the symbols of all that is manly, or brave, or virtuous; but it does not follow, indeed is not true, that the Italians, for instance, are as a body an effeminate race, though their language, from its vocalic character, lends itself more readily to love and music than the harsher languages of the North. Nor, indeed, is this true among the Islanders themselves. If the so-called effeminate Marquesans have only six consonants, the Maoris have but two more, and assuredly effeminacy could not be predicated of them as a race. Let us look a little nearer home, and see what has been done in the changes of the Old Classical Latin in the Romance dialects, and when we find in modern French such words as *Augustus* expressed by *Aôut* (only two vowel sounds, *maturus* by "*mûr*," *ligare*, by *lier*, *age* (through *étage*) from *ætas*, let us not accuse even the Hawaiians or Marquesans as though a prevalence of vowels and a corresponding paucity of consonants was any proof of weakness in a language. Nor do I believe, as I have hinted previously, that, as a matter of fact, the Polynesian dialects are as deficient in vocal or consonantal sounds as we should infer that they are from the grammars and dictionaries already published. I suspect we have done the native languages much injustice, partly from the ignorance (not an ignorance worthy of blame), on the part of those who first reduced them to writing, of any principles of philology, and partly, also, from these varying sounds having been committed to paper by persons whose ears had not been accurately trained to the recognition of the niceties between sounds apparently similar. Had the Missionary Alphabet, drawn up chiefly by Professor Lepsius and Max Muller, been available forty, or, better still, fifty years ago, I believe that even Marquesan and Hawaiian would have exhibited a list of distinct sounds, represented by letters ; in other words, an alphabet which would have been little inferior to that of modern Italian. Anyhow, as I have already stated, the letter *t* would not have been banished absolutely from Hawaiian, and *k* substituted in its place, because a certain number of words occur in which the distinction between these two letters is not very rigidly preserved. I cannot help, also, thinking that, to express with perfect truth the shades of sound recognisable by a musical ear in Polynesian, it would be necessary to add letters from another language besides Latin, as, for instance, the θ for the English *th*.

ART. II.—*Notes on the Extinction of the Moa, with a review of the discussions on the subject, published in the "Transactions of the New Zealand Institute."* By W. T. L. TRAVERS, F.L.S.

[*Read before the Wellington Philosophical Society, 6th September, 1875.*]

You are doubtless aware that a considerable amount of discussion has taken place, during the last few years, amongst scientific enquirers in New Zealand, as to whether the Dinornidæ became extinct before or since the occupation of the Islands by the present native people, and as the question at issue is one of great interest, I have been induced, in consequence of having lately received important information on the subject, which I propose to give in the sequel, to review this discussion.

In the year 1871 Dr. Haast, who leads the discussion on the first side, read three elaborate papers on the subject before the Philosophical Institute of Canterbury, in the latter of which he sums up the conclusions to which he professed himself justified in arriving, as follows :—

"1st. The different species of *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 cotemporaneous with the Moa, by whom the huge wingless birds were hunted and exterminated.

"4th. A species of wild dog was cotemporaneous 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 descendents (by which Dr. Haast evidently meant "successors") 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."

Many of these "conclusions" will be considered sufficiently startling by those who take the trouble to analyse the grounds upon which Dr. Haast affects to have arrived at them, but with a view to the sequel, and in order that no injustice may be done to Dr. Haast with reference to such of them as are specially under consideration in this paper, I think it right to extract from his publications the various passages in which he attempts to support them either by argument or evidence.

"Another argument," says Dr. Haast,* "in favour of this supposition, namely, that *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 enquiries, 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 extensively. We are, therefore, almost compelled to

* "Trans. N. Z. Inst.," Vol. IV., p. 71.

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 leave 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 fire-arms 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 hill-sides are of such recent origin as their position might at first suggest."

Further on in the same paper (p. 78), he says—

"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."

In support of the positions thus taken, Dr. Haast quotes not only the Rev. Mr. Stack, but also the Rev. W. Colenso and Mr. Alexander Mackay, a Native Commissioner, all of whom, he tells us, possessed excellent opportunities of obtaining accurate information upon this and other subjects connected with the present New Zealanders.

With regard to the Rev. Mr. Stack, he informs us that that gentleman did mention the existence, amongst the Maoris, of a proverb relating to the Moa, namely, "He Moa Kaihau," translated, "a wind-eating Moa," in allusion to a supposed habit of the bird of keeping its mouth open when running against the wind, (a habit, by the way, which exists in the Ostrich, and was only likely to become known, as regards the Moa, from direct observation), but he says (erroneously, however, as will appear from the extracts hereafter given from Mr. Stack's own writings on the subject) that "this was the only trace Mr. Stack could discover in the sayings of the ancient inhabitants, relative to the existence and habits of those birds." He then proceeds to detail, at great length, the circumstances under which he alleges that Moa bones and other animal remains had been found in kitchen middens, in what he terms "a Moa-hunter's encampment," at the Rakaia in the Province of Canterbury, particularly noting the discovery, amongst these remains, "of quantities of obsidian, identical in lithological character with that obtained near Tauranga."

Tauranga, as you are aware, is in the Province of Auckland, and I think I am justified in asserting that no obsidian has ever been found, *in situ*, in any part of the South Island, or even to the southward of the great volcanic system in the centre of the North Island.

The fact thus mentioned is, as you will find in the sequel, of very great importance when taken in connection with the information recently given to me.

But Dr. Haast, although he mentions the discovery in this encampment of stone implements and other articles of apparent Maori origin, dissociates them, at all events throughout the papers published in 1871, from those which he assigns to the "Moa-hunters," arguing, moreover, that it was not until long after the extinction of the Moa that the encampment in question was used by the present race.

If this fact were really well established, it would be a very interesting one; but a careful consideration of Dr. Haast's own statements has entirely failed to satisfy me that he was justified in drawing the line of demarcation above referred to, or, indeed, in dissociating the Maori at all from the destruction of the Moa.

With respect to the mode in which his supposed Moa-hunters killed their prey, he says:—*

"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

* "Trans. N. Z. Inst.," Vol. IV., p. 86.

been by the use of the boomerang, or a similar weapon, to be hurled at their prey."

Upon the question whether his Moa-hunters were cannibals, he says:—*

"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 North 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 Moa-hunter encampment in Tumbledown Bay, near Little River, found, close to it amongst some sand-hills, the traces of a cannibal feast; but there was nothing to connect the one with the other."

And again—†

"Mr. Mantell is 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 favorable 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 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 exter-

* "Trans. N. Z. Inst.," Vol. IV., p. 89.

† "Trans. N. Z. Inst.," Vol. IV., p. 91.

mination 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."

With reference to the name "Moa" as used by the Maoris, Dr. Haast says—*

"I have been told that the present race inhabiting New Zealand must have been cotemporaneous 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 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 the 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 *Palap-*

* "Trans. N. Z. Inst.," Vol. IV., p. 92.

teryx 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 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."

In the third of the papers above referred to, Dr. Haast criticises the views of Dr. Hector, Mr. Murison, and Mr. Mantell upon the subject under discussion, and, notwithstanding some very cogent evidence to the contrary, adduced by those gentlemen and others, sums up the discussion by stating the "conclusions" already extracted.

I think it necessary, however, before proceeding further, to call especial attention to the entire absence from these papers of any evidence relevant to the proof of the first, fourth, and fifth "conclusions." The first of these Dr. Haast probably adopted in order to support his theory that New Zealand was entirely submerged up to the close of the Tertiary period, and, on its re-emergence, was subjected, during Pleistocene times, to an universal glaciation similar to that of Greenland and the Antarctic lands.

But whence he derives the Dinornidæ and his wild dog is nowhere even suggested, unless, indeed, the language in which the first "conclusion" is couched admits of the assumption that he believes in special creation; whilst the fourth and fifth involve additional difficulties which are too palpable to need specifying. It would be well if Dr. Haast would supplement his papers on this part of the subject, by giving the evidence or reasoning, as the case may be, which led him to the conclusions in question.

Dr. Haast's statements as to the absence of any Maori traditions relative to the Moa, were in some degree supported by the Rev. Mr. Stack in a paper read before the Philosophical Institute of Canterbury, on the 5th of April, 1871,* in which the reverend gentleman, after referring to the invasion of the Middle Island by the Ngaitahu, a section of the Ngatikahungunu tribe, some 200 to 250 years ago, says—

"Ngaitahu, having incorporated the remnants of the two preceding tribes, the traditions of these tribes would become the property of Ngaitahu, 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-

* "Trans. N. Z. Inst.," Vol. IV., p. 107.

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 perhaps those 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 enquiry, 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."

He, however, says :—*

"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 (Dr. Haast), 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 the 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 any one not fully prepared to question the knowledge of the Maoris on the subject, into supposing that they were perfectly familiar with its form and habit. *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*

* "Trans. N. Z. Inst.," Vol. IV., p. 108."

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."

It will be observed that Mr. Stack does not go the same length that Dr. Haast does as to the time which has elapsed since the Moa became extinct, although he supports the Doctor in his opinion that its extinction preceded the arrival of the present race in these islands.

But whilst he goes no further than this in supporting his leader's "conclusions," he calls upon us to accept a series of very remarkable propositions, which he makes on his own account:—

Firstly, that the bones found on the surface of the plains in various parts of the North Island existed there before the introduction of the present race into New Zealand—an event which careful inquiry leads us to carry back to a very remote period.

Secondly, that the present race must necessarily have migrated from some place in which either the Cassowary, or some other bird of the same kind existed, and was so commonly used as food that the very structure of its skeleton was matter of ordinary knowledge amongst the inhabitants.

Thirdly, that, upon the discovery by the immigrants of the present race, of Moa bones on the surface of the plains, they would at once have assigned them to birds similar in structure to, but of immensely greater size than the Cassowary—a notable feat in comparative anatomy which would entitle the Maori who performed it to rank with Owen or Cuvier,—and, moreover, that the occurrence of bones under such conditions would lead them to hand down to their posterity, exaggerated accounts of the appearance and habits of a mythical bird; of the mode of hunting and cooking it; of the nature of its flesh; and of other matters connected with it which could possess no possible interest for the numberless generations of Maoris who could never have an opportunity of understanding such stories.

It will, however, be observed in the sequel, how naturally all that Mr. Stack has stated fits in with the information which I am about to communicate to you, and how needless it becomes to resort to improbable assumptions in order to apply "the allusions to the Moa found in the Maori poetry and proverbs," and the descriptions they give "of the appearance and habits of the birds," and the fact that "the name of the Moa is mixed up with their songs and stories."

On the other hand, Dr. Hector, Mr. Murison, Mr. Mantell, Sir George Grey, Dr. Buller, the Reverend Mr. Taylor, and many others who have enjoyed far greater opportunities of obtaining information on the subject than those who are quoted so approvingly by Dr. Haast, strongly dissent from the views propounded in his papers, and have adduced a large mass of facts relevant to the proof that the extinction of the Moa is a matter of comparatively recent date.

As bearing upon the special information set forth in the sequel, I call attention to the following passages from their several writings on this subject.

In a paper, by Dr. Hector, read before the Otago Institute in September, 1871,* in which he described the bones of an embryo Moa chick, found with the egg which had contained them,—and the cervical vertebræ of a Moa of large size, upon the posterior aspect of which, the skin, partly covered with feathers, was still attached by the shrivelled muscles and ligaments,—and a remarkably perfect skeleton, in which portions of the ligaments, skin, and feathers were still attached to some of the bones,—all of which were discovered in the Province of Otago, the Doctor says:—

"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 growth, was where the giant, wingless birds of New Zealand lingered till 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 neighborhood 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 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

* "Trans. N. Z. Inst.," Vol. IV., p. 110.

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 aboriginies, 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 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 the 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, at the top of the Carrick Mountains, which are in the same district, but to 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, amongst 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 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 a mile distant. This chert is a very peculiar rock, being a 'Cemented Water Quartz' or sandy gravel converted into 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 of them to have been of the same chert which occurs *in situ* at this locality, 50 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 incidently 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 on the West Coast, rudely carved on the back in the Maori fashion, 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 an hotel counter at the Dunstan Township as a match box, till it was sent to England, and, as I am informed, placed in a public Museum in Liverpool.

"Along with the trimmed chert flakes, the Messrs. Murison found polished adzes of aphanite, and even jade, which shews 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 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 cotemporaneous 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 spot where the Moa remains occur, to be used at native feasts, of which these bones are the only other existing evidences."

Dr. Hector then refers to the evidence afforded by the contents of the kitchen middens in the North Island, of the co-existence of the Moa and the Maori, and points out that Mr. W. D. Murison had suggested how infallibly the wholesale consumption of eggs, which were evidently highly prized as an article of food, must have led to their rapid extinction of the birds, without its being necessary that the birds themselves should be actually destroyed. With respect to the probability of still finding a living specimen, Dr. Hector says—"The whole of the Eastern District of the South Island of New Zealand back to the Southern Alps, was completely surveyed and mapped as far back 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 was 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 4000 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 their 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."

Mr. W. D. Murison, in a paper also read before the Otago Institute, in September, 1871,* after referring to the papers by Dr. Haast, already alluded to, says:—

"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 observation. 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 these 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 of 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 investigations 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 from ten to 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

* "Trans. N. Z. Inst.," Vol. IV., p. 120.

number of eggs must have been consumed as food; and scattered through the ovens were 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 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, there is 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 subsistence 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 fire were to be seen, full of innumerable fragments of chert, and all among the fires broken stone knives could be picked up. A further examination of the *debris* 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 was generally 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 *Rorokio*, 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 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."

Sir George Grey, in a letter to the Zoological Society of London, in 1870, wrote as follows :—*

"The natives all know the word 'Moa,' as describing the extinct bird, and when I came 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 those 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

* Quoted by Dr. Haast, "Trans., N. Z. Inst.," Vol. IV., p. 100.

destroyed and disappeared, as have several other wingless birds from different parts of New Zealand."

Mr. Mantell, in a paper read before the Wellington Philosophical Institute, in November, 1872,* says—

"The only other important discovery which I shall have to notice, is the old *kaianga* at the stream now known as Awamoa, a name given by me instead of its original name of Te Awakokomuka, to prevent confusion with other streams of the latter name in the district. This *kaianga*, which we found in 1852, afforded further unmistakeable proof of the co-existence of man with the Moa. The bones and egg-shells of *Dinornis* and its kindred, mixed with remains of every available variety of bird, beast, and fish used as food by the aborigines, being all in and around the *umus* (or native ovens) in which they had been cooked. Although my collection from this place reached England in 1853, it remained unopened until after my arrival there in 1856, when I caused it to be conveyed to the crypts of the British Museum, and there unpacked it in the presence of the great authority on our gigantic birds, Professor Owen. With the exception of two small collections which were selected for me by Professor Owen, and which I gave, one to the Museum of Yale College, U.S., and the other to that of the Jardin des Plantes, the whole of this collection is now in the British Museum. The fragments of egg-shells from these *umus* varied in size from less than a quarter of an inch of greatest diameter to three or four inches. These, after careful washing, I had sorted, and having, with some patience, found the fragments which had originally been broken from each other, and fitted them together, I succeeded in restoring at least a dozen eggs to an extent sufficient to shew their size and outline. Six or seven of the best of these I gave to the British Museum after their purchase of the collection; one is in the Museum of the College of Surgeons; the rest, including one very beautiful egg, with a polished ivory-like surface, are still in my ownership somewhere in England. Some idea of the labour entailed by this attempt to rehabilitate eggs may be gathered from the fact that several of those restored consisted of between 200 and 300 fragments. I may add that in the markings, size, and so forth, of the eggs (making allowance for the alteration of the former toward the ends of the eggs) I made out about 24 varieties, of which I have specimens."

The Rev. R. Taylor, in a paper read before the Wellington Philosophical Institute, also in November, 1872,† says—

"Early in 1843 I removed from the Bay of Islands to Wanganui, and

* "Trans. N. Z. Inst.," Vol. V., p. 94.

† "Trans. N. Z. Inst.," Vol. V., p. 97.

my first journey was along the coast of Waimate. As we were resting on the shore near the Waingongoro Stream, I noticed the fragment of a bone which reminded me of the one I found at Waiapu. I took it up and asked my natives what it was? They replied, 'A Moa's bone; what else; look around and you will see plenty of them.' I jumped up, and, to my amazement, I found the sandy plain covered with a number of little mounds, entirely composed of Moa bones; it appeared to me to be a regular necropolis of the race.

"I found the natives of the West Coast were totally ignorant of the name given to the bird on the other side of the Island, the Tarepo.* It was here I first heard the word 'Moa.' I was struck with wonder at the sight, but lost no time in selecting some of the most perfect of the bones, and then considered what was to be done with them, and where to bestow them. I had a box in which my supplies for the journey were carried; this I emptied and filled with the bones instead, to the amazement of my followers, who exclaimed 'What is he doing? What can he possibly want with those old Moa bones?' One suggested, *hei rongoapea* (to make into medicine perhaps;) to this the others consented, saying, *koia pea* (most likely.

"This visit to the Waingongoro was the opening up of one of the most interesting fields of research for the naturalist. My enquiries after the 'Moa,' and carrying off some of its bones, caused much talk among the

* In connection with this name, Mr. Taylor says ("Trans. N. Z. Inst.," Vol. IV., p. 97):—"In the beginning of 1839 I took my first journey in New Zealand to Poverty Bay with the Rev. Mr. Williams (the present Bishop of Waiapu). When we reached Waiapu—a large pa near the East Cape—we took up our abode in a native house, and there I noticed the fragment of a large bone stuck in the ceiling. I took it down, supposing at first that it was human; but, when I saw its cancellated structure, I handed it over to my companion, who had been brought up to the medical profession, asking him if he did not think it was a bird's bone. He laughed at the idea, and said, 'What kind of a bird could there be to have so large a bone?' I pointed out its structure, and when the natives came, requested him to ask them what it belonged to. They said it was a bone of the Tarepo; a very large bird which lived upon the top of Hitaurangi, the highest mountain on the East Coast, and that they made their largest fish-hooks from its bones. I then enquired whether the bird was still to be met with, and was told that there was one of an immense size, which lived in a cave, and was guarded by a large lizard, *and that the bird was always standing on one leg.*" Mr. Taylor was in error in supposing that the term 'Tarepo' was used by the Maoris to designate any species of the *Dinornis*. This was the name given by them to *Cnemiornis Calcitrans*—a bird well known to them, but now extinct. I would call special attention to that part of the passage from Mr. Taylor which mentions that the bird was always standing on one leg; a habit which was no doubt possessed by *Cnemiornis* in common with all other birds of the same family.—W. T. L. TRAVERS.

natives. I was most anxious to obtain a skull of the bird. I was told there was a great one in a swamp some miles inland. I promised a large reward for it, and though they said I should have it, they did not keep their word.

"In reply to my questions about its size, they told me it was quite as large as that of a horse, a sure proof that the bird had never been seen by any of those I spoke to. They, however, told me that these huge birds were formerly very abundant before the Europeans came, but they gradually diminished and finally disappeared. *Their nests were made of the refuse of fern root, on which they fed*, and they used to conceal themselves in the koromiko *(Veronica)* thickets, from which they were driven and killed by setting the thickets on fire; hence originated the saying, *Te koromiko te rakau i Tunu ai tē Moa* (the *Veronica* was the tree which roasted the Moa). The koromiko, when burnt, emits a kind of resin from its bark, which looks like grease, hence the origin of the saying, as all suppose the Moa to have been a very fat bird, which I should think was very questionable. When I next visited Waingongoro, expecting to carry off another load of Moa bones, I found to my surprise that they had disappeared. I afterwards heard that Mr. Mantell had passed that way after me, and had cleared the place of all worth taking.

"The last visit which I paid to Waingongoro was in 1866, in company with Sir George Grey. On our arrival there, he asked me to show him the place where I discovered the great deposit of Moa bones in 1843. I took him at once to the place, and to my astonishment I found the hillocks almost as thickly covered with bones as when I first saw them; the wind had uncovered a lower stratum since my former visit. Several officers stationed at the neighbouring redoubt expressed their surprise when told the bones were those of the Moa. They had seen them times without number, but, supposing them only beef bones, passed them without further notice. Several soldiers volunteered their services, and a great number of these old ovens were opened; all worked in good earnest, and no one more heartily than the Governor. It was quite amusing to see His Excellency grubbing up the old ashes, and carefully selecting what he thought worth carrying away.

"A large cloth was spread on the ground, and the various articles found were piled upon it; *these were of a very miscellaneous character, consisting not only of bones of the Moa, and fragments of its eggs, but of almost every other bird indigenous to these islands, including those of the Kakapo and Kiwi, with chert flakes, fragments of highly polished axes, and other articles.* These ovens seem to have been made in a double line, and to have been used for many years, as each layer of ashes was separated by a thin stratum of sand from the one immediately below, and the number of them was very great. The natives informed me that when the Moa hunt was to take place, notice was given to the neighbouring places, inviting them all to the battue. The party then spread out to enclose as large a space as possible, and drive the birds from their haunts, then gradually contracting the line as they approached some lake, they at last rushed forward and drove the frightened birds into the water, where they could be easily approached in canoes, and despatched without their being able to make any resistance. These Moa hunts were, doubtless, very destructive, as, from the number of men employed, and the long lines of ovens, the slaughter must have been very great; and, in addition to this, from the large quantity of egg-shells, a clear proof is given that they were eagerly sought for and feasted upon. Thus, the poor birds had little chance of continuing their race. I may also state that the Plain of Waingongoro is called Rangatapu, which may either apply to the hunters (the sacred band) or the ovens (the sacred row), and that the name Moa, like that of the roa, was most probably derived from the bird's cry. The Moa has passed away and its hunters as well, and the proverb is being fulfilled, 'Kua ngaro a Moa te iwi nei,' 'The Maori, like the Moa, has passed away.'" It will be seen in the sequel that Mr. Taylor's interpretation of this proverb is inaccurate."

I offer no apology for these somewhat lengthy extracts, which have been made for the use of readers elsewhere, who cannot have access to the "Transactions of the New Zealand Institute," all of which, however, require to be considered in connection with the matter under consideration, and more especially with the communications made to me, as hereafter detailed.

Before referring to these communications, however, I may call your attention to two papers in the recently issued volume of the "Transactions of the Institute," Vol. 7, one by Dr. Haast, and the other by Mr. Mackay, of the Geological Department of New Zealand, in which the writers arrive at different conclusions, as resulting from discoveries made during the exploration of a cave, near Sumner, on Banks' Peninsula; Dr. Haast, on the one hand, still maintaining his views as to the extinction of the Moa by a race prior to the present one in the occupation of the islands; Mr. Mackay, on the other hand, taking the opposite view.

Dr. Haast, in allusion to the opinions of those who have had the temerity to differ with him, says :—

"But now, as it were at once, the Moa-hunters disappear from the scene, but not without affording an insight into their daily life, by leaving us some of their polished and unpolished stone implements, a few of their smaller tools, made of bone, a few personal ornaments, as well as of fragments of canoes, whares, and of wooden spears, fire sticks, and other objects too numerous to mention; *but by which the fact is established that they had already reached a certain state of civilization, which, in many respects, seems not to have been inferior to that possessed by the Maoris when New Zealand was first visited by Europeans.*"* At the same time, if we consider the position of the kitchen middens on the dunes in the vicinity of the cave, and those which I discovered on the lines of inner dunes, in the neighbourhood of Christchurch, even the most ardent defender of the groundless assertions that the Moa only became extinct some 80 or 100 years ago must admit that, at least in this portion of the island, these gigantic birds were exterminated at a period when the physical features in this part of the Canterbury Plains near the sea were different from what they are now; that large lagoon-like lakes have since been filled up, and sand-dunes of considerable width have been added to those existing. In one word, those changes during quarternary times have been of such magnitude that it is impossible to estimate, even approximately, the length of time necessary for the achievement of such important alterations, worked out by the sea and the rivers entering it.

"And, as in other portions of this island, the deposits in which the kitchen middens of the Moa-hunters occur are of similar antiquity, I have no doubt that my views expressed on this subject, some years ago, will gain general acceptance in due time, although I know that erroneous notions to the contrary, when they have once become popular prejudices, are difficult to eradicate; especially when they are supported by one or two scientific men in New Zealand, *notwithstanding that their assertions never stood the test of critical examination, and have been refuted over and over again.*"

I have thus brought the controversy up to the latest moment, and will now proceed to state the information given to me, and the circumstances under which I obtained it.

In the course of a professional visit to Napier in the latter part of last May, I was introduced to Mr. John White, by the Hon. Mr. Russell, for whom he was then acting as interpreter in connection with some native transactions. At the time of the introduction I was not aware that Mr. White was the gentleman who had, under the auspices of the New Zealand Government, delivered the extremely interesting and valuable "Lectures on

* I have italicised this passage, which, as will be observed, is utterly at variance with the sixth "conclusion" at which Dr. Haast had previously arrived, as extracted from his paper of December, 1871. Driven from his former position, however, he still persists in dissociating the Maoris from the implements discovered in connection with the Moa remains in this cave.

the customs and superstitions of the Maoris," which were laid on the table of both Houses of the New Zealand Parliament in August, 1861, and are published in the Parliamentary Papers for that year.

After, however, becoming aware of this fact, I asked him, in the course of conversation, whether he possessed any information respecting the Moa, when he told me that he had, at his residence in Auckland, a large mass of manuscript matter on the subject, collected many years ago from perfectly authentic sources, and without reference, of course, to the controversy in question, and containing the fullest details as to the habits of the birds, the mode of hunting them, etc., and promised, at my urgent request, to write to me at an early date as much as he could manage to recollect on the subject in the absence of any opportunity of referring to these manuscripts. He assured me that the Moa was perfectly well known to the old Maoris, and that their histories and songs abounded in allusions to it. Soon after my return to Wellington I received two letters from Mr. White, which I here transcribe.

"NAPIER, 29th June, 1875.

"MY DEAR SIR,—When I promised to give you as much information as I could respecting the bird 'Moa,' I did not think that my memory was so sluggish, therefore I am really afraid to venture on giving you any sort of connected account of that bird, viz., its habits, food, what it lived upon, the season of the year when killed by the Maoris, its appearance, power, and all the hundred and one ceremonies which were enacted by the Maoris before they began the hunt, the mode of hunting, how cut up, how cooked, and what wood was used in the cooking, with an account of its nest, and how the nest was made, where it usually lived, etc. However, I will try and give you as much information under the circumstances as I can, promising to give you, at some future day, all that I cannot trust now to my memory to give, but I shall be able to do so when in Auckland and can consult my MSS. in my library at home.

"The 'Moa' lived on the young shoots of the fern (rarauhe) and the grass that grows on the edges of the swamps, and near the edges of the forest; it also ate the young sprouts of the korokia shrub, also a water plant in Waikato and Ngapuhi, called 'Pukekakeka,' at the South called 'Retoreto' or 'Returetu.' The principal abode of the Moa was near the forests, but it visited the lakes and water pools to eat the Pukekakeka. Though not a timid bird, it did not live near where man took up his abode, hence, when it was to be hunted, the tracks made by it to visit the water were sought, and men waited on those tracks to capture it. The Maoris, as a rule, were afraid of it, as a kick from the foot of one would break the bones of the most powerful brave, hence the people made strong spears of

'Maire' or Manuka wood six or eight feet long, and the sharp end of which was cut so that it might break and leave about six or eight inches of the spear in the bird.* With these the men would hide behind the scrub on the side of the track, and when the birds were escaping from the fear of the noise of those who had driven them from the lakes, those spears were thrown at them, thus sticking in the bird; the scrub on the sides of the track would catch the spears, and break the jagged end off, leaving it in the bird. As it had to pass many men, the broken spear points thus put into the bird caused it to yield in power when it had gained the open fern country, where it was attacked in its feeble condition by the most daring of the tribe. When taken, it was cut up with the stone, Tuhua obsidian (flint). I must digress a little. There are four sorts of Tuhua—Tuhua, which is black; Waiapu, which is of a light colour; Panetao, which is green; and Kahurangi, which is red. The first only is used in cutting up the bird Moa, the second is used by the people to cut themselves when they cry for the dead, the third is used when the dead are chiefs, the fourth is used when the dead are head chiefs or priests; also the third is used when the dead are children, and the same is used to cut the human hair. Again, the Tuhua is not used to cut up the bodies of the killed, but a Manipi Tuatini, or to the South it is called Manipi Huata, is used; this is not used to cut up the Moa; the hunters carry with them a block of Tuhua, and as it is chipped off and used, it is not used again for any other bird or anything else, but left at the spot where used. The Moa did not go in large flocks, but usually a male and female and their young. Hence the proverb. When a battle is as it were a number of single combats, it is called, 'He Whawhai Tautau a Moa,' 'a fight two and two like the Moa.' Again, the nest of the Moa was made by the bird collecting a heap of Toi-toi and other grass in a large heap and in the centre on the top lay its eggs. Hence, when the Kumera was cultivated and the weeds collected by the sacred men, who took the weeds and laid them all in a heap at the edge of the plantation, this was called a 'Moa,' as it resembled the nest of that bird. I cannot trust my memory to give the Karakias, the purport of the one which was said on the evening of the day before the hunt, is in substance this:—"The mists of the hills most celebrated in the locality of the hunt are invoked to make the birds' fat flow as the globules of dew that run down the leaves of the trees at dawn on a summer's day, and the God of Silence is cautioned not to allow fear or dread to come near the Moa." The

* I may mention that a hill on the East Coast, called Karanga na Hape, is said to derive its name from the circumstance that Hape, a chief of the Arawa, pursued a wounded Moa up the hill-side and attacked it with a Taiaha, when the bird kicked him and broke his thigh, and he rolled down the hill.—W. T. L. Travers.

last Moa hunt known or remembered was on the North Island at or near Whakatane, in the Bay of Plenty; the feathers of the birds killed there were, till a late period, in the possession of a chief called Apanui, an uncle of the half-caste, James Fulloon, who was murdered by the Hauhaus at that place, and it was also at or a little time before killed on the plains near the foot of the Ruahine mountains, north-east of Waipukurau at Napier. The wood used in cooking the Moa is the timber of the Koromiko, and hence the juice, when seen in that stump, is called 'Te ngako o te Moa.' There is a bird called the Kokako, which is said by the Maoris to have been an attendant on the 'Moa,' and was in most instances the informer of the vicinity of the Moa by its cry. I have heard this bird cry, which is a prolonged sound as if it called Mo-o-o-a. The Moa, it is also said, lived on the fern roots (roi), but there are three sorts of good roi; one is found near the edges of the swamps, one on deep black soil, and one at the edge of the forests, which is called 'Renga;' this was dug up by the beak of the Moa, and was the food most eaten by them. Again, the bird was known to swallow stones, which the Maori says was only of a certain sort, and hence, when they see a turkey oil-stone, they call it 'Moa,' as the stones swallowed by the Moa. This sort of stone was that used in polishing the Pounamu, and called a 'Hoanga Moa,' from which (the Moa swallows the stones) also comes the saying when a heap of stones are seen on a plain where no other stones are seen, 'He tutae Moa' (Moa excrement.) Again, as the Maori after his arrival here was the cause of the extinction of the Moa, hence, when a tribe has been cut off by war, and not an individual has been saved, the tribe is said to be 'Ngoro i te ngaro a te Moa,' "lost as the extinction of the Moa." You must excuse, me my dear sir, in giving you so little, but I dare not go more into the matter till I am again in communion with my old collection of MSS., which I hope, if the House of Representatives will be good enough to help me, while I sit down and write from these MSS., I shall be able to give a full and, I hope, a perfect account of the Moa in some one of the books I wish to write.

"I am, dear Sir,

"Yours very truly,

"JOHN WHITE.

"W. T. L. Travers, Esq., Wellington."

"NAPIER, July 23rd, 1875.

"MY DEAR SIR,—I forgot to say in my last letter that I have seen many old chiefs who have seen the Moa feathers worn in the heads of the old chiefs when the relators were boys. These men describe them as in some instances about two feet long, some eighteen inches, some twelve inches, some six inches long, with the down from the top of the quill to within the width of a man's hand at the top, the top being flat like the feather of the tail of a peacock. I think in my MSS. I have the names which these feathers were called.

"John White.

"W. T. L. Travers, Esq., &c., &c., Wellington."

In special connection with the valuable information given in the foregoing letters, I would call attention to those passages which bear most materially upon the extracts given from the papers previously cited.

It will be noted that obsidian is always found in the kitchen middens in which the Moa was cooked, and this is strictly in accordance with what Mr. White says respecting the mode in which it was prepared for cooking.

The term "Moa" is said, by Dr. Haast to be translatable into "a bed in a garden"—a fact referred to by Mr. White in connection with the form of its nest, which resembled, as he mentions, the mounds formed of weeds which had been collected from the Kumera grounds by the sacred men.

The proverbs quoted by the Rev. Mr. Taylor, in reference to the use of the Koromiko for cooking the flesh, and the extinction of this bird, are also referred to by Mr. White, but in slightly different language.

The use of the Koromiko for cooking the Moa's flesh, and the beauty of its feathers, and their use as ornaments, are referred to by the Rev. Mr. Stack.

The tracks observed by Dr. Hector on the mountains near Jackson's Bay, are just such as would be made through scrub by such birds, and along the sides of which the hunters could place themselves in ambush to attack the birds in the manner described by Mr. White, although it is probable that this would not be the only mode in which they would be killed.

I need scarcely say a word as to the authority with which Mr. White writes on all subjects affecting the Maoris. He has been engaged for upwards of thirty-five years in collecting materials for the history of the race, and of their habits and customs, and has been initiated by their priesthood into all their mysteries, and is, in effect, in a position to give the most authoritative opinion on all points connected with these matters. Indeed, I am only repeating the opinion of a gentleman well qualified to pronounce on the subject, when I say that Mr. White knows more about the history, habits, and customs of the Maoris than they do themselves.

Whether the foregoing communications will have any effect in inducing Dr. Haast to modify the views propounded in his papers, I cannot say; but I think they completely dispose of the assertion that the present New Zealanders knew nothing of the Moa. I may conclude by expressing a hope that means may be placed at the disposal of Mr. White, in order to enable him to devote the time necessary for bringing into proper shape the large mass of information he possesses relative to the life-history of the races which occupied these islands before the advent of the European settlers.

NOTE.—It will be observed that I have not noticed, in the foregoing review, the several papers published by Captain Hutton and others in the seventh volume of the "Transactions N. Z. Institute" relative to the Moa, a careful perusal of which, however, goes to strengthen the assumption that the ultimate destruction of this bird is matter of comparatively recent date. —W. T. L. TRAVERS.

ART. III.—*Notes on the Discovery of Moa and Moa-hunters' Remains at Pataua River, near Whangarei.* By G. THORNE, Jun.

[*Read before the Auckland Institute, 6th December, 1875.*]

Plates I., II., III.

IN February, 1875, I picked up a few metatarsi and other bones of the Moa while travelling on the coast from Ngungururu to Whangarei Heads, and deposited them in a settler's hut at Pataua River.

An incredulous smile greeted my announcement of the fact in Auckland, as it was not believed that the Moa existed in the densely wooded country to the northward, and as great an authority as Hochstetter, p. 64, says, "The Moas consequently seem to have been distributed all over the southern part of the North Island, but are totally awanting upon the narrow north-western peninsula north of Auckland, where, to my knowledge, no trace of Moa bones has as yet been found."

Since Hochstetter's time no authentic record has appeared of their existence. The northern limit of the Moa was then supposed to be a line from Bay of Plenty on the east to Kawhia on the west coast.

These bones were received after much delay, and exhibited at the second meeting of this session of our Institute, exciting some interest, from the fact of having been found 70 miles north of Auckland.

Although it was improbable, from the position in which the bones occurred, that I should succeed in obtaining a complete skeleton, this charm-ful subject so deeply interested me that I returned to the locality and spent two weeks in searching for and collecting relics of the past. My labour was rewarded by the discovery of over 200 Moa bones; and on my return from Australia, in the early part of this month (November, 1875), I showed the result of my explorations to Mr. F. T. Cheeseman, F.L.S. By offering to act as guide among the muddy mangrove flats, which render travelling unpleasant in these parts, I induced him to visit the locality.

We spent a very pleasant time in observing and striving to read aright the story full of charming interest which these relics, implements, and tools before you are ever willing to teach. Everything in this world has a history, something to tell, or something to teach about what it was, or how it came where it is.

I should like to be able to add, even in a small degree, to the slender knowledge we possess of the mode of life and thought of those races whose bones, tools, and toys are exhibited.

Truly we may run back, in fancy, into the past, and think of these early men as hunting or fighting, their women loving, and their merry children gathering roots, fruits, and berries, or joining cheerfully in the exciting and dangerous chase of the gigantic Moa.

I will content myself, however, with narrating and describing accurately the simple facts as observed, leaving it to *savants* to propound theories in connection herewith.

From Whangarei Heads, after a few miles walk over the fern-clad hills, you reach the extensive Mangrove swamps of Pataua and Taiharuru Rivers; crossing the Pataua, about a mile from the sea, follow the north-west bank of the river to the mouth, which is bounded on the east by a rocky but beautifully wooded hill, 200 feet high, from which the river takes its name.*

Standing on sand-hills to the south-west, you see the river winding down its bed, fully half-a-mile in width from hill to hill. On either side are Mangrove flats and Pipi banks, leaving a silver thread of water, fifty yards broad, at low tide. Some beautiful Pohutukawa trees line the north bank of the river, and amongst them are some grand old specimens—one, whose trunk measures twenty-one feet in circumference, has seen some hundreds of summers, as the erosion of the shore from the spot where the tree first commenced to grow would witness, and Pipi shells form a perpendicular little cliff there fifteen feet high.

To the north-west, along the sea coast for thirteen miles and a quarter, a fine sandy beach reaches as far as a creek called the Kowhaitahi (*Kowhai*,

* *Pa*, fortification; *taua*, the fighting party. Therefore the word would mean, the fort of the warriors, and a truly impregnable fort it made. The tons of Pipi shells on the top add additional evidence as to the use and value of this *pa taua* in by-gone times.

MOA and MOA HUNTERS

REFERENCE

o Moa bones and Kitchen middens.
x Moa hunter skeletons.
Swamps
Sand dunes and Ridges.

To accompany Paper by George Thorne Junr.

tree; *tahi*, one; but the one Kowhai tree from which the creek takes its name has long disappeared).

Sand dunes, about thirty feet in height, form a ridge above the beach, and fall undulatingly back three hundred to four hundred yards into extensive raupo and flax swamps. On these sand dunes the greatest number of relics were found, evidently accumulations of the hand of man; heaps of pipi shells, cockle, turbo, and mussels, oven-stones, charcoal, and ashes in the cooking places of the former inhabitants; close by, on the surface, are the bones of seals, fishes, human bones, and the bones of birds; amongst them these interesting remains of the Moa, which I collected with the greatest care, comprising:—

60 Toe bones and claws
27 Metatarsi (ankle)
14 Tibiæ (shin)
27 Femora (thigh)
70 Vertebræ
5 Pelves,
A number of ribs, etc.
Portion of the head of a smaller species, and the lower beak of another species.

The Pelves are in a poor state of preservation, except one belonging to the smaller species of Moa, which is not much broken. We could have added great numbers of fragments of Tibiæ and Femora to our collection, but considered them worthless; whether these pieces were broken by tramping of horses and cattle accidentally, or cracked open for the marrow (if any) contained, is an interesting problem. If the natives were in the habit of breaking the bones, why did they not break all of them?

Of the more perfect specimens I append a table of measurements, which will, I trust, lead to the identification of some species.

This sandy ridge was a fine feeding place of old. The ovens are particularly numerous, especially at eight or ten spots where the sand has been well blown in shore; at these places the surface is composed of a *bed of hardened fine brown sand*. On this, evidently older surface, heaps of sharp oven stones, charcoal, etc., close by the bones of Moas, mark the kitchen middens; near at hand, also, are little heaps of worn quartz pebbles. These are very singular, and excite curiosity at once, presenting, as they do, a striking contrast to the waterworn stones and pebbles strewn all about, which latter are of a blue colour.

These little quartz pebbles I take to be "crop-stones," swallowed by the Moa to aid digestion, although they are not as smooth as what I have seen exhibited in our own Museum for "Moa Stones;" they were probably in full use at the time of the bird's death, and not ready for ejection; it has been observed, for instance, that the Ostrich and Emu eject stones similar to those in the Museum from time to time in order to swallow others less rounded.

At every place where we found Moa bones, there also we found "crop-stones," which, on some spots, guided us to the discovery of Moa bones.

Obsidian chips or flakes were numerous, and occurred mostly on the surface of the *old bed of hard fine brown sand*. I carefully collected all I could find; at one place I found the "core" of obsidian, from which the flakes were chipped; the splinters and fragments around marking the site of the manufactory of their knives. At two other spots the fragments and splinters of obsidian would indicate similar workshops, but I failed to find the "cores." Some of these knives are blunted, and show signs of use, but when first chipped off would present a keen cutting edge.

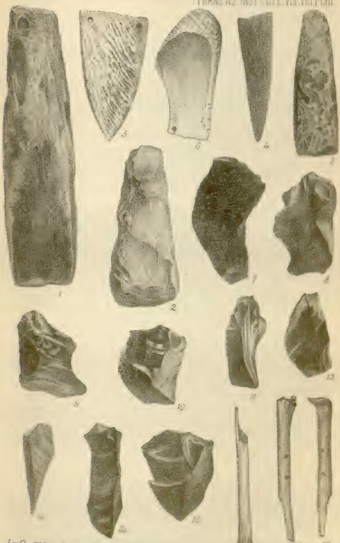
Dana informs us that in Mexico this volcanic glass was formerly used both for mirrors, knives, and razors. Plate III., figures No. 7, to 15, represent some of the most characteristic shapes found.

Egg-shell of the Moa occurred at three spots along this ridge, but the closest scrutiny only revealed about five ounces of small pieces belonging to various eggs. The fragments, however, are too small to attempt the reformation of a complete shell with any prospect of success; still the largest piece, about three inches long, is of sufficient size to measure the curve and allow the calculation of the diameter of an egg, which would give a diameter of 8·625 inches.

At the southern end of Pataua Beach, where the Pataua Hill breaks the force of the south-east gales, vegetation is still growing on the sand dunes close to the sea; but further north the drifting sand has cut the vegetation off and rendered the land barren 400 yards wide to the edge of raupo and flax swamps; the only plant growing amongst the sand is the *Pingao (Desmochœnus)*.

When I first visited this spot, in 1867, these sand dunes were covered on the swamp side with Manuka, Fern, Wi-wi, littoral plants, and several clumps of small trees, growing close to the sea beach. The dead limbs of those small trees are still to be seen heaped up with sand; the littoral plants have gone, the sandy bed in which they grew has been blown in shore, covering up the Fern, Manuka, and Wi-wi.

These sand dunes, between the swamp and sea, owe their origin primarily to blown sand, so that I am of opinion that the *Pingao (Desmochœnus)* periodically heaps up the sand at the beach for a sufficient length of time to permit the plants at the back to grow; then a time arrives when the sand commences to drift in shore, to add another layer to the sand dunes near



1–6. Flint implements.
7–15. Obsidian flakes.
16–18. Bone instrument.
To accompany Paper by G. Thorne Junr.

the swamp; that this process was going on at the time when Moas and Moa-hunters lived here, and still continues, is evident to me, and I hope, before I have done, to prove it to you.

The Maori track, in 1867, was a little distance back from the beach, and amongst the plants which were then alive, but are now covered up with sand; owing to the tediousness of walking in loose sand, travellers—now following the ridge close to the beach on the pipi shells and kitchen middens—could not possibly escape observing the Moa bones, and as the Revs. W. Colenso and Williams, with others, must often have passed this way, without reporting the existence of these bones, I am forced to conclude that they were buried under sand and vegetation; so that to these simple natural causes must any merit of discovery be accorded.

The skulls of two dogs and a cat were found at the Kowhaitahi end of the ridge; but as they were amongst the driftwood and loose sand, they are probably recent.

I examined carefully every bone we saw for the marks, scratching or gnawing of dog's teeth, but failed to discover any; it may be that the natives had no domesticated dog at this time, if the contrary, dogs could not have been numerous, or the fragile bones of the small Moa Pelvis would surely have been gnawed and broken.

The bones of smaller birds, such as Kiwi, Gulls, &c., were also to be seen; we collected some in the hopes of getting them identified.

The two swamps at the back of the sand dunes were probably one some time ago; but are now divided by a small causeway of sand, which has advanced from the sea and met a clay spur from the hills, the larger swamp draining itself into the Kowhaitahi Creek, and the smaller one into the Pataua; both are quite impassible for cattle. The smaller one will be drained this summer, and careful search made for buried Moa remains.

Stone Hatchets or Adzes.—In the locality I am now speaking of I found seven, of various sizes and shapes (exhibited), weighing from 4 oz. to 3 lb.; some of them are well made and polished, and have seen good service, others again are sharp, perhaps first re-ground; but one or two appear to have been made by a clumsy workman, or tyro at the art, and the too much chipped stone spoilt and thrown away. Plate III., figures No. 1 to 4.

Human Skeletons.—I found the remains of two bodies only on the Pataua Beach. One of them is that of a large man, the almost perfect skeleton of whom I have lodged in the Museum; the teeth are complete, but much ground down. This individual had been buried about three feet below the recent surface, and three or four feet of sand intervened between him and the old bed of hardened brown sand to which I have alluded, with shells and stones on it, and is probably recent.

The other human remains were of a far more interesting character, and consisted of the larger bones of a man and part of a very thick skull, laid on and close by the stones of an oven, and, singularly enough, the bones were all much charred by fire. I exhibit the *trochanter* of a thigh bone, and also a piece of his enormously thick skull, shewing the effects of fire plainly. This charred skeleton was on the lowest bed of hard brown sand and was clearly burnt by design. I can hardly believe them to be the remains of an over-cooked cannibal feast; but am more inclined to look upon it as evidence that these Moa-hunters burnt their dead, as did, for example, the lowest races of men in Australia; a practice, too, which there is reason to believe was almost universal among the earliest races of men in past times.

Between Kowhaitahi Creek and Hora Hora River are several Tapu grounds of the Maoris, from one of which we brought the skull and thigh bone of a large man; further on the sandy beach is backed by soft clay hills, with perpendicular face seaward, and which, within half-a-mile of the Hora Hora, are composed of a yellow sandy clay, forty feet perpendicular to the sea, sloping back on the land side to small swamps, and covered with vegetation. In places the wind—having found a little break in the cliff—has, here and there, hollowed out three sides of a pit, and blown back large quantities of sand, leaving the rounded blue pebbles and stones in the bottom, and in some places the sand, blown seaward by the land breeze, lodges at the foot of the cliff; nearer still to the Hora Hora the drifting sand has gained complete mastery, having destroyed all the vegetation on the sand-hills. It has the appearance of shifting alternately to the seaward or the land side of the ridge, according to the prevalence of land or sea breezes. On the top of this sand hill, scattered all over the surface, are blue water-worn pebbles and a few heaps of shells and sharp oven stones.

I was once, after a very heavy gale of wind, at this spot, which is not *tapu*, and examined the remains of a cannibal feast, viz.—four large cooking stoves, and as many human skeletons close by them. The bones were in heaps; the skulls had rolled a little distance off; one of the skulls was pierced with some round instrument, leaving a hole, about an inch in diameter, on the crown of the forehead, inclined to the left hand side. This spectacle, so suggestive of rough and troublous times, is now hidden from view.

In one of the saddles of this ridge, which is composed of a yellow-coloured sand, and still thirty feet high—the hardened brown sand is wanting here; but the adjoining cliffs are of a yellow sandy clay—I found the portions of at least three Moas, one large stone axe, but no obsidian flakes.

The Moa bones got here consist of—

4 Metatarsi
4 Femora
12 Vertebræ
5 Ribs.

One of these birds was of large size, the tibia being nearly two feet long, and one of the most perfect bones obtained; but the bones of this and another smaller specimen are soft, yellow, and light, much lighter than any other bones we have found; they have, I think, lost all their gelatine, for, on touching a dry fracture of a bone with the tongue, the tongue will adhere to the lime; when damp, those yellow-coloured bones would crumble in your fingers; although the utmost care was used in digging them out, some of them were so fragile that they would not bear their own weight in the air when freed from sand. The rib bones were, apparently, not much disturbed, but fell to pieces on being lifted. Underneath these bones, and amongst the sand, were the little white quartz pebbles, similar to those at Patua. The most determined doubter must now admit that these curious stones are really "Moa stones."

Adjoining this sand ridge is a clay flax-covered ridge, on the northern side of which, down to the south bank of the Hora Hora River, the Maoris recently had a nice cultivation, an isthmus washed by the sea on one side, and the river on the other joins the Hora Hora pa to the cultivation; on the sea-washed bank of this isthmus the skeleton of a man is to be seen. The Pa, which forms the south head of the river, is about 150 feet high, is very picturesque, and has a very fine double ditch or fosse round the only accessible side, and resembles in some respects Pataua Head.

The coast is rocky from this point to within a mile of Ngungururu River, there the shore is a low sandy flat, with a fine beach, but I observed no Moa remains.

We will now retrace our steps, cross the Pataua River on to Pataua Hill, for the purpose of examining the isthmus joining that hill to Taiharuru Island. This isthmus is a sandy ridge about 100 yards long, with the sea-beach on one side, mangrove mud flats on the other (*vide* Plate II., Secs. 3, 4, and 5). For the length of 50 yards this ridge has been completely denuded of the vegetation with which it was once covered, presents an oblique face to the sea, and the sand is being blown off the top and in shore, exposing heaps of pipi shells and cooking stones as the evidence of former eating places. The other end of this ridge is covered with a thick mat of plants which are thriving in all similar places in this locality, viz., the *Muhlenbeckia; Coprosma acerosa*, or sloeberry; the prickly little *Leucopogon frazeri*; and *Desmoschænus (Pingao)*. The seaward face of this part of the ridge is over five feet higher than the bare sandy portion, and is almost perpendicular (Plate II. Secs. 3 and 5).

The gradations between the lower bare sandy ridge with its oblique face to the sea, and the higher verdure-clad ridge with its steep face to the sea is well observable, and, as our surmises received confirmation here, I describe the process as minutely as possible, for I wish you clearly to understand that these remains have been covered with sand and overgrown with thick littoral plants; and, since the oldest inhabitants knew nothing of these burying-places or camping-grounds, it is clear that these relics could not be observed till the surface had been removed and the old bed exposed to view.

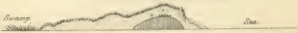
A small channel is formed in the outer face of the ridge, either by the tramping of cattle or the encroachment of the sea, or both, down which the sand will run, and through which the wind rushes like as through a funnel, and soon the space widens; the sand is removed from the roots of the plants, the blowing sand cutting the leaves off, and the ridge is thus lowered in time to the bed of the old camping-ground. One of those small channels is already of considerable width, leaving on the sandy end a mound with a tuft of dying vegetation, its stringy roots hanging down all round. On the other end of this channel the face was steep, and a human skeleton was falling out of the bank; the skull had fallen out, but the other parts appeared in a horizontal position, with two feet of loose sand between the bones and pipi shells beneath (Plate II., Sec. 5). We brought this skull to Auckland and marked it. Portions of two other human skeletons were exposed on the bare sandy end of the ridge. We could not discover any traces of the Moa in this spot.

About two miles south-east, across the Taiharuru River, is a snug little cove, with a horse-shoe beach one-third of a mile in length, called by the Nova Scotians, Baleladech Bay (I failed to learn the native name); it is at the north end of the farm of Wm. M'Leod, and close to his house, at the head of this bay, is a sandy ridge about 20 to 30 feet high, 100 yards long. Each end is bounded by soft clay rocks, with the sea on one side and a swamp of the Taiharuru River on the other.

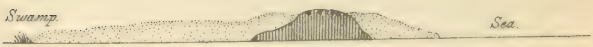
The blown sand here covers about four acres, and the present surface is literally strewn with human remains. I distinguished the heaps of bones belonging to 24 human skeletons, and I was shewn a spot where ten additional had been covered up again with sand. Kitchen middens are heaps of shell-fish and tools. I obtained here some of the finest obsidian chips and one ill-formed adze. After very careful search I found embedded, in brown hardish sand, about three yards apart, portions of the skeletons of two Moas, a large species and a smaller one, as will be seen from the ten vertebræ and fragments of leg, thirteen toe bones, and portions

Sec. 1. From N.E. to S.W. across the position of BURNT SKELETON on PATAUA.

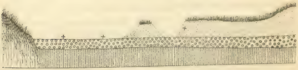
Sec. 2. HURA-HORA. Dotted line shewing probable original face of Cliff.



Sec. 3. PATAUA ISTHMUS.



Sec. 4. PATAUA ISTHMUS. Vegetation gone.



Sec. 5. PATAUA ISTHMUS. Parallel to Sea.

MOA AND MOA HUNTERS

REFERENCE

Hard Fine Brown sand.
Moa bones.
o *Kitchen middens & Shells*
\+ *Human skeletons*
Blown Sea sand.
Vegetation.

To accompany Paper by George Thorne Junr.

of two pelves. These bones are much decomposed, and were lying fully six feet below the present top of the highest mound of cooking stones, pebbles, and shells. W. M'Leod informed me that seven years ago this ridge was covered with a beautiful carpet of *Muhlenbeckia* and *coprosma;* no sand was visible at all, and he was not less surprised than the Maoris to see these skeletons unearthed as the vegetation died and the sand was drifted in-shore.

I have five of these human skulls here marked; amongst them is one of a child (probably a girl of thirteen or fourteen years); it is the only skull I observed exhibiting marks of violence, viz., an abrasion of the skull at the back of the head.

In one of the human skeletons, the small and large bones of the legs were doubled up, evidently undisturbed since burial; the bones of the upper part of the body were scattered around, but the distal (ankle) ends of the tibiæ (shin), and the proximal (upper) ends of the femora (thigh) were embedded in sand, shewing that this individual was buried in a cramped posture.

The Maoris knew not of the existence of this burying-place till exposed to view gradually during the past seven years, by the disappearance of the vegetation and removal of the sand.

At Whale Cove, a little rocky inlet, with a small beach at its head, the sand commenced to drift only three or four years ago, and has now covered about four acres, being curiously blown up hill to the left, owing to the height of the cliff. Of Moa bones, an imperfect metatarsus was all I found here; but in the coprosma-covered bank, a human skeleton was falling out of the sand; some bones remained in the bank as evidence where it had lain. I also found the wing bone of a bird (probably albatros) broken in the middle, one end ground smoothly off, with four little holes very neatly bored, two in each side. It had been used perhaps as a musical instrument, but more probably hung as an ornament (see Plate III., Figs. 16, 17, 18).

At Stockyard Bay, a mile or two further south, on Captain Eyre's land, is a semicircular cove, with a beach for a quarter mile. The sandy ridge here, as at M'Leod's Bay, is a saddle between the sea and a swamp of the Taiharuru River; vegetation has not been destroyed by wind and sand, except in a place where an old stockyard once stood; here, on an old cooking-place, I found one vertebræ bone and some small valueless fragments of a small species of Moa.

Being now convinced of the wider range of the Moa in those parts than I at first thought probable, I examined, in company with Mr. Cheeseman, the extensive sand-hills between Bream Head and Manaia.

Those sand-hills are several miles long, varying from a quarter to half a mile wide, and are in some places 70 to 80 feet high, with sea-beach on one side and large swamps and small lakes on the other. On the northern extremity of the ridges, *Pingao (Desmoschœnus)* and *Spinifex* grass is growing amongst the hills, retaining the loose sand in little heaps, so that no shells or other remains are visible; on the southern or Bream Head extremity, the ridges are bare, and the sand shifts freely, leaving in the saddles between the summits of sand-hills, hardened beds of yellow-coloured sandy soil strewn in places with sharp stones and worn pebbles.

The sides of these sand-hills presented some beautiful examples of false or cross stratification and ripple in the blown sand. On the oblique face which these hills presented seaward, were here and there large mounds of pipi shells and kitchen middens. Walking down to examine the first of these mounds, we observed a collection of quartz pebbles, "Moa stones." We pondered over them with deep interest, feeling sure that, although all osseous remains may have disappeared from these older sand-hills, the Moa once existed here. Our conjectures were well founded and confirmed by the discovery of a much worn metatarus, portions of a femur, and a vertebræ. At another similar mound a tibia was found, and at a third mound some fragments of tibia and femora were to be seen; also the portions of tibia of a small species of Moa, with proximal end tolerably perfect.

Of obsidian flakes and adzes, we found none.

We observed the remains of several human skeletons, but the bones were much broken and worn. Here also we found two pieces of bone evidently carefully bored and shaped by the hand of man (Plate III., Figs. No. 5, 6), and probably applied to some practical or ornamental purpose.

I have been more careful to collect facts than to explain what they mean, since in every study the mastery of facts and the knowledge of their relation to one another is of first importance. *Conclusions* can always wait, always take care of themselves; but now that I have described what I have seen, I may be allowed to point briefly to some of the more obvious ideas suggested.

When I first found a Moa bone at Pataua, I thought it must have been carried there, or that marauding tribes from the Bay of Plenty or Poverty Bay had brought them in their canoes as a supply of food, a small commissariat, in fact, and the human skeletons were the slain in the battle while attempting to or after having effected a landing on an enemy's shore. It may be so, but I think it far more probable that those huge wingless birds lived, were hunted, killed, and eaten there.

The physical character of the localities, Pataua and Manaia, point unmistakably to this latter conclusion. You will readily conceive how the wary Moa-hunter would skilfully drive the probably sluggish, stupid bird down the mud flats and bed of the Pataua on to the narrow sand dunes between the impassable swamp and the sea as into the most cleverly contrived trap. Here the real struggle would take place on which depended his only supply of animal food.

The dry, silicious sandy nature of these dunes fits them peculiarly for the preservation of osseous remains, and these bones seem to be of very great antiquity, compared with similar ones from Canterbury.

The variety of relics of this kind north of Auckland is perhaps in part due to the early extinction of the bird by the natives of the district.

It is interesting, also, to find this bird in these wooded parts of the country, for although there are a few acres of fern land to the east of Parua Bay, yet the Moa could not have lived here without entering the timbered country and feeding on roots which he would dig for with his powerful foot, or berries which would be within reach of his tall beak. However, the extensive flats and pipi banks, dry at low water, would furnish an abundant supply of food for the Moa, if he had a relish for molluscs or small fish, which is very probable, for Darwin ("Voyage of *Beagle*," 2nd ed., p. 89) reports that "South American Ostriches, although they live on vegetable matter, such as roots and grass, are repeatedly seen at Bahia Blanca, lat. 39° S., on the Coast of Buenos Ayres, coming down at low water to the extensive mud banks, which are then dry, for the sake of eating—as the Gauchos say, of feeding on small fish; they readily take to the water, and have been seen at the Bay of San Blas, and at Port Valdez, in Patagonia, swimming from island to island." So that the Moa might readily cross these rivers, or even Whangarei Harbour, to feed on the large flats which are there dry at low tide.

I think that further and accurate observation will prove the *habitat* of the Moa to have been all over this North Western Peninsula. The sea beaches, such as I have described, are numerous all round the coast; those at Te Arai are very likely places, and the Limestone Caves at Waiapu and Whangarei are probably capable of telling some deeply interesting facts relative hereto. We only want more general interest awakened to bring these facts to our knowledge for the benefit of science.

These huge, wingless birds of the past have disappeared, and given place to other and perhaps more beautiful forms of life; it is no use guessing how long ago these creatures flourished on the earth; we certainly know that they lived in New Zealand down to very recent times, and we rightly judge that their disappearance in New Zealand was hastened and completed by the hand of hunters, who, to my mind, were, without doubt, the ancestors of the Maori.

TABLE OF MEASUREMENTS OF DINORNIS BONES FROM PATAUA NEAR WHANGAREI.

DIMENSIONS OF METATARSI, IN INCHES.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 25 26 27
Length	*16.125	*13.125	12.0	*12.5	11.75	...	7.0	Pr. 4.875	5.5	Pr. 5.375	5.125	4.625	5.125	5.125	4.5 F.	5.5	5.25 *	5.0	4.5	4.5	*4.75	4.5	*5.25	Measurements of no practical value; specimens too much worn.
Circumference at Middle	5.25	4.5	4.875	4.0	4.5	4.375	3.125	2.25	3.0	3.0	2.625	2.625	2.5	2.5	2.5	2.75 *	2.5 *	2.5 *	2.25	2.25 *	2.5 *	2.25 *	3.0 *	
Breadth, Distal ...	5.125	4.875	4.125	...	3.75	...	2.875	2.0	2.5 F.	2.5	2.3125	2.125	2.25	2.375	2.0	2.5	2.25	2.125	1.875	1.875	1.875	2.0	2.5	
,, Middle ...	1.75	1.625	1.75	1.5	1.75	1.625	1.1875	0.875	1.1875	1.125	1.0	1.0	1.0	1.0	1.0	1.0	0.875	1.0	.875	.875	.875	.875	1.125	
Thickness, Middle	1.5 *	1.125	1.1875	1.125 *	1.125 *	1.125	0.6875	0.625	0.6875	0.6875	0.625	0.625	0.5625	0.625	0.5 *	0.625	0.5 *	0.5625 *	.5	.5	.5 *	.5 *	.625	
Breadth, Proximal	3.75	3.0	3.125	2.75	3.0	...	2.125	1.625	1.9375	1.9375	1.75	1.625	1.875	1.875	1.5	1.875	1.75	1.75	1.5	1.5	1.875	1.375	...	
									a pair.															

DIMENSIONS OF TIBIÆ, IN INCHES.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Length	...	23.125	*21.0	*21.75 *	..	13.0	13.0	12.25	12.375	11.375	9.375	10.625	11.5	11.5
Breadth, Proximal	4.0	5.25	4.625	3.875	5.125	3.75	3.75	3.375	3.375	3.0	2.5	2.875	2.875	2.875
,, Distal	...	3.0625	2.875	2.875	...	1.75	1.75	1.75	1.75	1.625	1.3125	1.625	1.625	1.75
Circumference at Middle	3.625	4.625	4.875	4.625	...	3.25	3.25	3.125	3.25	2.75	2.375	2.75	3.0	3.125
		very Pr.				a pair.		a pair.		very Pr.	Pr.		a pair.	

DIMENSIONS OF FEMORA, IN INCHES.‡

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Length	10.0 *	10.125 *	10.375 *	9.375	9.25	8.5	7.875 *	6.25 *	6.5 *	6.125 *	6.25 *	5.625 *	Pr. 5.875	6.0 *
Breadth, Proximal†	3.25	3.625	3.75	3.125	3.0	3. *	3.125	2.0	2.125 *	2.125	2.125	2.0 *	1.875	2.0
,, Distal	3.75	3.875	4.0	3.5	3.75	3.	...	2.5	2.25	2.5	2.375	2.0625	2.25	2.125
Circumference at Middle	5.375	5.625	5.625	5.375	5.5	3.5	4.0	3.5	3.0	3.25	3.375	2.75	2.75	2.875
				a pair.										

* Denotes that the bone has been denuded, and the measurement is short.

† The breadth proximal end is measured from the head of the Trochanter straight across, which does not always give the greatest breadth.

‡ Thirteen Femora too imperfect to give any practical value to the measurements.

Metatarsi are generally more perfect and more numerous than other osseous portions; perhaps the hard dry skin protected the bone for some considerable period, or this bone may have contained less juice. F., fissured; Pr., perfect.

Art. IV.—*Notes on Moa Remains in the vicinity of Cape Campbell.*

By C. H. Robson, Chief Lighthouse-Keeper.

[*Read before the Wellington Philosophical Society, 12th February*, 1876.]

Plate IV.

Previous to my arrival at Cape Campbell in March, 1872, to take charge of the light station on the Cape, which forms the northern extremity of the Flaxbourne sheep run, the property of Sir Charles Clifford, formerly Speaker of the House of Representatives, and Mr. F. A. Weld, now Governor of Tasmania, I had heard nothing of Moa bones having been found near it, but soon after, having occasion to visit Flaxbourne on business, I was there shewn part of the tibia of a large Moa. Upon asking one of the shepherds where it came from, he told me that it had been found on the run, and that he had seen other bones which, from his description, must have been tarsi, and this was all the information which I was able to obtain respecting them, then or at any subsequent time; and seeing that the Flaxbourne run extends south from Cape Campbell about 20 miles, with an average breadth of four miles or more, it was, to say the least, a little vague. It served, however, to direct my attention to the fact that this part of New Zealand had, at one time, been frequented by the Moa, and to set me on the look-out for its remains. In the winter of 1873, after a heavy fall of rain, one of my sons found, on his way home from Flaxbourne, at the mouth of a stream some five miles from here, our first Moa bone—a right tarsus, which had evidently been carried down by a freshet, which had taken it nearly to high water mark on the beach. Thinking it probable that more bones would be found higher up the stream, we made a careful examination both of its bed and banks, from the beach to its source, but without finding any more bones, except a small portion of the distal end of a tibia, much decayed; and I think it most probable that the remainder of the skeleton has been washed away by degrees, and either taken into the sea, or buried in the shingle on the beach. On the sketch map (Plate IV.) which illustrates this paper, the stream in question is marked 1. Upon making an examination of the bone above-mentioned, I saw that it had been in a fire of some kind, and the thought struck me that it might have been cooked by the ancient Moa-hunters, so we explored the vicinity of the stream for traces of them, and on a bank to the south of it found some old ovens, which I at first thought might have been used by the Moa-hunters; but a careful examination soon convinced me that the place had been used as a camping-ground by the Maoris on their journeys up and down the coast, or when they came to catch eels in the stream, and that, instead of being Moa-hunters, they were fish eaters and cannibals. The ovens contained, besides ashes and charcoal, shells, bones of fishes and birds, as well as human remains, but not a trace of a Moa bone. On a sand-bank not 20 yards from the ovens, we found the greater part of a human skeleton, which had, I think, been buried, and probably belonged to a woman, one of some travelling or fishing party. The under jaw accompanies this paper. These ovens were close to the stream first-mentioned, and about five miles from the end of Cape Campbell. Much nearer to it, only about a quarter of a mile from the lighthouse, I found another tarsus much smaller than the first. It was found partly embedded in a steep clay hill at the spot marked 2 on the map, but no other bones could be found near it. All the remains mentioned above were found to the east and south of Cape Campbell; to the west of it lies Clifford Bay, extending from the Cape to the White Bluff, which divides it from Cloudy Bay. All along the shores of Clifford Bay, as far as the western extremity of the sand-bar, which separates it from Lake Grassmere, are to be found old ovens and the signs of Maori occupation. Two places have also been pointed out to me where great battles are said to have been fought between the natives. All the stone implements which accompany this paper were picked up at various times at the places marked on the map by crosses. At the place marked 3, is a piece of flat land, lying between the hills and the bay, ending in a reef of large rocks covered with mussels, and here, as might be expected, are the remains of a considerable Maori settlement. The natives inhabiting this settlement were certainly not Moa-hunters, for, on opening a great number of the old ovens, ash heaps, etc., we found chiefly shells, with fish, bird, and seal bones, but no Moa bones; and I am of opinion that these ovens, etc., are of too recent a date for any to be found in them. Maoris were, I believe, living about the mussel rocks the last 50 years. Proceeding along Clifford Bay in a southwest direction, we come to its deepest indentation, where the shore is now formed by a sand-bar, on one side of which is the sea, and on the other the lake, Parera-te-hau, or Grassmere, a shallow brackish lagoon, occupying about 4000 acres, and the resort of swans, Paradise ducks, stilt plovers, and other aquatic birds; and here again we come upon the remains of the Moa, which must have frequented the lake in numbers, bones having been found all round it, but chiefly at the places marked 4, 5, and 6 on the map. There are also a number of old ovens on the sand-bar, full of fish, bird, and seal bones. Lake Grassmere must at one time have formed part of Clifford Bay, for at its western side I came upon the remains of an ancient sea beach, samples of which I send herewith. More recently, its area seems to have been occupied by a forest, the trees growing below the present level of the sea. In September, 1874, after a very wet winter, the lake broke through the sand-bar to the sea, leaving a large portion of its

To accompany Paper by
C. H. ROBSON.

bed dry, exposing a number of trees, many of them being of large size. At various points, both in the dry bed of the lake, from which I send shells, and beyond its limits close to the hills, I have found Moa bones, the greater number in an advanced state of decomposition. At 4 and 5 were found parts of a foot with toe bones and a small tarsus, all of which I forward with this paper, and have marked them all with numbers to correspond with those which indicate on the map the places where they were found. So far as I have been able to discover, without making any very extended search, the Moa-hunters do not seem to have inhabited this part of the coast, or if they did, they were probably Maoris, such as now inhabit New Zealand, all the stone axes, etc., which I have found near their ovens and camping-places being similar to those in use amongst them up to the time when they became acquainted with the use of iron tools. No doubt there have been plenty of Moas about here at some time, but whether they lived here at the same time as the Maoris does not seem clear. I am, however, unable to agree with Mr. Booth and Dr. Haast in thinking that they have been extinct for thousands or even for hundreds of years; and I would direct particular attention to the state of preservation in which the tarsi, which accompany this paper, have been found. They were all obtained on the surface, exposed to wind and sun and rain, and would long ago have turned to dust had the date of the bird's extinction been so remote. I think Mr. Booth is right enough in saying that we know just three things about the Moa, namely, that it has lived in New Zealand, that it does not live in it now, and that it could not live in it now.

ART. V.—*Notes on Moa Caves, etc., in the Wakatipu District.*

By TAYLOR WHITE, ESQ. (communicated by Captain HUTTON).

[Read before the Otago Institute, 24th August, 1875.]

Cave near Mount Nicholas.

THIS cave is situated on the south side of Lake Wakatipu, two miles east of the Von River, in a small conical hill about a quarter-of-a-mile from the Lake. There is a tolerably steep rise, covered with long fern, to the entrance of the cave, which is in the overhanging face of a mica schist rock.

The entrance is about sixteen feet high, and ten feet broad, from which it narrows, both in height and width, to five feet. The top meeting the bottom at the end of the cave. The estimated length of the cave is forty feet.

The floor consisted of a fine powdered rock, which was encrusted to a depth of two inches with rectangular crystals of a clear salt* resembling saltpetre. Some of this, or a similar substance, was found in pieces two inches long by one deep. The depth of the sand was nine inches.

Below this was a coarser formation of small flakes of schist, which extended to a depth of two feet six inches. The next stratum was composed of still coarser material, with broken blocks of schist through it. The depth of this was not tried.

The only trace of water was a slight drip on the left side near the entrance. In places the roof was encrusted with a thin covering of a white substance† which, probably, damp had caused to exude from the rock.†

No traces of animal life were found lower than about six inches from the surface, except at the entrance end, where the material appeared to consist of animal and vegetable matter, which had drifted down from the other parts of the floor, which had a steep incline from the entrance inwards.

Thirty feet from the entrance, in the two-inch crust, a small quantity of double-shafted feathers, of a greyish-brown colour, and three inches long, were obtained. They were scattered separately through the sand. The height of the cave at this place was about three and a-half feet, and the width six feet.

Further in was a small collection of short sticks, fern, and broom, which might be the remains of a nest. Here the feathers were scarcer, and a *metatarsus* was found in good preservation which measured 8 inches in length, $6\frac{7}{8}$ girth at proximal end, $3\frac{7}{8}$ at thinnest part, and $8\frac{3}{4}$ girth at distal end;‡ also portions of egg-shell of a green colour, which appeared to be parts of a large egg, probably that of a large duck.

In both of these places feathers of different birds were found, the greater number belonging to the Paroquet *(Platycercus)*. These appeared to be generally nearer to the surface than those first mentioned.

Close to the end of the cave were found a fibula, measuring $11\frac{1}{8}$ in length, and $4\frac{7}{8}$ girth at the proximal end, and several vertebræ, and a portion of an upper mandible. All of these belonged most likely to the same bird.

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* Sulphate of soda, or Glauber's salt.—J. G. B.

† Gypsum.—J. G. B.

‡ D. casuarinus.—F. W. H.

There were also bones of other kinds of birds, some of which were very delicate, together with a considerable number of pieces of egg-shell. These were white, and might belong to a duck, but no feathers of this bird were found.

Excrement of a large bird was also found, which extended to a greater depth than the feathers. Some of this consisted of undigested fragments of what looked like the stalk of the fern.

Cave near Queenstown.

This cave is situated about a mile from Queenstown, in the range of hills on the south of the Gorge-road, and immediately above Jack's public house.

The entrance is difficult of access, the hill being almost perpendicular below it, It is fourteen feet high, by five feet wide. The floor, for the first ten feet, is level, and consists of fine mica sand to a depth of two feet, below which come blocks of schist, intermixed with finer material. The floor then has a steep descent for about sixty feet, and consists of very large schist blocks, intermixed with smaller. The average height is from six to eight feet, and the average width six feet. The roof had in places a thin white incrustation, but the other no sign of water drip.

At the junction of the sand and schist blocks, at the commencement of the descent, a quantity of double-shafted feathers of a brown colour, and with light-coloured down near the tube, were found, together with quill feathers of small birds—Paroquet, Lark, etc. These were most plentiful at a depth of a foot below the surface, but were also found at a depth of four inches. Some were immediately under large schist blocks. They appeared to be chiefly in a layer of hard-trodden excrement.

Perfect droppings were also found in the sand, and a few specimens of a similar outward appearance, contained undigested vegetable fragments, some of which seemed to be branches and stalks of fern broken into short pieces of three-quarters of an inch in length. No bones were found with them.

To the left of the mouth of the cave, and slightly higher up the hill, at a distance of about 200 feet, was a crevice of an angular form, about five feet wide and fifteen deep, which had been made by a forward slip of a portion of the hill.

In this Mr. Russell, of the American Transit of Venus Expedition, found bones belonging to a very large bird,* also bones of several smaller varieties, and a portion of a large egg. The birds must have fallen or slipped in while examining its capabilities as a nesting place.

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* D. robustus.—F. W. H.

Dimensions of Moa Bones from Drift at Owen's Punt, Kawaru River.

No. 1.

		Girth.			
	Length.	Proximal.	Middle.	Distal.	
Tibia	$29\frac{3}{4}$	$18\frac{3}{4}$	6	$15\frac{3}{8}$*	
Fibula	18	$7\frac{7}{8}$	...	...	Originally larger.
Metatarsus	$15\frac{7}{8}$	$13\frac{3}{8}$	$5\frac{3}{4}$	$15\frac{7}{8}$*	
Phalanx	$3\frac{1}{2}$	$6\frac{1}{2}$	$3\frac{3}{8}$	$5\frac{1}{8}$	

These were dug out of a perpendicular wall of sand, thirty feet high, and were eight feet from the surface. A corresponding Tibia and Metatarsus were found in the creek drift. Both Tibia were broken by a clean fracture in the centre length.

No. 2.

		Girth.			
	Length.	Proximal.	Middle.	Distal.	
Right femur	...	...	...	...	
Left ,, ...	$11\frac{3}{4}$	$12\frac{1}{8}$	$5\frac{3}{4}$	14 †	
Tibia.................	$21\frac{3}{8}$	$12\frac{3}{4}$	$4\frac{3}{4}$	$11\frac{3}{4}$†	
Fibula	$13\frac{1}{4}$	$5\frac{7}{8}$	...	...	Originally larger.

Found ten feet below the surface, Tibia damaged at the proximal end.

No. 3.

		Girth.			
	Length.	Proximal.	Middle.	Distal.	
Left femur	$12\frac{1}{2}$	$12\frac{3}{4}$	$5\frac{7}{8}$	$14\frac{3}{4}$	
Right ,, ...	13	14	$6\frac{1}{2}$	14	dmgd. at prox. end
Left Metatarsus ...	$9\frac{1}{8}$	$10\frac{1}{8}$	$5\frac{3}{4}$	13 ‡	,, slightly.
,, ...	$11\frac{3}{8}$	$6\frac{1}{4}$	$4\frac{1}{4}$	$11\frac{1}{8}$†	,, ,,

Found in the creek bed.

Singular places in which Moa Bones were found.

Above the saddle between Mount Rosa and the spur leading to the bluff on the Kawaru River is a slight hollow of an oval form, about 60 feet wide, and surrounded on all sides but that facing the hill by a wall of rock eight feet high, which had the appearance of being in blocks, a number of which had fallen inwards, causing several crevices to be formed between them and the rock. At the bottom of the largest of these, where the rock was slightly overhanging and the front block sloped steeply downwards towards the rock, making a wedge-formed bottom at a depth of six feet and a width at top of five feet, with a length of nine feet, the length at bottom being only five feet, a number of bones belonging to at least four Moas were found.

* D. ingens.

† D. struthoides.

‡ D. elephantopus.—F. W. H.

Also, at a distance of 100 yards from this place, where the rock cropped out in the form of a step, there was a hollow in the rock four feet deep, eight feet long, and four feet wide, slightly wider at the bottom, from the rock overhanging. In the centre of the bottom of this was a large block of stone on edge, heavier than a man could move in such a small space. Around this block, and apparently under it, were bones of a large Moa, the majority of which were not obtained on account of the narrowness of the space.

Dried Specimen of a supposed Maori Rat.

This was found in a hollow under an overhanging rock. Buried in the sand was a spherical nest of grass and plants, in which was a perfectly mummified rat, without the hair. The hair was lying by the side, and was of a yellowish-red colour.

Either the skull was lying separate from the body, or there was the skull of another in the nest; I think the latter must have been the case. I put the skull in a match-box and the skin in my pocket, out of which it unfortunately dropped.

In the nest, or in the sand covering, were several feathers of the Kiwi.

At another place of a similar description, in what appeared to have been a hawk's nest, I got some hair, which I thought similar to that first found, and which I had lost.

The body was two-thirds the size of the common rat, a dried specimen of which I happened to have found and examined a short time previously.

Notes by F. W. Hutton.

The green egg-shell, from the cave at Mount Nicholas, proves, on microscopical examination, to have the true *Dinornis* structure. It is of a rather pale sea-green colour, smooth, but not polished, and covered with irregularly placed shallow rounded pits. The thickness of the shell is 0.04-inch, and the diameter of the egg appears to have been about four inches. The white egg-shell obtained from the same cave also belongs to the Moa. The feathers from this cave are not very well preserved. Most of them are pale yellow-brown, margined with darker, while a few were dark brown. The largest is six and a-half inches. The feathers from the cave near Queenstown are in an excellent state of preservation, much better than any previously obtained, and many have both shafts quite complete. The after shaft is much more slender than the true shaft; but often nearly as long; the barbs gradually get more distant from one another towards the apex, and they are generally opposite on each side of the shaft. I saw no sign in any of the feathers of the barbs near the base being in groups of four or five as described by Mr. Dallas in the "Ann. Natural

History," 3rd series, c. 16, p. 66, in the feathers of *D. robustus.* There are no barbules on the barbs near the apex of the feather, and the shaft is not produced beyond the barbs. In colour these feathers are reddish-brown, with a central longitudinal dash of dark brown towards the apex of the shaft. The down is brownish white.

These two caves, therefore, have furnished two new kind of Moa feathers, making three distinct kinds that are now known. The green egg-shell is also quite a new type, approaching that of the Cassowary.

With regard to the Rat; the fur is exactly similar in colour to that of a specimen in the Otago Museum, locality unknown, which is certainly only a variety of *Mus decumanus*, but the skull obtained by Mr. White is much smaller than that of any rat that I have seen.

Art. VI.—*Extracts from a Letter from* F. E. Maning, Esq., *relative to the Extinction of the Moa.* [Communicated by T. Kirk, F.L.S.]

[*Read before the Wellington Philosophical Society, 4th October, 1875.*]

1. The Moas still existed in great numbers when the first Maori colonists arrived here.

2. They were called Moa because the Maoris were acquainted, either by experience or tradition, with other large birds, which they called by the same name.

3. There was little or no excitement in hunting the Moa, except such as a hungry man feels when hunting for a dinner.

4. They were most stupid and sluggish birds; and they were destroyed wholesale, by setting the grass and scrub on fire, and would quietly allow themselves to be roasted alive without moving. The natives killed in this way vast numbers more than they could use, or even could find, when the fire spread to great distances.

5. One unusually dry summer, a Maori hunter set fire to the scrub, and it caused such destruction amongst the Moas, that from that time forward they were so scarce as not to be worth the trouble of hunting, and soon became extinct.

6. The natives have a saying, "as inert (ngoikae) as a Moa."

7. Periodically (I suppose once a year) the Moas threw off their sluggishness, and fought with great fierceness, when the Maoris took advantage of their disabled condition.

8. When the Maoris first came into the northern part of the North Island, where the Moa was comparatively scarce, they soon found that,

amongst other things, the Moa was very fond of fern roots, and to procure it, a couple of Moas would soon scratch up and perfectly harrow one or two acres of ground. The Maoris would then kill the Moas, and plant their kumeras in the finely harrowed ground. From this, a small patch of cultivated ground has come to be called a "Moa."

9. Flint and obsidian knives were *always* used by the Maoris at the same time that they had the well-polished tools and weapons of stone. The polished tools were used for canoe building, making paddles, spears, clubs, agricultural instruments, etc., and were exceedingly valuable. The obsidian splinters were not worth the trouble of making into a regular shape; the edge was as keen as a razor, but so brittle, that it could not be used for cutting wood to any advantage. These knives were used for cutting flax, flesh, hair, and for surgical operations. The edge soon came off, when another chip would be split off the large lump of obsidian, which every family that could afford it would have lying by the house, or concealed somewhere near at hand. These blocks were usually brought from the Island of Tuhua by the Ngapuhi, when returning from southern expeditions, and were articles which fetched a considerable price in the way of barter. When I first came to the colony, in many inland villages the obsidian knife was still much used; it was merely a sharp chip, but when split off artistically, extremely sharp.

ART. VII.—*Notes on the Maori Cooking Places at the Mouth of the Shag River.* By Captain F. W. HUTTON, F.G.S.

[*Read before the Otago Institute, 24th August, 1875.*]

LAST summer I was very kindly invited by F. D. Rich, Esq., to explore the old Maori cooking-places on his estate of Bushy Park, at the mouth of the Shag River, and as the Museum Committee were fortunately able to furnish the necessary funds, I gladly accepted the invitation. Not having much time at my disposal, I secured the services of Mr. B. S. Booth, already favourably known to the members of this Institute, by his paper on the Moa swamp at Hamilton,* to conduct the explorations, and on the 23rd of January Mr. Rich and myself inspected the ground, and formed our plan of operations.

The locality has already been well described by Dr. von Haast† as a low ridge of sand-hills, running north and south for about 400 yards

* "Trans. N.Z. Inst." Vol. VII., p. 123.

† "Trans. N.Z. Inst.," Vol. VII., p. 91.

from the tertiary rocks that form the sea cliffs south of the Shag River to the mouth of that river; these hills, being about sixty feet in height near their southern end, and decreasing in altitude towards the river. Inland of the sand-hills there is a low flat, about two feet above high water mark, and this flat is bounded on the east by a tidal backwater, communicating with the river, which flows along the northern end of the sand-hills into the sea.

The flat is covered with a luxuriant growth of grass; but, on the sand-hills, a few scattered tussocks—chiefly in the hollows—are the only vegetation. The northern end of the sand-hills have been considerably worn away by the river, and now form low cliffs from five to eight feet high, in which are exposed some of the old Maori middens, consisting chiefly of shells and fish-bones, but also containing bones of dog, seal, moa, and other birds.

On the very highest point of the hills we also found considerable deposits of shells, Moa bones, and Maori trinkets, and we therefore decided to have a deep trench cut in an east and west direction, right across the hills at this point, in order to ascertain to what depth traces of human occupation extended, and when that was completed, we determined to have pits sunk on the lower parts of the hills, and on the flat, to ascertain the nature of the remains there also. Accordingly, Mr. Booth, with the assistance of another man, commenced to work on the 25th January, and on the 11th February, the trench and pits having been completed, I again visited the ground, in company with Mr. Rich, to examine the ground and decide what should be done next.

The explorations thus made exposed the whole structure of the sand-hills and the flat, and proved convincingly that the Maori middens were only surface deposits, seldom more than four feet deep, scattered irregularly over the hills and flat. We, consequently, gave orders to stop the excavation, and I requested Mr. Booth to continue the surface explorations, and to collect for the Museum for as long a period as he could stay. This he agreed to do, and he remained camped on the ground until the 24th April, when he left, sending to the Museum ten boxes full of the collections that he had made.

Not having any room for unpacking these boxes, I have only opened the three most important ones, examined their contents, and packed them up again; but Mr. Booth supplied me with catalogues of the contents of each box. I am not, therefore, in a position to describe the whole of the collections made at these middens; but, from my own observations, from the notes supplied to me by Mr. Booth, and from my examination of the three most important boxes, I am, I think, in possession of sufficient information regarding the Maori, or "Moa-hunter," feasts to make it unnecessary for me to wait until the whole collection has been examined before laying the results before you.

The deposits of shells and bones generally extended to only four or five feet from the surface; but, in one place, Mr. Booth found bones of dog, seal, and moa, mixed with shells, at a depth of twelve feet. This deposit was covered by four feet of clean sand. On the summit of the highest hill we obtained bone fish-hooks, flakes of chert and obsidian, ground stone implements, fishing-net sinkers, and ornaments manufactured out of *Dentalium giganteum*—a fossil abundant at the Waitaki. With these were moa bones of several species, bones of fish, and immense numbers of the following shells, viz., *Haliotis iris*, *Amphibola avellana*, *Chione stutchburyi* (partly coloured), and *Mytilus dunkeri* (still retaining its colour). All the ornaments manufactured from *Dentalium*, the obsidian flakes, and the ground implements were got close together round one oven, at about two feet from the surface. Above them was a heterogenous mixture of bones (including many belonging to the Moa), and shells; and a similar mixture extended for another two feet below them.

In the deepest deposit found (twelve feet), besides bones of seal, dog, moa, penguin, and fish, there were shells of *Haliotis iris* and large quantities of *Chione stutchburyi*, still partly retaining their colour. These shells of *C. stutchburyi*, however, differed from those of the same species found in all other parts of the midden, by their being much larger. This may, perhaps, be accounted for by the Maoris at that time having collected their pipis on a different bank from the one they afterwards used; for we know that *C. stutchburyi* has survived from the Miocene period without decreasing in size.

It is quite unnecessary for me to give lists of all the remains at each of the excavations made by Mr. Booth, for they were all nearly alike. Moa bones were never found unassociated with beds of shells, and although shell beds did occur without moa bones, these just as often underlaid beds with moa bones as overlaid them.

The following is a list of the animals, remains of which were found in the midden, so far as I have examined the collections:—Seal, dog, rat, *Dinornis casuarinus*, *D. crassus*, *D. elephantopus*, and *D. gravis*. Albatross, penguin, and many other birds not determined. Fish-bones were very abundant, the commonest species being *Thyrsites atun*. The following shells were the only ones found:—*Calyptræa maculata*, *Imperator cookii*, *Turbo smaragdus*, *Haliotis iris*, *Amphibola avellana*, *Mactra discors*, *Mesodesma novæ-zealandiæ*, *Chione stutchburyi* (the most abundant of all), and *Mytilus dunkeri*. No bones of *Harpagornis* nor of *Cnemiornis* were found.

Only three or four bones of young moas were found. Moa egg-shell was not uncommon; but Mr. Booth thinks that the whole quantity obtained would probably not make more than three or four eggs. Two moa bones were found, which, according to Mr. Booth, had been gnawed by dogs. A piece of skin of some animal was found at a depth of about two feet, in the sand. There was no shell bed over it.

In some places near the south end of the hills, moa bones were more abundant deeper down than near the surface; but this was not observed in other places. The moa bones were not in continuous layers like the shells, but in patches. Mr. Booth also noticed that the heads of the same species were always in one patch. Gizzard stones in small heaps were abundant It is also worthy of notice that no moa bones are found in any other locality in the neighbourhood, and none were found on the Bushy Park estate when it was first ploughed up.

It is very difficult to give an opinion as to the age of these deposits. Twelve feet of blown sand would not necessarily take long to accumulate, neither would four feet of shell deposit round the ovens. Many of the shells still retain a considerable portion of their colouring matter; but the greater number of them are white and friable. With the exception of the pelves, all of which were rotten, most of the moa bones were in a better state of preservation than the shells; but Mr. Booth remarks that "the state of preservation in which the bones were found did not depend on their depth, nor the length of time they had been buried; but altogether on the pureness of the sand in which they happened to lay. Whenever the sand was discoloured with ashes, or any other matter, the bones were invariably rotten;"

A stump of totara, probably part of an old eel-pa, was found fixed upright in the river bed below high-water mark, and, on being extracted, it showed that it had been dressed with stone adzes. This stump appears to have been about six feet long. At high-water mark it had rotted through, and the upper portion, two feet in length, was found covered by about a foot of sand. The lower portion, four feet in length, two feet of which were in the ground, is, however, perfectly sound. Mr. Booth also remarked that the lowest shell beds always rested on pure sand, without the slightest discolouration, and he, therefore, thinks that the first occupation of the spit was before any grass was growing on it.

Dr. Haast has stated* that the land has sunk about three feet since the date of the first ovens; but a careful examination of the ground failed to corroborate his observations. No ovens were found as high as low-water mark, although scattered stones that had been used for cooking were found

* "Trans., N.Z. Inst.," Vol. VII., p. 93.

on the river side of the spit below high-water mark, but none below low water mark. These stones had no doubt been washed out of the sand by the undercutting of the river.

On the whole, I am inclined to think that the totara stump proves that the occupation of this midden was previous to the introduction of iron tools by Europeans, and the state of preservation of the shells and bones points to the same conclusion, but I know of nothing that proves that the moa remains are more than a century old, although it is quite possible that they may date back for several centuries. There is certainly not the slightest evidence to show that this spit was occupied at two distinct periods, with a long interval between, during which interval the moa became extinct, as stated by Dr. von Haast. In my opinion, the very last Maoris who camped there fed occasionally on the moa.

Having now given all the facts that I know relating to the occurrence of bones and shells in these middens, it only remains to mention those facts entirely collected by Mr. Booth, that throw some light on the habits of the Moa-hunters and the nature of their feasts.

Of the leg-bones of the moa, nearly all the tibia were broken for the purpose of extracting the marrow; in three months' work Mr. Booth only found three whole ones. Of the femora found, about one-fourth or one-fifth were unbroken. The metatarsi were generally broken. All the pelves but one were broken. The spinal column appears to have been generally cut through at the junction of the neck with the body, and again at eight or twelve inches below the head. Very few heads were found that had been broken for the extraction of the brain. The sternal ribs were generally still lying in their places with the sterna showing. Mr. Booth remarks that there had been but little flesh upon them.

In one place, ten feet square, fifteen pelves were found, with a few vertebræ attached to them; but usually the bones were scattered. All these fifteen pelves were much broken.

In reviewing these facts, Mr. Booth concludes that food was not so abundant with the Maoris, as supposed by Dr. Haast, as almost all the bones except the skulls were broken. He also thinks that the moa feasts were only occasional, a small flock of six or seven individuals of the same species being captured at a time. He also remarks that the charred state of some of the necks proves that they were occasionally roasted, while others may have been steamed. Mr. Booth also thinks that the Maoris used the bones for fuel, as in several places he found heaps of burnt bones from six to twelve inches in depth, and no wood, only a few small pieces of charcoal and burnt grass and sea-weed. He also remarked that the sterna were occasionally full of fish bones, as if they had been used for plates; but this may have been accidental.

In conclusion, I will mention that the collection made during these excavations has furnished sufficient material for determining the species of the Maori rat and the Maori dog. It also contains complete sets of caudal vertebræ of the moa; complete feet, with hind toes of *D. crassus* and *D. casuarinus* (?); the complete larynx, hyoid bones, and palate of *D. crassus*; the ossified sclerotic ring of some species of moa, probably *D. crassus;* and several sterna, with their sternal ribs.

Art. VIII.—*The Mythology and Traditions of the Maori in New Zealand.*

By the Rev. J. F. H. Wohlers, of Ruapuke, Southland.

[*Read before the Otago Institute, 12th October, 1875.*]

Part III.—Maori Mythology*—Miscellaneous Tales.

1.—*The Tale of a Fishing Canoe Blown off the Land.*

A long time ago there were two men living quietly at Hawaiki (most likely the Island Savaii at the Samoan group, or Navigators' is meant). They used to go out fishing, and when they came back their wives met them on the beach, cleaned the fish, and prepared the meals. One day, while they were out fishing for baracouta, there came a great wind, and blew them away on the open sea. After having been tossed about by the waves for a long time, they came to an unknown land. Here they dragged their canoe on shore, and then went about seeking for pieces of dry wood to rub fire with, but found none. However, some pieces they had in the canoe, used for baracouta hooks, would answer when dry. These they put under their arm-pits. Then, when they went along the beach, they saw some foot-marks; some were the impressions of ordinary human feet, but some seemed to have been made by club-feet. They wondered what sort of beings those people might be, and how they could find them. By and by they heard the sound of axes in the bush, and, proceeding in that direction, they saw two men busily at work chopping out a new canoe. They seemed to be quite absorbed in their work, for their eyes always followed the chips as they were flying from their adzes. Once they looked up and scanned about, but did not observe the two strangers who were cautiously approaching. At last the latter went boldly up and discovered themselves. After the first surprise, the men asked, "Where do you come from?"

* See "Trans. N. Z. Inst.," Vol. VII., Miscellaneous, Art. I.

"From Hawaiki. The wind has blown us away from our shore. Where do you belong to?" "To Tahiti-nuiarua" (perhaps the Tahiti of the Society Islands is meant). Then they all went together to the settlement. While on the way, the men said to the strangers, "When you see our women, behave in an unbecoming way; you must not laugh, for if you do they will surely kill you."

The natives of that island lived in a very low state of civilization; they did not even know the fire. When the food was brought, the strangers found that it was the raw meat of the hair-seal, and they could not eat it; but the natives ate it as their ordinary food. The women, in their uncivilized state, behaved very unbecomingly, and carried besides, formidable flint weapons. But the strangers did not laugh, and, therefore, were not killed. By and by the strangers began to rub their pieces of wood to produce fire. At first the people looked at them with curiosity, but when there arose a smoke, and when a strong smell of burning reached their noses, then all began to howl an enchantment, to protect themselves against the ghost, which, in their opinion, the strangers were conjuring up. Their howling went on. "Piopio, sea by the eastward, what brought thee here to my sea by the land? Get up, go!" The two strangers went on with their friction. When the chaffings were ignited, they wrapped them in dry grasses, and waved the same about to fan it into flame, and then they lighted a fire. The natives all the time kept up their howling, "Piopio, sea by the east-wind, what brought thee here to my sea by the land? Get up, go!" Meanwhile the two strangers had dug a small pit, put dry wood over it and stones on the top, and then set it on fire. When the wood was burned up, and the stones, being now red-hot, had fallen into the pit, they wrapped the raw meat of the seal in wet grass, and, having first raked some of the hot stones out, they placed the parcel of meat on those hot stones which were left in the pit; then they put the other hot stones on the top, more wet grass over the same, and then covered up the whole with earth. Now they sat down and waited for the meat to be cooked. The natives all the time looked at the steaming heap, and howled their enchantment. When the meat had been steaming long enough, the oven was opened. Then there arose a fragrant steam, and when the appetizing smell reached the noses of the natives, they stopped howling, and exclaimed, "What a nice smell!" And the cooked meat looked so tempting. Then all relished the meal, the natives remarking, "Now, for the first time, we eat cooked food!" "Yes," said the strangers, "you are strange animals, living on uncooked food; you are not like human beings."

After this the natives told them that there was one evil they were suffering from, namely, a monstrous bird, which ate people. They asked if the direction which the bird used to take was known. "Yes," was the reply, "and if some of us go that way when the bird happens to come, he gobbles us up." Having learned this, they went to the haunts of the bird, and erected a sort of block house, having only one small opening at some height from the ground, into which they jumped and then waited for the appearance of the bird. After some time they saw it coming. The body was still at a distance, when the head already reached their little fortress. The bird came nearer, and raised its huge beak towards the opening where the men stood; but the throw of a heavy axe from the men broke one of its wings. Again, it raised its beak, and again an axe broke its other wing. Then the men jumped down and killed it. After that they went to its cave, and found there a heap of human bones.

Now the two men felt a great desire to go back to their own home, to their wives and families. So they launched their canoe, and paddled away in the direction of their island. At last they reached it. It was night when they landed. They went to their own houses, but there was no one in; there was only the smell of dogs. While they looked about, they observed the glare of a fire in some other house. They went in quietly and sat down, for all the people were asleep. By and by a woman sighed, as if in her sleep. "When the day declines the love arises. The father is parted from Hawaiki. There comes a sound from over the mountains. O, dear—o—." When at last daylight came, the people woke up, and one of the women exclaimed, "There are our husbands."

2.—*The Adventures of Tama.*

Once upon a time there was a chief named Tama, and his wife's name was Rukutia. They had a son and two or three daughters, all still children. One day there came a company of visitors, namely, Tutekoropanga and his followers. A feast was made, and then both parties stood up for a dance. Tama and his party wore maros, made of dogs' tails, round their hips, and Tutekoropanga and his party wore maros, made of precious red feathers. The ornaments of the latter were much admired, and Tama felt that thereby he and his party were put in the shade. This vexed him so much that he withdrew from the gay company, and shut himself up in his ornamented private house. But while he thus sat fretting alone, Tutekoropanga made himself agreeable to his wife, Rukutia, which ended in an elopement. Before Tutekoropanga left, he spoke thus to Tama's children, "Tell your father that it will be quite impossible for him to pursue me, for I have laid my spells upon the briars, thorns, nettles, and ravines of the forest, and upon all the monsters and whirlpools of the sea." Then he departed with his followers and with Rukutia. Tama's son went to his father's private house, and, resting his arms and chin upon the sill of the window opening, looked in. The father was uttering an invocation, and, when he had finished, the son said, "Our mother is gone away with Tutekoropanga." Again the father repeated an invocation, and then went to the house of his children. Here they all had a long cry, and, when they had done, the father asked, "Why has your mother forsaken you?" "Because," answered the children, "you are so plain looking. Our mother liked Tutekoropanga better, because he is such a handsome man." The father then said, "Stay here quietly with your brother." Then he went away, determined to see his ancestors, who had departed this life, and were living in the nether world, and to ask them to make him handsome.

While he is on his way thither, it may not be out of place to give here a short description of what the Maoris thought of a life after death, before Christianity was introduced. It could not be called a belief, because they were not interested in it. It was but a vague conception, and none of the old wise men could give a clear description of the same. The following, however, may be taken as a general summary. When people died, their souls went to a place called the Reinga, somewhere under the earth, but not identical with the Po, which latter seems to have been a more ancient idea, and the abode of superior gods and very great chiefs. The Reinga was surrounded by hills, having a lake in the centre, round which, on the banks, the departed dead lived again in their bodily shapes. When a soul arrived, she alighted first on the top of one of the hills, and waited till observed from below. Then some one would call up, "Dost thou belong to me?" If not, the soul would shake her head; but, if asked by a parent or relation, then she would throw her head back as a sign of yes. Then she would be asked to hover down, and when she reached the ground, she would be again in her former bodily shape. Rank, of course, would be respected; but there was no reward or punishment for good or bad deeds done here; yet there were stages. People died there again, and then passed on to another stage; and somewhere there was a passage through which they must go. Here stood two great spirits, called Tuapiko and Tawhaitiri, one on each side of the passage, bending over towards one another, and between them the departed soul had to pass. A light soul would fly through swiftly and escape, but a heavy and clumsy one would be caught by the two spirits, and destroyed. Dying again, and passing from stage to stage, it is not clear if some at last landed in the Po; but some, at least, when they had passed through about ten stages, made their appearance again in our upper world, some in the shape of blue-bottle flies, and some as candle-moths (the latter are still called "wairua tangata," man soul); this was the last existence of common man. There were other spirits residing in our world; if they had ever been men or not, is not clear; some of them, called atua* (the term is now used for God), would attach themselves to some men, and be their familiar spirits. But there were also cannibal spirits, called ngingongingo (or Rikoriko), who dwelt in the ruins of deserted houses and villages, and would creep into the living, when such came too near them, and eat up their insides, till their bodies wasted away and died.†

We must now return to Tama in our tale. It appears that in the first stages of the Reinga, the ancestors could, in certain conditions, still be visited by the chiefs of their living descendants. Tama met on his way with a white heron (kotuku), and, borrowing his shape, he flew and alighted on the bank of the lake in the Reinga. Here he was observed by his ancestors, Tuwhenua and Tumaunga, and their daughter Te Kohiwai. They looked at the bird, which was going along the margin of the lake, stretching its long neck, and picking up food. They remarked, "That is something new in our place. There are eight (or, as the Maoris generally counted by twos, sixteen) bends in its neck!" At last it struck them that it might be their descendant, Tama. Then they told Te Kohiwai to make a charm called a tamatane, used to find out the identity of a person, and go and throw it at the bird. She did so, and it fastened at once on its neck. Then she led the bird to Tama's ancestors, and, on arriving there, he had regained his human shape. Looking at his ancestors, he was struck by their extraordinary beauty—they were tatooed.

When the first greetings were over, the ancestors asked Tama, "What has brought you here?" "The treasure of your ornaments," he replied. "I wish to be made handsome." They consented to his wish, and drew gracefully curved lines over his face and body. But not long after, when he went and bathed, it came all off, and he complained that it did not last like theirs. Again the lines were drawn upon him, but these, likewise, did not last. "How is it," said Tama, "that your tatoo lasts, and mine does not last?" "Ah," said they, "we cannot make a lasting tatoo here; for that purpose you must go to your other ancestors, to Toka and Ha, at the place of Tuapiko and Tawhaitiri. There they have the proper instruments and pigments, and also the skill of performing the operation." Then Tama went to that place. "What brings you here?" asked those ancestors. "Your ornament," he replied. "I wish to be tatooed." "Ah," said they,

* The ancient gods were called tangata-men; but they had the attributes of gods. Atua also means anything incomprehensible, from a ghost to a work of machinery.

† I can find no paper with a Maori text of the foregoing description; I could easily render it into Maori, but that would not be a text out of the mouth of an old Maori.

"that is death right out." "But you are alive." "O yes; one can live through it, but it is as bad as death." However, it was at last agreed that it should be done. The instruments were sharpened and the pigment got ready. Then he was laid down, and the operation commenced. It was long and painful, and he often fainted. When his breath returned, he could only faintly say, "O, Taka; O, Ha! I am very bad." Then the operator would reply, "It is not I, it is the instrument that causes the pain." However, after many days of painful operation, the work was at last finished. Then he was carried into the house, and laid before the fire. After two or three days he felt better. Then the sores began to fall off, and by and by he found himself having been made a handsome man. He went to the water and bathed, but his tatoo did not wash off. After some time he said to his ancestors, "Now I want to go back to my children." Then they gave him some presents, consisting of rotu, puairuru, and pokeka-kiekie. The rotu is described as a flower, or the extract of a flower, of great virtue. May the name of the lotus flower have been carried by the Maori ancestors even so far as New Zealand?

Tama came safely back to his children. He stayed with them a short time, and then one morning he told them that they must again stay quietly at home, and that he would go and try and find their mother. Then he disguised his newly acquired beauty with dirt and ashes, and made himself look like a mean man. He armed himself with a maipi (a long weapon, having at the point a defiant tongue carved), and a sharp flint; he took also some of the sweet odours with him. So he started on his fresh adventure, repeating an invocation, to counteract the spell which Tutekoropanga had laid on his way. It was a prayer that the mountains and other obstacles might move aside to afford him a passage. By and by he came to a large forest full of impenetrable thorns and brambles and other obstacles; but he bent the thorns and brambles with his maipi, and then cut their strained parts with his sharp flint, and so forced his way through. At last, after a great deal of tiresome labour, he arrived on open ground, and, when near Tutekoropanga's place, he fell in with a company of people who were breaking firewood. When they saw him, and taking him for a straying poor man, they called out, "There is a slave for us!" "Don't, don't," said Tama. And looking so tired and miserable, the people said, "No, we will not load him with firewood." Then, keeping to them, the people told him that they were getting firewood, in order to make bright fires in the evening, for Rukutia, the wife of Tama, whom Tutekoropanga had taken away from him, was to dance before them, and they wished to light the house up with bright fires, so that Rukutia could display the features of her face (her grinning) to the best of advantage.

It was now getting evening, and Tama went with the wood-carriers into the large house, and sat down by a post. The fires were lighted, the people assembled, and Rukutia was called for. Tutekoropanga handed her an ornamented apron to tie round her hips. When she was coming forth to begin her performance, Tama prayed that her eyes might run with water. No sooner had she begun to distort her face (a main feature in that sort of dance) when her eyes began to run with watery tears, and she had to squat down to dry them. Again she stood up, again Tama repeated his prayer, and again she sat down to wipe her eyes. After some more trials, the people began to murmur, "What is the matter with Rukutia that her eyes so run. It used not to be so." Then Tutekoropanga became angry, and beat Rukutia, and she cried. Then the fires were left to go out; the people dispersed; and those, who slept in the house, Tama charmed into a deep sleep. By and by, when the house was quite dark, Tama opened some sweet odour, which he carried under his arm-pits. The odour partly awoke Rukutia, who said, "O thou sweet smell of rotu! Dost thou come from Tama, my husband?" Then Tama shut up that odour, and opened another parcel, which contained an abominable stench, and Rukutia said, "O what a bad smell! The house is full of stink." Then he shut that up and waited a while, and then opened the mokimoki, when Rukutia exclaimed, "O thou sweet odour! Doest thou come from Tama, my husband?" By this time Tutekoropanga had waked up, and said roughly, "What a nonsense! Can Tama get over my spells and come here?" To this Rukutia replied, "To my impression, the eyes of the mean looking man appeared to be those of my husband." When all were fast asleep again, Tama stole quietly out of the house, went to the water, and gave himself a thorough washing, so that his tatoo shone forth handsomely; then he tied up his hair, and dressed himself in a gentlemanly fashion, and went back to the house, and sat down outside close by the door. Now he pronounced a charm, to the intent that Rukutia might want to come out. It was not long when the door was opened, and Rukutia came out. He pulled her gently by the dress, when she looked round, and there sat Tama, her husband, and now, O so handsome! "O, my own husband," she said, "let us flee together." "No," said he, "you stay here with that husband of yours." "O take me away with you," she begged. "This is a bad man, he always beats me. I cannot live with him. Take me away with you." "No," said he, "it was for my ugliness you left me for Tutekoropanga. Stay here. But one fine morning, when you see my shining sail on the sea, then climb upon the whata, rouse all the people, and call, 'There is Tama, my husband.'" Then he went away and left her there.

When Tama got back to his own place, he prepared for a voyage. He put a quantity of ashes and a supply of wood boards on board, manned his canoe, and then set sail for Tutekoropanga's place. Now the great sharks (taniwhas) and all the monsters and dangers of the deep, which were under Tutekoropanga's spell, to keep Tama off, began to assail him. To some he threw ashes to darken the water, to others wood boards to let them bite at, and, while they were thus occupied, he went on. One fine morning Rukutia saw his bright sail on the sea. Then she climbed on the whata, roused all the people, and called, "There is Tama, my husband." When the canoe drew near the land, then all the people, but especially the women, admired Tama, that handsome man. They all called for Tutekoropanga to come and see Tama, the handsome man. But he would not believe them, and remained in his house. Tama, meanwhile, called to Rukutia to swim on board, which call she quickly obeyed. Then all the women called in a chorus, "O, Tutekoropanga! Do you sit lazily at home while Rukutia goes away with Tama, that handsome man." But he believed his spell to be sufficient to keep Tama away. Meanwhile Rukutia had reached the canoe. Tama took hold of her hair, and pulled her in; then, with a sharp flint, he cut off her head. Then he ordered the canoe to be turned about, and to sail for home, with the dead woman aboard.

When they reached home, the body having been bent together into a roundish ball (the knees under the chin, as the Maoris formerly handled their corpses), was wrapped in kura (a precious red substance) and put into a box made for the purpose, and buried in the house near the wall. Now Tama sat day after day in the dead-house, and mourned for his wife, Rukutia. At last, when the spring season came round and the tutu bush put forth new shoots, he heard a humming sound, and then he saw a blue-bottle fly humming, "U—m—u, notwithstanding my head off, u—m—u." Upon this Tama got the corpse up again, and opening the box, he found his wife alive, her cheeks were moving with a sweet smile.

8.—*Ruru-teina and Te Roronga-rahia.*

Ruruteina was the youngest of several brothers, who made him their cook, and to perform all sorts of mean work for them. At the same time there was living, at some distant place, a young lady named Te Roronga-rahia, who was spoken of as the most beautiful of all women. The elder brothers made up their minds to pay her a visit, so they got their canoe ready; took their youngest brother Ruru with them as their cook and man of all work, and then sailed to that place. When they had landed they left Ruru to carry the luggage into a sort of store-house near the beach, which was to be their abode during their stay, and they themselves went to the large common-house of the village. Here they were treated with food, and in the evening there was an assembly of pleasant company. Then every one of the brothers made himself agreeable to a female partner, and every one of them asked his partner quietly to tell him which of them was the renowned Rorongarahia. The answer to every one was:—"Tell no one. I myself am Te Rorongarahia." So, every brother believing he had won the affection of the most renowned lady, kept the secret. But they were all deceived. The beautiful Roronga was a modest girl, and did not mix with the rude young folks. She was quietly staying at home, with her waiting maid, in her own private house.

When Ruruteina had finished carrying the luggage he went to fetch some water, and, seeing some children playing at spinning tops, he asked them to show him the road to the well. "There," they said, "that road, passing close by the house of Te Roronga." "So," he said, "is that the house of Te Roronga?" "Yes." Now, in the evening, while his brothers were amusing themselves in the village house, Ruru paid his visit to Te Roronga. He was kindly received and friendly entertained by that beautiful lady. However, he left by time, and when, later in the night, his brothers came home to the store-house, which was their temporary lodging, they found him sleeping on the luggage. This went on for several days and evenings. One day he heard his brothers say that next morning they were to start for home before daybreak. Now, by this time, Ruru and Te Roronga had already fallen desperately in love with each other, and she had consented to go with him. So, in the evening, while his brothers were amusing themselves with their partners in the village house, Ruru conducted his lady-love and her handmaid into his private cabin in the canoe, and then went and laid down on the luggage, where his brothers found him when they came home. Then their things were carried on board, and a little before day-break, when they embarked, it was found that every one of the elder brothers had a female companion. All got on board, and then sailed away; no one suspecting Ruru of having ladies hidden on board.

On their voyage home, they had to land at a certain place to wait for a change of wind. They went ashore and tried to get fire, but could not succeed. However, a smoke was seen at some distance, and Ruru was told to go there and fetch fire. He did not want to go, fearing some one might open his cabin; but they made him go. Now, at the place where the smoke had been seen there lived a great lady, whose name was Te Ngararahuarau. When Ruru came to her house, he saw her two maid-servants, called Kioreti and Kioreta. The lady heard them talking and asked, "Who is there?" "Ruru," answered the servants. "What is he come for?" "To fetch fire?" "Let him stay for the meal," called the lady. So, when the meal was served, the lady herself made her appearance. Ruru was disgusted, for she wore a dress with an enormous long skirt trailing behind her, and, when he tried to get away, she entangled him in its folds, and not only that, but she had draggled it also over the food, and covered the same with dirty lizard-scales.* When the meal was over, the lady withdrew, and then Ruru asked the servants, "Is she always so?" "Yes," said the servants. "But do you think she is human?" "No, indeed; she is a monster." Hereupon the lady, who had overheard the conversation, screamed "I will kill you." Then the servants told Ruru to make his escape while they themselves ran and hid themselves under some rocks. Ruru ran, and Te Ngararahuarau called after him, "Ruru come back; Ruru come back." And when she found that he would not come back, she screamed, "You may not see me in a fair day; but, let there be a misty day, and I will be with you. When Ruru came to his brothers, he told them what an adventure he had had, and that he was afraid she would pursue him there. Then all agreed that they would kill her. For that purpose they constructed a rude house, with a small window opening at the back. In the middle of the house they placed a wooden post, which they dressed up so as to resemble Ruru. Then there happened to be a misty day, and Te Ngarara made her appearance, calling, "Ruru where are you?" "Here," he answered, from behind the image inside the house. Te Ngarara went in, and mistaking the post for Ruru, encircled it with the drabbletail of her dress. Then, hearing a busy noise outside, she asked: "Ruru, what means that?" Ruru answered, "Only your brothers-in-law making a meal for us." But they were heaping fagots round the house, and blocking up the door, and then set it on fire all round. Ruru made his escape through the back opening. The house was seen enveloped in a sheet of flame; Te Ngarara was stifled with dense smoke, and she cried, "O, Ruru, you are forgetting me!" Now, while the monster was perishing in the flame, the scales of her skin tried tried to escape; but the people were watching round the burning house, with sticks in their hand, and threw back the scales, as they rushed out, into the fire. Only two scales escaped, all the rest perished with the monster.

I cannot give the uncivilised Maori credit of weaving a moral in their fable; but think civilization might draw one out of it with some advantage. If foolish pride, which prompts people to a display of vain show in a general, and to distorting the human form in a particular bearing, could be killed, then a few scales which might escape—if their breeding be kept in proper bounds—would be harmless and would be allowed to live.

At last, the wind being fair, they started again, and arrived at their

* I had to modify this, in order to meet the taste of civilised fashion. It will be seen in the Maori text that her skirt was a huge lizard-tail.

home. Then, to the wonder and perplexity of their parents, every one of the elder brothers introduced his wife as the famous Rorongarahia. But the mother could not see such world-renowned beauty in any of them. However, they had got wives, and, as it seemed, every one to his own satisfaction. Then the mother looked with pity on her youngest son, and said, "You alone have come back without a wife." "Well," he answered, "has no one looked into my cabin in the canoe?" "No; what should there be to look for?" Then he begged his mother to go and see. She did so, and there found the most beautiful lady, and in tears. But the handmaid sat quite composed. Ruru-teina had taken down to them two roasted birds. Te Roronga had eaten only a very little of hers; but the handmaid had eaten hers clean up. The mother called the people together to come and see the most beautiful lady, the wife of her youngest son. Now the elder brothers found that they had been taken in, and every one beat his wife, because she had deceived him.

4.—*Rona.*

Rona is known in New Zealand, not only by the Maori, but also by some Europeans, as "the man in the moon," and for that reason I must not pass him over, though it is rather a rude tale.

One day, while Rona was out fishing, his wife went out of the house and called, "Hoka! come down; we two ——." Hoka answered, "I dare not. Rona is a jealous being. Let Rona get far out on the sea, and I will come." But Hoka was such a rude man that he came straight over the fences, and broke them down. Before Rona came home, Hoka was off again. Then Rona asked his wife how the fences had been broken. The wife said that the wind had blown them down. "But there was no wind on the sea," said Rona. The wife said, "O, such a wind was blowing here." On another calm day, when Rona was again far out on the sea, fishing, the wife called again for Hoka. Again the fences were broken down, and when Rona came home, the wife told him again the same tale of a great wind. Next calm fishing day, Rona, pretending to go out to sea in the fishing-canoe, hid himself in the house, and then found it all out. He caught Hoka, tore off a part, and then let him go. He roasted that part, intending that his wife should eat it; but she ran away, her small children following her crying; the eldest daughter stayed with her father. Rona called after his wife: "If you come back you shall eat it." She went with the children to the wild ranges of the mountains; but, after some time, she thought it best to send the children home to their father. She instructed them how to find him, and then, by means of sorcery, she put them into a log of wood, and rolled the same into the sea, to let the wind drive it home.

When the log of wood, with the children in it, drifted to the fishing-ground of their father, it was seen by some men in a canoe; but when they tried to lift it out of the water, the children prayed that it might be too heavy. The men found it so, and let it drive. Soon after it drifted against the canoe of their own father. Then they prayed that it might be light, and the father lifted it into his canoe with ease. When the canoe was filled with fishes, they paddled home, and then Rona told his eldest daughter to carry up that log of wood. She did so, and put it by the whata, where they hung up the fish. Next day the girl was sitting outside, weaving a coarse grass-mat, and then heard a plaintive singing. Listening, she heard the following words:—"The moon is slow to rise. We shall be killed by our mother. The moon is slow to rise. We shall be killed by our father." Then the girl went and called her father, who came and heard the same wailing. Now it happened that a fire broke out—if by accident, or wilfully by Rona, I do not know—and everything was burnt up.

After this, Rona, in his trouble, tried to fasten himself to the sun; but he found it too hot; then he fastened himself to the moon, and there he remained eating the moon. When he has eaten her up, then he waits till she is grown full again, and then he eats her up again.

5.—*The Adventures of Paowa.*

The first part of the following tale would have read better two hundred years ago, because it is a cruel witch story; but the second part is more pleasant.

Paowa, on a voyage in his canoe, landed at some distant place where there lived an old witch. Her name was Te Ruahine-mata-maori (the old woman with a Maori face). She made the strangers a meal of small kumeras; perhaps, it was for that, she was also called the Ruahine-kai-piha. After the meal, the strangers asked for some fresh water to drink, and when she went to fetch some, Paowa bewitched her. So, when she came to the well, she found it dry—at least so to her appearance. Then she went to another place for water; but found that also, or appeared to be, dried up. Then she wandered about over hill and dale, seeking water, but found all the springs dry. Meanwhile Paowa set fire to her place, and then sailed away. When the old woman looked round toward her place, she saw it all in a blaze. Then she sung:—

"Let my house be burned; but let my store remain.
Let my place of enchantment be burned; but let my cellar remain.
Let my garden be burned; but let my fences remain.
Let my dirt-pots be burned; but let my dogs remain."

When she came back she found her place burned down, and Paowa and his party gone, and the canoe was out of sight. Then she called her dogs, which for some time sniffed about seaward, and at last indicated the direction Paowa had taken. Now she girded up her breath; put some kura, which contained great power of witchcraft, under both of her armpits, and then dived into the sea. By virtue of the kura she was enabled to shoot along under the water to a great distance with great speed. She bobbed up her head and saw the canoe, but a great way ahead of her. Again she dived, and shot along a great distance; she bobbed up her head again, and found that she had gained considerably on the canoe. When next she dived and came up again, she was so near that she was perceived by Paowa and his crew. They paddled with all their might; but soon came to the conclusion that escape by sea was impossible. So Paowa made for the shore, jumped out, and sent the canoe on with the crew. He took refuge in a cave, pursued by the witch; but the latter found on her arrival the entrance already barricaded by Paowa. She sat down and scratched at the stones. Paowa made a fire in the cave and heated some stones. At the same time he roasted also a piece of nice food, and then asked: "Well, old woman; how are you?" "I am here," she answered. "There is a morsel of food for you," said Paowa, handing her a nice bit between the stones. She took it, and having eaten it, she said, "Well, my grandson, that was a nice morsel." "You shall have more," said Paowa, "just shut your eyes and open your mouth." She did so, and then Paowa pushed a red-hot stone down her throat, upon which she fell down and died. Then Paowa went out, and when he touched her body there were flashes of lightning from under the armpits. Then he found that there she had hid her kura, and he took it all away.

Paowa was now provided with excellent powers of witchcraft, but he was in difficulties how to get home, his canoe was gone, and there being no way over land. However, he must manage by witchcraft. So he got into a log of wood, rolled into the sea, and let the wind drive him home.

The canoe had reached safely home, but the men, making quite sure that Paowa had been killed by the witch, told the people that he was dead. Then a time of great mourning was agreed upon. The people came together; some cried, while others cooked, and some others carried firewood. When the latter were busy collecting firewood near the sea, Paowa's log of wood was washed on the shore near them. They rolled it up on high and dry ground, but found it too heavy and too wet to carry it home; so they left it there; they did not know that there was a man inside. When they were gone, Paowa came out, went away and hid his kura, which contained such wonderful virtue of charms. Then he disguised himself, so that he looked like a mean old man, and then he went into the village, and sat down where some women were cooking. They were busy filling flat baskets, like dishes, to be carried to the mourners. "Give me something to eat," asked Paowa. "Indeed, you are mighty bold," said the women, "to ask for food which is for the mourners, who cry over the death of Paowa." But one old woman, more kindly disposed, said, "Never mind, poor old man. Give him something to eat." So some dried fish were given him. Then again Paowa said, "Give me some oil." "No," said the women "the oil is for the mourners; there is none for you." Again some old women said, "O let us give him some oil." When he had got the oil, he said, "Give me some clothes." "Where are the clothes?" the women exclaimed. "We have no clothes for you." But again some kind hearted women said, "Never mind; let us give him some clothes." When he had got the clothes, he said, "Give me some feathers to put on my head." "Indeed," said the women, "he even begs for feathers. Go along; we have no feathers for you." But the kind hearted old women said, "Let us humour him. Give him some feathers to stick on his head." So that ornament was also given him.

Paowa had now got what he wanted, and went away to the place where he had hidden his charm. He washed himself clean, tied up his hair, and put the feathers in it. Then he dressed and anointed himself with oil mixed with the charmed kura, and so he was transformed into a most handsome Maori gentleman, yet so, through the virtue of the charm, that he could not be recognised at once by the people. He now went back into the village where the mourners were assembled, crying over the supposed death of Paowa. When the people saw him, they exclaimed, "What a handsome chief is there coming," and he was invited to come among them. He was much admired, especially by the women. A mother remarked, "He must be a husband for my daughter." "For my daughter, I should think," remarked another mother. By and by Paowa made advances to a nice young lady, a grand-daughter of the aforementioned kind hearted old woman, who was much pleased by that. At last the people ventured to ask him who he was. Then, assuming his own natural features, he said, "I am Paowa." Now all the people recognised him, and there was a great and loud rejoicing. The mourning for the supposed death of Paowa was now turned into a feast of joy.

6.—*Whiro—Tura.*

I must give Whiro a place here, because he was once, before the old Maori religion was understood, through a mistaken identity, nearly being taken for the devil by Europeans. He seems to have been a gloomy sort of man. Once he held his grand-child, a baby, on his knees, and had occasion to call the mother, his daughter-in-law, to come quickly and take the baby away, and to wipe his knees. The mother did both, and laughed. This had been observed by others, who talked about it, till it grew into a tale of indecencies. When old Whiro heard of that, he was so vexed, that he resolved to emigrate. For that purpose he made a canoe, and when the planks on the upper rim were lashed on, the string got round the neck of the man who was pulling on the other side, and, at the same time, Whiro pulled on his side, and the man was killed, if by accident or with intention, is not clear. Whiro buried him under the chips, and said nothing about it. The man was missed and sought, but not found till the time when the canoe was being dragged to the sea. Then, while the people were dragging, their feet moved the chips, and the dead man was found. Then the people said that Whiro had killed him. This made him still more gloomy, and he now resolved to sail away on the wide sea to death. He persuaded a man named Tura to accompany him, but did not tell him that it was a voyage to death. Tura left his wife and a son named Iraturoto at home.

When they were sailing along, they met Tutatahou and Rokotakawhiu. These seem to have been some sort of spiritual beings. Tutatahou called, "Whose canoe is that?" One of the crew answered, "A canoe of supernatural beings;" and for that presumption he was killed, as by lightning. Again Tutatahou called, "Whose canoe is that?" and again one of the men answered, "A canoe of supernatural beings" (atua). He also was killed. Then, being asked the third time, Tura said, "It is Whiro's canoe," adding some explanation (the meaning of which I do not understand, nor could the wise men explain). Then they were allowed to pass on.

Now Tura began to have misgivings as to how their voyage would end, and he suspected Whiro to mean to sail out of the world. When they came to a place called Otea, they passed so near the land that Tura could lay hold of some overhanging branches of the bushes. He held fast and let Whiro go on with his canoe, to death. Tura climbed up the bushes; but the place was not inhabited. He went on travelling in the direction homeward, and after many days he came to a settlement, but it was inhabited by a strange race of people, called the generation of Nukumaitore. Their heads, arms, and legs were so short and so much shrunken into their bodies, that they seemed to have no limbs at all. They were sitting on the tawhara fruit of the kiekie tree, slowly waving their hands on their short arms. Tura claimed the hospitality of an old woman (always a good policy when one comes among savages), and she befriended him. By and by she also gave him a wife. The people there lived on raw food; they did not know the fire. When Tura made a fire, they all ran away into the bush; but when he had cooked some meat, the savoury smell brought them all back.

In the course of time Tura's wife found herself pregnant, and when her time was come, there came to her several old women, each carrying a sharp flint and some soft rags. Tura asked his wife what these meant with the sharp flints. She answered, "To cut me open, and to take out our child. We know of no other way for a child to come into the world. The mother often dies under the operation, but the child is saved alive." Tura told her that there was a natural way for a child, and then drove all the women away, and put his wife into a house by herself. By and by a child was born, the first natural birth of that place.

Tura stayed at that place till his child could run about. Then one day, while his wife was doing his head, she asked, "Tura, what means that, there are white hair mixed with the dark?" "That," he answered, "means decay, and reminds me that I am drawing towards death." Now he felt a strong desire to go to his own home, where he had left a wife and a son. After much crying he took leave of his second wife and child, and began to travel homeward. It was through an uninhabited country, and he walked for many days with little or no food. At last he found a dead whale stranded on the shore. Being now so weak that he felt he could go no farther, he made a small hut, laid in some store of meat from the dead whale, and then had to lay down, being now very ill. Every time his breath returned, he called the name of his first son in his own home, "Iraturoto, Iraturoto." The son, at the same time, was dreaming every night that his father lay sick and alone, and was calling him. So he set out to find his father in the direction indicated to him in his dreams. At last he found him, and nursed him till he was better, and then brought him home.

The end of the Maori tales worth translating.

ART. IX.—*On the Building Materials of Otago.* By WILLIAM N. BLAIR, C.E.

[*Read before the Otago Institute, 13th July and 21st September, 1875.*]

The Building Materials of Otago.

ANY information we have on the building materials of Otago is so interspersed with extraneous matter that it is comparatively useless. Even the initiated, whose duties require frequent reference to the subject, have considerable difficulty in availing themselves of the researches that have been made.

The aim of this paper is to present, in a concise form, the more valuable portions of the information already published, as well as to record my own observations and experience during the last few years. As some of the earlier information is not quite trustworthy, I have endeavoured to confirm all statements of facts by recent investigations. I do not, however, wish this paper to be considered exhaustive or entirely free from errors; on the contrary, it is only intended as an introduction to a thorough investigation of a subject which is of the utmost importance to the colony at large. Although considerable care has been taken to avoid mis-statements, it is quite possible such may exist, and I look to the members of the Institute for their correction.

The natural resources of New Zealand generally are equal to those of many old countries that take a prominent position in the affairs of the world; and, although Otago seems deficient in some of the products which ensure permanent prosperity, such as bituminous coal, and metals, there is an abundant supply of good building materials of every description, and, with the exception of one or two articles, they are well distributed throughout the province. Many of the best supplies are still untouched, and in all probability *the best* of each kind is not yet discovered. It will, therefore, be many years before the extent of our resources in building materials is known, or the properties of even what has already been discovered thoroughly understood. A still longer time must elapse before our stores are utilized and developed. This can only come with the increase of settlement and wealth and improved facilities for transit. Although all these causes are daily acquiring strength, they cannot exert a direct influence on the question till the cost of producing the native article comes nearer that of the imported one.

In considering the subject before us, I shall treat it under the following heads:—*First*, Stones, Bricks, Concrete, and Roofing Materials; *Second*, Limes, Cements, and their Aggregates; and *Third*, Timbers and Metals.

Building Stones.

Building stones are usually divided into three classes, determined by their composition, viz., Silicious, Argillaceous, and Calcareous. Although this is perhaps the most natural and distinct classification that can be adopted, it is objectionable, as bringing together stones of so very different character. For instance, granite and sandstone in the first class and porphyry and clay-slate in the second. I purpose, therefore, to consider them under two heads, with the conventional names of "*Hardstones*" and "*Freestones*."

Properties of Building Stones.—Before proceeding to treat in detail the individual members of these classes, it would be well to consider the properties of building stones generally, with special reference to the causes that lead to decay, and the means of preventing it. The principal bases of stones are silica, alumina, and lime. As can readily be inferred from the most superficial knowledge of these earths, the hardest and most durable stones are those in which the former predominates, many of them, such as granite and basalt, being indestructible. The building stones most subject to decay are sand and limestones. In the former, it is caused chiefly by the mechanical action of winds, rains, and frosts; and in the latter, by these and chemical agency combined. Sandstone is composed almost entirely of silica or quartz grains, or dust cemented together by lime, alumina, magnesia, or iron, and sometimes by a combination of two or more of these minerals. As the particles of quartz are, like the stones already mentioned, practically indestructible, the durability of sandstone depends entirely on the cementing material. When this is nothing but alumina or clayey matter, the stone is of an inferior quality, that base being deficient in adhesive properties, and generally soluble in water. The stone is therefore peculiarly susceptible to the action of the weather. The presence of an undue preponderance of clayey matter in sandstone may be detected by washing small pieces in water. If a large muddy residium is given, the specimen should be rejected as perishable. Craig Leith sandstone, the best in Great Britain, contains—

Silica	98.3
Carbonate of lime	1.1
Iron alumina	0.6
	100.0

Caversham stone, on the other hand, contains—

Silica	24.4
Carbonate of lime and magnesia ...	53.0
Alumina	17.6
Soluble clay	1.5
Oxide of iron	1.4
Water and loss	2.1
	100.0

The reddish sandstones generally contain iron in considerable quantities; when the iron is naturally in a low state of oxidation, the stone has a tendency to decay on exposure. Change from wet to dry seems to prevent rather than assist the cementing process. But when the iron is highly oxydized, and the whole a perfectly homogeneous and compact mass, the stone is not affected by the changes of the weather, and may, therefore, be taken as durable.

Sandstone was deposited under water and hardened by pressure and drying, consequently it has a distinct natural bed. The stone is often of such a uniform colour and consistency that the lines of stratification are quite invisible, and as the stratum may not have retained its originally horizontal position, the mere inspection of a specimen in a museum or of a block in a quarry will not give the bed of the stone. It is, however, easily determined by the quarrymen, from the facility of working in a certain direction as compared with others.

As a general rule, sandstones are hardest and most compact when found at the lower side of a thick stratum, or in the vicinity of basaltic dykes, or other volcanic rocks that may have disturbed them. The facilities for drainage afforded by the lie of the adjoining land has also considerable influence on the consistency of the softer sedimentary rocks.

In building with stones from stratified rocks, it is absolutely necessary that they be laid on their natural bed. A disregard for this rule is the sole cause of decay in a large majority of cases where buildings have failed. When the stones are placed in an inclined position, they afford the greatest facility for absorbing moisture, and when vertical, the superincumbent weight has a tendency to split them. The latter evil is often greatly aggravated by a practice that exists among masons of working the beds slightly hollow, so as to ensure a neat joint.

The appearance of some of our soft stone buildings fully bears out the above remarks, as to the necessity of laying stones on their natural bed; some of them are smooth and solid after many years exposure, while others from the same quarry, and under exactly the same conditions, are in an advanced state of disintegration. This state of affairs could be prevented by simply marking the stones in the quarries where the lines of stratification are easily determined, and generally well known. Independent of the increased durability, it is advisable to lay all stones on their natural bed, for they are a fourth stronger in that position than in any other.

Calcareous stones are less subject to decay from the mechanical action of the weather than sandstone, but more susceptible to chemical agencies. As the cementing material is always the same, the durability depends entirely upon the aggregates, and the proportions in which they are mixed. The compact and crystalline limestones are believed to be unstratified, consequently they are not liable to exfoliation, and may be used in any position; but some of the softer kinds give indications of having been deposited in horizontal layers, in which case it is necessary to build with the stone on its natural bed. Although limestone is generally more compact than sandstone, it absorbs more water; but, on the other hand, the water affects it much less than sandstone. The compactness of limestone seems to keep the water from freezing, and so neutralizes its most powerful disintegrating property. All the softer limestones are hardened by exposure to the atmosphere; at the same time the atmosphere contains the elements of their destruction. The indurating process is not, as is sometimes supposed, attributable to the absorption of carbonic acid from the atmosphere, like the setting of mortar. The lime in the stone, being already a carbonate, cannot in this way absorb more of the acid. The hardening on exposure is caused entirely by the evaporation or drainage of the moisture contained in the pores of the stone.

The ingredients in the atmosphere that have the most deleterious effect on stones are muriatic and sulphuric acid, both of which have an affinity for lime, and combine readily with it, thus rendering the stone soluble in water. The former acid is always present in the atmosphere near the sea, and the latter in manufacturing towns, where coal is burnt. All the softer limestones are more or less subject to the pernicious effects of both these acids, and when magnesia enters into their composition, they are particularly susceptible to the action of sulphuric acid. The English Houses of Parliament are built of magnesian limestone, from the Bolsover quarries in Derbyshire—its composition being as follows:—

Silica	3.6
Carbonate of lime	51.1
Carbonate of magnesia	40.2
Iron alumina	1.8
Water and loss	3.3
	100.0

It is well known that this stone has been a decided failure; the buildings were not many years finished when they began to show symptoms of decay. This result is due entirely to the sulphuric acid with which the smoky atmosphere in London is impregnated. The selection of the Bolsover stone for such an important work is perhaps the most curious instance on record of the miscarriage of skill, experience, and good intention. The English Government, fully alive to the necessity of having the Houses of Parliament built of the best stone procurable, appointed a Scientific Commission for the purpose of enquiring into the qualities of the various building stones in Great Britain. The Commissioners were men of the highest standing, whether as regards their disinterestedness or scientific attainments; they had *carte blanche* to examine, enquire into, and experiment on every stone in the kingdom, in short their instructions appear to have simply been "select the best." After a long, laborious, and expensive investigation, and with the best possible intentions, the Commissioners selected "the magnesian limestone, or dolomite of Bolsover," one of the most worthless stones for the purpose in Great Britain. The sole reason for this untoward conclusion is in the fact that, at that time, the peculiar affinity of magnesian lime for sulphur was unknown, and the Commissioners had the strongest possible proof of the durability of the stone in Southwell Minster, where it had withstood the action of the weather for 800 years. This was, however, in the pure air of a small country town—a condition that differs materially from that which the material occupied when exposed to the smoky and acidulous atmosphere of the metropolis.

Tests.—Except in rare cases, such as the arches of a long-spanned bridge, and the lower courses in a spire or chimney, the pressure on stones in a building never approaches their crushing weight; their cohesive properties may, therefore be disregarded in a popular investigation like the present one. I shall, however, consider shortly the proofs or tests of durability that should be observed in building with freestones.

Generally speaking the hardest, heaviest, and least absorbent stones in a class such as sand and limestone are the best; but this is no criterion when comparing classes. In sandstones the chemical test is the maximum amount of silica, and minimum of alumina; the proportions of the other ingredients being within certain limits apparently of no consequence. The best limestones are those that approach nearest the crystalline state; uniformity of tint and homogeneity of structure are also favourable indications. So far as strength and beauty, as well as durability under ordinary circumstances are concerned, the magnesian limestones are best when the lime and magnesia are in equal proportion. This, however, as already shown, seems the worst proportion for a smoky town.

The absorbent properties of stones can be tested by subjecting them to the action of water under a slight pressure. With 14 lbs. on the square inch English Sandstones absorb from one-seventh to one-fourth of their entire bulk; Limestones, one-ninth to one-fifth; Oolites and Dolomites one-fifth to one-fourth.

The resistance of stone to disintegration can be tested by what is called Brard's process; this consists in boiling specimens in a solution of sulphate of soda (Glauber's salts) and afterwards dipping them at intervals into the cold solution for a few days. The action of this salt closely resembles that of frost, and M. Vieat has calculated that the effect, after two days' application, is equal to the force exerted by frost at 21° Far. on wet stone. The hardest granite is segregated by Brard's process in thirty days.

Artificial Induration.—The artificial induration of building stone is a problem that has occupied the attention of scientific men for many years, and numerous processes have been tried, with varying degrees of success. All the earlier experiments were confined to oils and bituminous matters; but these have, in most cases, proved more liable to decay than the stone they were intended to preserve. Latterly the means of preservation have been sought for in acids, and solutions that form new chemical combinations calculated to arrest and resist the progress of decay. Silicate of potash, chloride of calcium, and other compounds of a similar character, have been used in various ways with considerable success, and it is thought that through this agency a perfect remedy will ultimately be discovered—a very great desideratum when the relative cost of building in hard and soft stone is considered. It seems to me, however, that there will always be a difficulty in applying the indurating fluid in the most effective manner. If it is simply spread on the vertical face of a building with a brush, as is usually done, it is not only apt to be washed off by rain, but it cannot possibly penetrate any great distance into the stone, which is thus covered with a hard skin liable to peel off. A liquid might be forced into the heart of the stone by hydraulic pressure, before being placed in the building; but, in all probability, the power required to do so would impair its cohesive properties.

Geographical Distribution.

The geography of the Otago building stones comes more properly under the consideration of the Provincial Geologist, and is clearly shown on Captain Hutton's Map. It is, however, necessary for the completeness of this paper that a general indication of the localities be given. Commencing with the older rocks, we have true granite in mass at Preservation Inlet, and in numerous veins and isolated blocks in Stewart Island, and along the whole of the West Coast, syenite and other granitic rocks are also found in large quantities in the same localities, and the Bluff Hill is chiefly composed of the former. Gneiss, mica-schists, and other crystalline rocks of a similar character, which compose the Manipora Formation, abound from Preservation Inlet to Martin Bay, and inland to the Manipora and the Te Anau Lakes. Schists and clay slates exist in the Wanaka formation; a broad zone extending from the Taieri Plain and Waikouaiti to Lake Wanaka, and which is flanked on each side by narrower belts of the newer slates, and possibly limestones of the Kakanui formation. Although the two groups last mentioned are generally the repositories of the most valuable metallic lodes, they are the least productive in building stones. Roofing slates, and a few varieties of limestone and marbles, are, however, found in them. The Kakanui, or Carboniferous Formation, comes next in order; it extends in a narrow strip parallel to the schists and clay slates from Balclutha *viâ* Switzers and the Eyre mountains to Martin Bay. There are also large areas between the Big River and the Monowai Lake, at Orepuki, Stewart Island, and the Upper Waitaki, with small patches at the Bluff, the Takatimos, Akatore, and the Horse Range. The Triassic, otherwise Maitai and Putaki formations, occupy the whole of the country between the Clutha and Mataura, as far inland as Gore, thence extending in an irregular chain to the Takatimo Range. The Waipai, or Cretaceous Formation, is represented in this Province by a strip of limited area, extending from Shag Point to Otepopo, and a small patch at Mount Hamilton. The Oamaru, Pareora and Wanganui series, corresponding to the Eocene, Miocene, and Pliocene of Geological Chronology, occupy portions of the coast from the Clutha to the Waitaki, including the Waitaki Plain. The Maniototo Plain, Ida Valley, Manuherikia Valley, and the Tokomairiro Plain, all belong to this group, and an irregular belt of the same runs from Orepuki to the head of the Te Anau Lake. The economic products of the Pleistocene Formation are chiefly clays, gravels, and sands, which will be considered further on.

The volcanic rocks of Otago yield valuable building materials, and are situated chiefly between Saddle Hill and the Waikouaiti; but there are isolated patches at Aparima, Waihola, Upper Taieri, and between Shag Valley and Oamaru.

Products.—Adopting Captain Hutton's numbers and classification of the Otago rocks, the following Table gives the industrial products of the various formations:—

No.	Age.	Formation.	Products.
1	Pleistocene	Pleistocene	Clays, Shingles, Gravels, and Sands.
2	Pliocene	Wanganui	Clays, Shingles, Gravels, Sands, and Limestones, Building Stone, Brown Coal, Cement Stones, or Septaria.
3	Upper Miocene	Pareora	
4	,, Eocene	Oamaru	
5	Cretaceous	Waipara	Marble, Limestones, Flint.
6	Jurassic	Pukitaka	Sandstones and Limestones for Building Purposes, Hydraulic Limes, Coal, and Ironstone.
7	Triassic	Maitai	
8	Carboniferous	Kaikoura	Best Sandstone for Building Purposes, Marbles, Limestones for Mortar, Ironstone, Lead Ore, True Coal, Bitumen, Shale, Fine Clay.
9	Silurian	Kakanui Wanaka	Roofing Slate, Flagstones, Minerals, Ores of Tin, Copper, and Lead.
10	Laurentian	Manipora	Marble, Serpentine Metals, and Precious Stones.
11	Eruptive	Basalt Trachyte Granite	Building Stone, Road Metal, Pozzolana and other Natural Cements, Sulphur, Borax, and Precious Stones.

Hardstones.

The hardstones suitable for building purposes in Otago are,

First, True granites and syenites, with their varieties, syenitic or hornblendic granite, and pegmatite or congealed granite.

Second, Metamorphic rocks, gneiss, clay slates, schist, and quartz rock.

Third, Volcanic and trap rocks, basalt, bluestone, greenstone, dolomite, phonolite, timarite, breccia, and trachytes, with an endless variety of intermediate links and gradations.

Granites.

Granite is the monarch of building stones; although hard and tough, it is not difficult to work with the hammer, pick, or chisel. It can be got in any sized blocks, and takes a polish like marble. Granite has been used for centuries in engineering works and other structures that were calculated to last for ages; but it is only of late years that it has been extensively used for ordinary architectural purposes. The introduction of stone-cutting and dressing machinery into the granite quarries has given this branch of the trade a great impetus, and it is possible that within a few years granite will supersede freestone in the more important public buildings of large cities.

According to Captain Hutton, Preservation and Chalky Inlets are the only localities in the province where true granite is found in mountain masses; but it exists in large veins and blocks in Stewart Island and the whole of the West Coast. Professor Black, in Stewart Island, and Dr. Hector, on the West Coast, report its occurrence at every step.

In appearance the Preservation Inlet granite is not unlike that found in the Island of Mull; it is of a pinkish tinge with grey spots, and rather coarse in the grain. Although it, in all probability, is equal in strength and durability to most of the granites of the old country, and consequently suitable for kerbing, paving, and engineering purposes; its colour will be an objection in architectural works.

I have no doubt our supply of granite for monumental and architectural purposes will ultimately come from the veins and blocks that are so profusely scattered in the various localities above-mentioned. Some specimens already obtained are most beautiful in colour, fine in the grain, and otherwise admirably adapted for the best class of work.

There is a vein of light grey granite at Seal Island, the colour of which is uniform and agreeable; it has a white ground and dark spots, and the grain is very smooth.

Similar veins of clear white granite, with spots of brown mica, have been found at George Sound. In one sample, the mica is in mere specks, but in the other the mineral appears in large lustrous flakes. Both are extremely beautiful, and seem capable of taking a fine polish; but it is possible the latter, from an excess of mica, would lose its appearance in an exposed situation.

Syenite, as you are aware, differs from true granite only in so far as it contains hornblende instead of mica. As mica and felspar are considered the perishable ingredients in these rocks, the durability of syenite can never be questioned; it is also on the whole tougher and more compact than ordinary granite. This stone is found in various localities on the West Coast and in Stewart Island, but the chief supply now available for industrial purposes is at the Bluff. Practically, the whole of the Bluff Hill consists of this material; it could, therefore, scarcely be in a more accessible situation. The Bluff syenite is hard and compact, and of a uniformly bluish-grey tint of great beauty, consequently it is suitable for kerbing, paving, and massive masonry, as well as monumental and architectural works. In my opinion, this stone is little, if anything, inferior to the famous Aberdeen granite, and I have no doubt the quarrying and dressing of it will ere long become an important industry. There is a curious variety of syenite found at Milford Sound, the body colour of which is a pure opaque white interspersed with oblong rectangular blotches of dark grey and black; these blotches are occasionally an inch long by three-eights of an inch in breadth.

Another vein of syenitic granite exists at Isthmus Sound; the grain is rather coarse, but the colour, which is of a uniformly grey tint, is good.

Pegmatite, or compact granite, is found at Milford Sound and Paterson Inlet. The former is of a grey tinge, with large spots of silvery white mica of great brilliancy. This is, perhaps, the most beautiful stone in Otago; but it is doubtful if its appearance would be permanent out of doors. The stone at Paterson Inlet has a pinkish ground, with grey spots, and is much coarser in the grain. When the utilitarian appetite of the colonist has been satisfied, and he has means and leisure to bestow on the ornamental, the beauties of the West Coast granites will be highly appreciated.

Although the stones above described vary much in appearance, there is little difference in their composition, and they are all embraced in the generic name of granite. All granite rocks are composed of felspar, quartz, mica, and hornblende, and the variety is due entirely to the number of the ingredients that it contains and the proportions in which they are mixed. An undue preponderance of mica and felspar in granite—particularly when the latter is alkaline—is supposed to render the stone liable to loss of colour and to decay; but, with that exception, granite of all kinds is practically imperishable.

I have compared Mr. Skey's analysis of the Otago granites with that of the Irish varieties given in "Juke's and Geikie's Geology," and find that, though at opposite sides of the globe, their composition is practically the same.

Metamorphic Rocks.

The second class of hardstones, forming the metamorphic rocks, is comparatively useless as a building material; a few of the connecting links between them and granite, being of a crystalline texture, might be utilised; but, as gneiss proper, and the harder kinds of schist, are composed of the granitic constituents in a stratified form, they will neither break nor cut across the grain, consequently can only be used in the roughest work. There are several crystalline stones of the metamorphic formations of Otago that seem suitable for ornamental purposes.

Granulite, of a light grey colour and fine grain, has been found at Breaksea Sound. Syenitic gneiss, of a grey flaky appearance, exists at "Connecting Arm," and brownish gneiss at Anchor Harbour. These all appear capable of being dressed or polished into columns or slabs for monumental purposes.

The slates in this series of rocks should yield paving stone. It is reported that such exists at Chalky Inlet, on the West Coast; but I have no particulars regarding them.

Volcanic and Trap Rocks.

It is from this class that the principal supply of hardstone is at present obtained, therefore the fullest information on its products and their properties is of the utmost importance. So far as varieties are concerned, it is quite impossible to give even an indication of their extent. Although the area occupied by these rocks is comparatively limited, the building stones they yield are simply confusing in their profuseness. They comprise every texture and colour, from the black basalt that yields to nothing softer than diamond, to white tuffa, that can be sliced with a pocket-knife. Generally all compact stones of volcanic origin are durable, and being unstratified, there is no danger in using them in any position. As already stated, eruptive rocks are found in several localities in the Province; but, so far as I am aware, the Peninsula, and the district between Otago Harbour and Blueskin Bay, are the only places that produce the Trachytes, Breccias, Phonolites, and other stone of so varied a character. There are few rocks of economic value outside this area, except the ordinary blue and greenstones.

Commencing with the hardest, we have black basalt and basaltic conglomerates at the Bluff, Dog Island, Purakanui, Tairoa Heads, and various other places on the Peninsula, so hard that more steel than stone is removed in dressing them. They are, therefore, comparatively useless as building material, and I shall not consider them further.

Bluestone, which is so largely used for road metal, and ordinary rubble masonry, is to be found in almost all districts that have been disturbed by volcanic agencies. Sometimes it exists only in combs and small columns fit for nothing but road metal and pitching, but at other times it occurs in large dykes that yield valuable building stone. The best quarries in the Province are those in the Dunedin Town Belt, the valley of the Leith, and Ross Creek. The most of the bluestone used in Dunedin comes from those quarries. It forms excellent rubble, with a little labour-picked ashlar, but it is altogether too hard for chiselled work. The basements of nine-tenths of the buildings in Dunedin are built of bluestone rubble, and many important edifices, such as St. Paul's Church; the Wesleyan Chapel, New Knox Church, Mercantile Agency Store, and the residence of the two Bishops, are built of coarse hammer-dressed rubble, with facing of lighter coloured materials, the effect of which is very pleasing.

Greenstone is simply bluestone in a more tractable form, and is used for much the same purposes. There is, however, no supply near the centres of population, so its use hitherto has been comparatively limited. Greenstone is found in the Mataura Valley, on the shores of Lake Wakatipu, and at Greenhills, in Southland; its colour varies from light green to dark grey.

Dolorite is a dark grey, or brownish stone, of vesicular texture, and harder, but more brittle, and easier worked than bluestone. It is usually found near volcanic centres associated with the other basaltic rocks. It is quarried for road metal. At Waihola and Tokomairiro a small vein that yielded building stone, now exhausted, was at one time worked near the top of York-place. The base of the University Building, one of the finest pieces of massive masonry in the Province is chiefly built of dolorite from this quarry.

Phonolite, or clinkstone and porphyry, are found in Bell Hill. As they do not exist in masses, they are comparatively valueless as building material. Some of them are remarkably beautiful in colour and fine in texture, capable of being used for ornamental purposes. A polished block of phonolite in the Museum shows an arrangement and blending of various shades of grey colours that excell the best efforts of the grainer. The Gaol and some of the other old buildings of Dunedin are built of clinkstone.

Timarite, an eruptive rock found on the Peninsula, resembles closely the Bluff syenite in colour and consistency, the only difference being that the latter has a slight tinge of green, intermixed with grey, instead of blue. It seems adapted for both useful and ornamental purposes, but has hitherto been little used.

The *Breccias* and *Trachytes*, with their connecting links, come next in order, and they are the most important class of hardstones in Otago. They exist in large quantities in the vicinity of Port Chalmers, and throughout the Peninsula, and, in most cases, the quarries are easy of access by rail or water. The Port Chalmers stone, which was the first utilized, still holds the first place in point of strength and durability, and in the facility presented for getting it in large blocks. It is, however, inferior to some of the others in colour and smoothness of grain, which are essentials in architectural work. The Port Chalmers stone is a true breccia of a bluish-grey colour, with the rock fragments of all sizes, up to six inches. It is hard and tough, but yields readily to the pick. The Port Chalmers Graving Dock—one of the finest structures in New Zealand—is built entirely of this stone; the quarry, from which it is obtained, being within 200 yards of the work. All the kerbing used in Dunedin and Port Chalmers is from the same locality.

Most of the quarries now worked yield stone of a fine texture, easily dressed, and altogether well-suited for any architectural works of a substantial character. Although the labour of rubbing this stone to a perfectly smooth surface is greater, there is not much difference between it and the hardest sandstone, when worked with the chisel and fine axe. Some good specimens of this class of work can be seen at the Mercantile Agency Store, the Union Bank, and Messrs. Sargood's new warehouse.

After that used at the Dock, the next good building stone discovered was at Sawyer's Bay; with the exception of colour, this stone is, to all intents and purposes, the same as the former. The colour is a light grey, about the same shade as Portland cement, but with a slightly orange tinge. In consequence of its better colour, and the proximity of the quarry to the railway, this stone soon became a favourite in Dunedin. It has been extensively used, both as ordinary rubble and dressed ashlar-work; the facing of St. Matthew's Church, Messrs. Ross and Glendinning's warehouse, Messrs. Cargill's store, and a large number of private buildings, are of this material. It may be interesting to note that the railway now in progress through Wales' Quarry, at Sawyer Bay, has revealed the fact that the white stone is only on the outside of the cliff. On penetrating a distance of thirty yards, the colour gradually changes to blue, as found in the other quarries about Koputai Bay. On the other hand the Deborah Bay Tunnel, so far as it has been pierced, twenty-five chains at the south and ten chains at the north end, is almost entirely through Sawyer Bay stone, the same colour, but much softer than in the quarry. It should be noted that the Sawyers Bay stone does not retain its color when exposed to the weather. Although there is no symptom of decay, the stone in some of the older buildings is already considerably defaced by large stains.

The quarries and railway cuttings show that the breccia rock extends from Sawyer Bay to the township of Mansford, a distance of nearly two miles, and from the sea level to the top of the range at Lane Rock, a height of 500 feet. The width inland is not known; but, were it only a crust on the mountain side a quarter of a mile thick, it could produce stones sufficient to make a Liverpool of Docks in Otago Harbour, with a Glasgow in each of the other provinces. The accessibility of the Port Chalmers stone is also worthy of notice. Two railways run through it at different levels, and the Harbour, with deep water at several places, skirts the foot of the rocks.

Breccia, similar to that at Sawyers Bay, is found at Broad Bay, Castle Larnach, and several other localities in the Peninsula, with the exception of Castle Larnach, which is chiefly built of this material, the Peninsula stone has not been much utilised.

A breccia, of much the same consistency, but of a beautiful brown colour, exists on the northern slope of Puka Tapau. It seems capable of taking a fine polish, and will probably be used for monumental purposes. Another stone of the same colour, but finer in texture—possibly trachyte—is found in small quantities at Kakanui mouth.

The *Trachytes* proper, as a class, furnish softer and easier worked stones than the breccias; they are, therefore, more suitable for the ordinary purposes of the builder. There is a large assortment of trachytes on the Peninsula, and in the vicinity of Port Chalmers; many of the deepest cuttings on the Northern Railway, between Carey and Deborah Bay, are composed entirely of this material.

Tomahawk Valley produces a brown trachyte, with light orange spots; it is not much harder than some kinds of sandstone, and seems capable of being easily dressed; although rather dark for the whole front of a building, it might be introduced into some portions with grea effect.

The Port Chalmers trachytes are generally light in colour; one sample in the museum is a delicate fawn of uniform tint and soft even texture. Those in the railway cuttings, of which there seems to be an enormous quantity, are white, with a pale blue or greenish tinge. I am not aware that either of the latter two has been utilised; but there is no doubt this will be done on an extensive scale when better means of transit are provided. The white stone particularly should soon become popular in Dunedin, everything being so favourable to its use; it is easy of access, easily worked, and can be obtained in large blocks; it has, also, every appearance of durability.

There is a peculiar looking trachyte, or tuffa, at Harbour Cove on the Peninsula, which, so far as consistency is concerned, should be classed with the freestones. Its colour is a light brown, with white spots, and the texture is much the same as Oamaru stone, but with less grit in it. The stone dresses as easily as an ordinary sandstone, and has a handsome appearance with any kind of work, smooth, dressed, chisselled, or picked. Although the chalky feel of its surface is a symptom of weakness, the class to which it belongs is a durable one, and it is therefore entitled to a fair trial. The steps at Larnach Castle are made of the Harbour Cove tuffa, in one length of eight feet. Although thus placed in the most trying situation, the stone is wearing remarkably well, and Captain Hutton says that soft trachyte is often as durable as basalt or bluestone.

Freestones.

The freestones of Otago are naturally subdivided into three classes :—

1st. Marbles,
2nd. Limestones,
3rd. Sandstones.

As some of the trachytes and tuffas just described might well be classed under the head of freestones, so, on the other hand might the marble and crystalline limestones be included with the hardstones. It is, however, less confusing to let each be considered with the other members of its own family, although its character accords better with a stranger.

Marbles.

The marbles of Otago are still, practically speaking, unknown and untouched ; the information collected about them is meagre in the extreme, and the few known deposits have not yet been utilized.

A grey variegated marble exists at the Horse Range in considerable quantities ; it has all the characteristics of a true marble, and seems equal in every respect to the imported samples of the same variety. It has not, however, been worked, and there is little known as to the extent of the seam.

Dr. Hector reports the existence of marble of various colours and consistency in several localities on the West Coast. In no case, however, did he find the rock *in situ* ; the specimens were always taken from large isolated blocks and boulders. They comprise pure white and the common variety of colours, with others of a rarer description, such as white and green specked with brown and lead coloured mica. The white is stated to be suitable for statuary ; the samples in the museum shew the grain to be rather coarse and crystalline for this purpose. But, in all probability, this defect will not exist in stone from solid rock, should such be discovered. From a geological point of view, the localities just mentioned, as well as the carboniferous formations, are calculated to produce marbles of all kinds, so I trust they will ere long be thoroughly explored.

A connecting link between marble and limestone is found at "Crooked Arm" in the stone called Cipollino. It has all the appearance of coarse grained loaf sugar, interspersed with small brown specks. The stone is very beautiful, and seems sufficiently hard and durable for at least ornamental purposes indoors, but its general character as a building material is little known.

Limestones.

The limestones proper are as varied in colour and consistency as they are great in numbers; they comprise every shade and hue, from dark grey and blue to pure white, and every texture and degree of hardness, from stone as hard as basalt to chalks and recent concretions that can be dug with a spade. There is often a difficulty in deciding as to whether certain stones should be called limestones or sandstones; strictly speaking, they should be put in the class to which their predominant ingredient belongs; but, like the purely chemical arrangement referred to at the outset, this brings unlikely relations together; for instance, Caversham stone is more than half lime, though it has all the appearance and attributes of a sandstone. The classification of doubtful specimens is, therefore, made on the general resemblance as to their class rather than on a chemical basis.

Again, commencing with the hardest and most compact, we have a large mass of limestone at the Twelve Mile Creek, on Lake Wakatipu; in colour and texture, it closely resembles ordinary green or bluestone, possibly a little softer, but every bit as tough. The rock seems shattered on the surface, and incapable of yielding anything but materials for rubble work and ordinary ashlar, but it is probable that large blocks will be obtained when the quarry is opened out. The stone has not yet been extensively used for building purposes, but its excellent quality, and the ease with which it can be quarried and shipped, cannot fail to bring it into prominent notice.

A bluish-grey granular limestone is found associated with the marble in the Horse Range; so far as strength, durability, and appearance is concerned, it would make an excellent building material. In all probability it is the best limestone for the purpose yet discovered in the province. It is found on the Shag Valley side of the range, but I have no information as to the accessibility of the rock or the size of the blocks attainable.

There is fine limestone in the Peninsula much darker in colour, but closely resembling in texture the famous Bath stone of England. It has little or no grit, works freely, and seems durable. The colour is a peculiar tint of brown, rather sombre for building in a mass, but suitable for facings and monumental work. The stone is said to exist in large quantities, and to be procurable in moderately sized blocks. I am, therefore, confident it will become one of our most popular building materials, when means of transit are provided. The deposit is in a very inaccessible situation, near Boat Harbour on the eastern side of the Peninsula, consequently the stone cannot be utilized at present.

A hard shelly white limestone has recently been discovered at Kakaunui, and used in some structures in that locality; it is of a uniform colour and consistency, nearly as hard as Sawyers Bay stone, but much easier worked; it should prove a valuable addition to our stock of building materials. A variety of this stone, from the same place, similar in colour and consistency, but full of large fossil shells, has been quarried for the foundations of the new road bridge; it is admirably adapted for work of that kind, but is altogether too rough for architectural purposes. These stones are both procurable in large blocks, and the supply is unlimited.

A coarse grey limestone, of uniform colour and consistency, is found in large quantities on the Totara Station, near the Waireka Creek. With the exception of the foundations of the Waireka road bridge, it has hitherto been little used. Although more friable, the stone is about as hard as the Tasmanian sandstone; it has a beautiful warm tint of an agreeable shade, and seems capable of being dressed in any way, from hammered to polished work.

A valuable addition to the limestones has recently been worked at Waihola Gorge, in the shape of a beautiful grey stone, found on the western side of the main road, about 40 chains from the railway. The stone, when newly quarried, is harder than the Oamaru stone when dry, consequently it must be very much harder after being exposed to the air for some time. It can be dressed in any way, is capable of taking a fine polish, and, being easy of access, it cannot fail to become popular as a building material, whenever the Southern Railway is open. A solid face of stone, 20 feet thick, is already exposed in the quarry, consequently the appliances for handling and transporting blocks must alone determine their size.

Both sides of Waihola Gorge contain large quantities of the limestone that is used for lime burning. This is a very hard compact stone, of a beautiful white or light cream colour, without a speck. So far as strength, appearance, and durability are concerned, it makes good building stone, but hitherto it has not been found in blocks of sufficient size. The whole rock is shattered into layers a few inches thick.

The blue and grey limestones of Pleasant Valley come next in order. Several varieties of them exist in large quantities, and they are all remarkable for beauty and uniformity of colour, fineness of texture, and the ease with which they can be dressed and carved. Unfortunately, however, they are too soft and friable for out-door work. This stone has been used in the

Bank of New Zealand, Waikouaiti, Mr. Hepburn's house, Brooklands, and other prominent buildings in that district.

I now proceed to the consideration of the most important building material that hitherto has been used in Otago, viz., the *Oamaru Stone.*

The use of this material is coeval with the settlement of the district in which it occurs, but it was little known beyond till 1866, when an export trade commenced with Dunedin. The first large building erected of this stone in the city was the University.

The Oamaru stone occupies that large tract of country in the northern parts of the province, extending northward from the Kakaunui to the Waitaki Plain, and outward from the coast to the Kawroo River. The same class of stone is also found from Riverton to the head of the Te Anau Lake in Southland, and at Castle Rock on the Taringtura Downs. Practically speaking, the supply of this material is inexhaustible. There are extensive quarries worked in the Oamaru district, from which a large quantity of stone is produced annually, both for local wants and export to other parts of the colony and Melbourne. The trade with the latter port is of recent birth, but it promises to be ultimately an important one. The principal quarries now at work in the Oamaru district are at Cave Valley and Kakanui. The town of Oamaru is chiefly supplied from Cave Valley, and Dunedin and other southern districts from Kakaunui. The trade to Dunedin alone is sufficient to keep one or two vessels constantly trading to Moeraki.

Much has been said as to the relative merits of the Oamaru stone from different localities, but I do not think that there is any practical difference in similar samples. The constituents of the stone are almost the same throughout the province, so any difference in colour or texture must be due to its proximity to foreign matter or facility of drainage.

The Oamaru stone, correctly speaking, is a white granular limestone. It has a remarkable uniformity of colour and texture; not only can large blocks be got of the same tint and consistency, but whole cities might be built, in which one stone could not be distinguished from another.

According to Mr. Skey, its component parts are—

Carbonate of lime	90.15
Alumina	1.55
Oxide of iron	.55
Soluble silica	.45
Insoluble matter	7.15
Loss	.15
	100.00

The ordinary English building stone which most resembles this is the Kelton Oolite, its analysis being—

Carbonate of lime	92.17
" magnesia	4.10
Iron and alumina	.90
Water and loss	2.83
	100.00

The weight of Oamaru stone, wet from the quarry, is 105 pounds per cubic foot, and, when perfectly dry, 92 pounds; that of the Kelton Oolite, when dry, 128 pounds. The lightest limestone in England is the Bath Oolite, which weighs 115 pounds per cubic foot. The New Zealand product is, therefore, the lightest by about 23 pounds per cubic foot.

Applying the chemical tests to the Oamaru stone, we place it on a par with the Oolites and common limestones of England and the Caen stone of France. According to Dr. Hector, the resistance it offers to the disintegrating action of Glauber Salts is comparatively feeble. Its inferiority to the above mentioned stones consists chiefly in its excessive porosity. I have made several experiments, with the view of measuring its absorbent powers, the results of which are worth recording; A block of Kakaunui stone, used as a footstool in my office since 1868, and consequently thoroughly dry and hard, furnished the best possible materials for the tests. A piece of this stone, seven inches square and one and a half inches thick, equal to 73.5 cubic inches, weighing, when dry, 56 ozs. 17 dwts. 11 grs. troy, was put in water; within 40 hours it had absorbed 12 ozs. 15 grs., equal to 31 per cent. of its entire bulk, and 21 per cent. of its weight. The specimen was allowed to remain in the water for sixteen days, when the quantity absorbed had increased to 14 ozs. 2 dwts. 19 grs., which gives 36 per cent. of the entire bulk, or 228 gallons of water in a cottage wall ten feet square and one foot thick.

A bar of Oamaru stone, 13 inches long and 1.65 inches square, was next placed vertically in a glass of coloured water; it stood 3.2 inches into the liquid. In six hours the moisture was quite visible to the top of the bar, and in twelve hours the colouring matter had risen 7½ inches. As the stone in both these experiments was particularly dry, the maximum results are probably obtained; but, on the other hand, the vertical position of the bar, in the second experiment, was less favourable to the absorption of moisture than that usually occupied by stones in a building, particularly the horizontal parts of mouldings, cornices, copings, and window cills. It should be pointed out that the Oamaru stone absorbs 36 per cent. of its bulk without pressure, while the most porous English stone only absorbs

25 per cent., under a pressure of fourteen pounds on the square inch. It is doubtful, however, if an increase of pressure in the former case would give corresponding results, the stone being so excessively porous, gets completely saturated at once. When the dry samples were first put into water, the air rushing from the pores of the stone, caused bubbles to rise to the surface for fully ten minutes. The first experiment shews that the stone is capable of absorbing ten pounds per cubic foot more water than it contains when in the quarry, a result to me quite unexpected, and not easily explained.

One of the most important points, in connection with the use of Oamaru stone, is the degree of induration it attains in drying, and the loss sustained by subsequent exposure to moisture. So far as the hardening is concerned, I am quite satisfied that the largest blocks used in ordinary masonry become equally hard throughout in a few months, and possibly in a few weeks, under the influence of a warm dry atmosphere. The hardness is not confined, as is sometimes supposed, to a thin crust on the surface of the stone, but penetrates to the centre, making the whole a perfectly homogeneous mass. In consequence of the time required, I have not been able to prove by direct experiment that a stone once hardened becomes soft on exposure to wet. I fear, however, that such is the case; the window-sills and mouldings on the south side of the University building are now fully softer than when they left the quarry, and the chances are that these stones had acquired a considerable degree of hardness before being placed in the building. The cornice and parapet on Messrs. Dalgety, Nichols, and Co.'s warehouse, although in a much more favourable situation, on the sunny side of the street, is softer still; the stone can be scratched out in handfuls by the finger nails. This is, however, one of the oldest, if not actually the oldest piece of Oamaru stone masonry in Dunedin; it is, therefore, possible the material was bad to begin with.

Against these unfavourable examples, the bridge in Thames Street, Oamaru, built in 1860, and several other buildings of the same age, in that locality, are not decayed, nor unduly charged with moisture. The ultimate durability of our Oamaru stone buildings cannot of course be determined at this early stage of their existence, and any estimate, short of actual trial, is little more than conjecture. Professor Black might, however, give us his opinion as to whether it can long resist the action of the saline breezes from the Ocean Beach, the sulphurous fumes of the Green Island coals, and the other impurities that are now so rapidly accumulating in the atmosphere of Dunedin. I should be loth to prophecy evil, but if the durability of the Oamaru stone is to be measured by its power of resisting moisture, it is to be feared that the handsome spires and facades that now ornament the city will not transmit the names of their architects to many succeeding generations.

Although the bad qualities of the Oamaru stone are quite apparent, there is, on the other hand, so much to recommend it, that it will always be a popular building material. I shall, therefore consider the work for which it is well adapted, and the precautions necessary to ensure the best results from its use.

The stone is well suited for any ordinary work in a dry warm climate, like Victoria, and it is unexcelled for internal decorations of all kinds and in all situations. It is suitable for ecclesiastical architecture generally, and forms a beautiful contrast as facings to darker stone.

It should not be used in the southern side of buildings, particularly if they are recessed, and it is altogether unfitted for window-sills, parapets, and the upper side of large mouldings and similar projections. Buildings of this material should be designed to have as few of these as possible, and where unavoidable, the flat tops of the stones might be covered with some preservative; from an æsthetical point of view, this is the only part of a stone building where such should on plea be permitted. Dampness can be prevented, to a certain extent, by an impervious foundation and internal lining, hollow walls, and other expedients of a similar nature. I have made several experiments with Oamaru stone, to test the efficacy of certain appliances occasionally used to prevent damp. A bar of dry stone, after receiving two coats of ordinary oil paint, was deposited in water. In 40 hours it had absorbed 34 per cent. of its bulk, including the weight of the paint, against 31 per cent. absorbed by unprotected stone in the same time. Another sample, coated with soluble glass, the principal indurating ingredient in artificial stone, absorbed 27 per cent., exclusive of the weight of the solution, which was four per cent. more.

Although these experiments give an indication of the results to be derived from the application of the materials referred to, they are altogether too crude to be advanced as conclusive. The oil in the paint was absorbed to such an extent by the stone that the colouring matter, which remained on the surface, could be washed off by water. It is, therefore, probable that much better results would be obtained by more coats, and the use of a heavier pigment like red lead. With reference to the use of soluble glass as a remedy for damp, I am not sure that this is a property to which it lays special claim. Although porosity is a primary cause of decay, it may be possible to increase the hardness and durability of stone, without removing the lesser evil. Besides, the method of applying the solution adopted by me, may not be exactly correct.

The following is a recapitulation of the results obtained by the various experiments on Oamaru stone.

Weight, when fresh from quarry	105 per cubic foot.
,, ,, quite dry	92 ,,
,, after 40 hours' immersion in water	111 ,,
,, ,, 16 days' ,, ,,	115 ,,
,, painted stone, after 40 hours' immersion in water, including paint	111 ,,
,, of stone coated with soluble glass, after 40 hours' immersion, including solution	111 ,,

The principal buildings entirely of Oamaru stone in Dunedin are :—The University, First Church and Manse, Union and New South Wales Banks, Fernhill, and the Pier Hotel. In Oamaru, nine-tenths of the buildings are of this material, and several of them, such as the National Bank and the Star and Garter Hotel, are worthy of a place with the architecture of the old world. The private residences in that district can also be classed along with the country houses of England, notably Windsor Park, Elderslie, Moa, and Totara. The stone has also been used in numerous road and railway bridges, many of them of considerable span.

The granular limestone found in Southland resembles closely the Oamaru variety in composition and colour; it is, however, a little coarser in the grain, and, if anything, harder and more compact. Large deposits are known to exist at Aparima Castle Rock, and several adjacent points, but hitherto it has been little utilized.

Sandstones.—The sandstones of Otago are as varied in consistency and more numerous than the limestones, but excel them in diversity of colour. The extremes in the latter are generally connected by gradations of blue and gray; but sandstones merge into all conceivable shades and hues.

As already stated, the Craigleith sandstone, the analysis of which has been given, is the best in Great Britain. It is, however, too hard for many purposes, so the Midland and Scotch stones, that have five or ten per cent. less silica, may be taken as the type of a good and useful building material. A corresponding type, in the colonial product, is found in the Tasmanian freestone, of which the High School, Custom House, and Cargill monument are built; it contains 86 per cent. of silica. Any Otago sandstone that has so much of this base, and has a hard compact texture, may be considered strong, durable, and dry.

The highest class of sandstones, as regards their relation with the hard stones, are grits. These abound throughout the Province, chiefly in the form of large boulders, or erratic blocks, like the Sarsen or Druid stones of the South of England. Numbers of them exist on the ranges about Kaikorai, Tokomairiro, and Kaitangata. They yield stone of a red or brownish colour that varies in texture from coarse sandstone to conglomerate with large pebbles. The blocks are usually harder than ordinary sandstone; but are sometimes wanting in cementing material, so much so that the stone easily reverts, under pressure, to its original gravel.

The grits furnish good building material for massive coarse work; but are comparatively valueless for architectural purposes. The railway bridges at Chain Hills and Glenore are built of this kind of stone—that in the former work is comparatively fine in the grain, but the others are coarse and full of pebbles. They are both used in large blocks, which, along with the dark colour of the stone, tends to give the structures a massive appearance very appropriate to this clase of work.

Closely allied to the grits, and existing under much the same circumstances in the same localities, we have numerous freshwater sandstones. They are of various colours; but are all extremely hard and compact, apparently highly charged with silica. A very handsome stone of this kind, found in the Hillend district, has been used in the abutments of the Clutha Railway Bridge; it is of a silver-grey colour, and an even hard texture. Other samples found in the same locality, and at Chain Hills, are of a reddish-white colour, equally compact. Both varieties are too hard for dressing with the chisel. There is a good specimen of white sandstone in the Museum, from Murison's Gully, on the Rough Ridge; in all probability it belongs to this class. A connecting link between the grit and sandstone proper is found on the western side of the Waihola Lake, from Mary Hill to the Gorge. It has a tough granular texture, capable of being easily dressed with the pick or chisel, but too hard for smooth work; its colour is a light warm brown, very suitable for architectural purposes. The stone is supposed to exist in large quantities; but has hitherto been little used. Mr. Duff's house is the only building of it that I know.

The sandstones proper, which embrace all sedimentary rocks *in situ*, are found in immense quantities throughout the Province. Unfortunately the more accessible supplies are of an inferior quality, consequently this stone has hitherto been little used for building purposes.

One of the hardest sandstones in Otago is that at the Falls, Gore Township, and at other places on the Mataura River, it is of a dark green or blueish tint, almost as hard as bluestone and equally unworkable. It is found in large blocks, with natural joints and beds, and so is very suitable for massive coarse work; the two bridges over the Mataura are built of this material.

A sandstone, of much the same quality though scarcely so hard, is found on the northern slope of the Puketapu; its colour is generally a light blueish grey, like Portland cement, but occasionally merging into yellow. The new road bridge at Palmerston is being built of this stone. Although found in large blocks, the deposit is supposed to be limited.

There is a hard yellow sandstone associated with the limestone at the Twelve-Mile Creek, Lake Wakatipu. The rock is very much shattered, consequently the stone is not procurable in large blocks; but it can be got of a sufficient size for housebuilding. This material has been used to a small extent in Queenstown.

Waikara, as might be expected from the geological character of the district, produces a compact hard sandstone, suitable for building. The only sample in the Museum is rather dark for architectural purposes; but I have no doubt there is an abundant supply of all kinds between the Clutha and Mataura. In 1865, Dr. Hector said of this stone: "It has a disagreeable colour; but its texture and stability is superior to any of the sandstones in the Province which have, as yet, been examined, although others have been seen that will probably prove of quite as good quality." The Waikara sandstone contains 80 per cent. of silica, which is a near approximation to the Tasmanian stone in its essential constituents. Mount Hamilton, in Southland, produces an excellent sandstone of much the same character as that at Waikara, but firmer in the grain, and of a bluish colour. Altogether this is a first-class building material; but I have no information as to the extent of the deposit, or the facilities presented for working the stone.

The district between Palmerston and Moeraki contains an immense assortment of sandstones, many of them, like a portion of the cliffs in Trotter's Gorge are too soft and friable for building stones; but there are a number of isolated blocks and veins that yield good materials. A fine yellow stone, of much the same texture as the one from Waikara, has recently been worked near Puketuitai, and there is a smooth-grained dark red ferruginous sample from the Upper Horse Range, in the Museum. Both of these would make excellent building stones. The former, having a beautiful colour, should be particularly sought after when the means of transit are provided. These are only quoted as examples of what the district can produce; there are at least five places on the railway line between Pleasant Valley and Trotter's Creek, where good sandstones can be obtained.

Proceeding further up the Waihemo Valley, we find the accommodation house at Coal Creek built of a coarse-grained yellow sandstone, found in the neighbourhood. It is also said that a large deposit of fine white stone exists in the same locality.

A hard brown sandstone has recently been discovered and worked on the north side of the Otepopo Hill. It is being used in lining the tunnel now in course of construction through that range. Although hard, the stone dresses readily with the axe. It is found in large blocks, with regular vertical cleavages, in both directions, at right angles to each other, which gives the stones two natural faces, as true as can be worked artificially, thereby presenting great facilities for quarrying and dressing. The brown sandstone of Otepopo is too dull in colour for ordinary architectural work in large surfaces; but seems well adapted for basements, facings, and massive masonry.

The class of sandstones that comes next under our notice is the rusty-yellow varieties found at Anderson Bay, Arden Bay, Kaikorai, Saddle Hill, and Greytown. In my opinion these rocks are simply ordinary soft sandstone, like that at Caversham, dried, consolidated, and baked by volcanic fires. In the early days of the settlement, this stone was used to some extent in Dunedin and its vicinity. In the Juror's Reports of the New Zealand Exhibition, analyses are given of several varieties, which show them to have, to a moderate extent, the essentials of a good building material. The reporters, however, say that, in consequence of the excess of impalpable cement contained in the Arden Bay stone, "it will not be durable if much exposed to the weather;" and that the Anderson Bay stone "breaks up rapidly when tested with sulphate of soda, so it will not resist the action of frost." These two stones happen to have been used in the New Zealand Clothing Factory, built about the year 1861. From its enclosed position, the southern wall of this building never gets the sun, so the stone has been subjected to the severest meteorological test that can be applied in Dunedin. The predictions with reference to the Arden Bay stone have been realized, as the lintels and sills are beginning to decay, but three lintels of the Anderson Bay stone are as fresh as when erected.

The class of sandstone that comes next in order of hardness, I shall call the "Otepopo Free Stone," as that district furnishes the greatest number and variety of specimens. They, however, occur at other places throughout the province, notably on Mr. Larnach's property, near Broad Bay.

In the Otepopo Valley, the stone is of all shades, from clear white to dark yellows and reds; that at Mr. Larnach's is bluish-grey, like Portland cement. Although it abounds in great quantities, and often in accessible situations, the distances of the deposits from centres of population or a shipping port, has hitherto prevented its use; neither has the stone, to my knowledge, been analyzed. It seems to have most of the attributes of a good building material. The only objectionable feature I can discern is an apparent deficiency of cohesion between the particles of sand. As the cementing ingredient does not appear to be clay or lime, it is possible that this defect does not exist in stone from the bed rock. If the objection just mentioned is not found to be a serious one, I have no doubt our main supply of freestones for architectural purposes will ultimately be drawn from the Otepopo sandstone.

The lowest grade of freestones, and the last in my list, is the well-known Caversham stone. The deposits of this rock throughout the province are practically illimitable. It can be found anywhere along the coast, and for a considerable distance inland, from Kaitangata to Moeraki. The extent of the deposits in accessible situations increases the regret often felt about the inferiority of the stone, and one is apt to wish that it had exchanged places with the carboniferous sandstones in the neighbourhood of the Dome Pass or Eyre Mountains. This stone has been found below sea level at Green Island and Otago Harbour, and 1000 feet above it, at the Leith Saddle: and the Look-out Point tunnel, 950 yards long, is through a solid rock of the same material. I might almost say *a solid stone*, for there are only five or six cracks in the entire length. The Caversham stone is generally of a bluish-grey or yellow colour; but these are seldom blended in any way; its texture is also remarkably uniform; in peculiar situations, such as isolated cliffs and near basaltic dykes, the stone occasionally changes, but the solid stratum of rock is perfectly homogeneous.

Although it was extensively used as a building material some years ago, Caversham stone is altogether unsuited for any purpose where strength or durability is required. It does not at first harden on exposure, like the limestones, but begins to decay whenever erected, if exposed to winds, rains, or frost. Some of the Caversham stone, used in old buildings that have been painted, is still sound, but there are a few exposed examples, particularly on southern walls, that are not decayed to a considerable extent.

This completes a description of the principal Otago building stones, on which I have information. You may have noticed that, although they comprise specimens from all quarters of the province, there are a few isolated districts capable of producing good materials, to which no reference has been made, viz., the Upper Waitaki, Tapanui, Switzers, and the Waiau. I know little or nothing of their resources, consequently I am reluctantly compelled to omit them.

The first part of my next paper will be devoted to the consideration of bricks and concrete, after which I shall revert shortly to stones as the building material for which they are substituted, and institute comparisons between the relative merits and cost of the three materials.

Bricks.

The materials for making bricks are so widely and abundantly diffused throughout Otago that the difficulty is to find a locality where they do not exist.

Like many other native products, colonial bricks were for a long time held in great disrepute, and it was even thought impossible to produce a good article from the materials at command. There is not the slightest ground for this impression ; on the contrary, the clays of Otago are, so far as I am able to judge, superior in quality to the English ones. In one respect their superiority is very marked, that is, in their freedom from stones and gravel, which is such a drawback to the English brick maker. The inferiority of the colonial article was caused entirely by want of care in selecting and preparing the clay, and insufficient burning. It is simply the old question of dear labour against large profits. In the early days of the settlement, when discomforts of any kind were accepted as a matter of course, or considered a charm of colonial life, so little attention was paid to our dwellings that everything connected with them became second rate ; materials and workmanship were alike defective ; but a radical change has within the last few years come over our ideas. Our houses are growing larger every year, and we are not satisfied with anything short of the comforts, if not the luxuries, of the old country. It is this change in the demand that is improving the quality of the colonial bricks as well as other building materials, and those who provide them must cater to the public taste.

Clay, for ordinary bricks, should not be too stiff and plastic on the one hand, or too friable and sandy on the other ; neither should it contain an excess of lime, iron, or alkaline earths, although small quantities of these ingredients are in certain circumstances desirable. Bricks made of stiff rich clay shrink in drying, and crack and twist in burning ; but this can be prevented by an artificial mixture of sand. If the clay is quite free from sand to begin with, about 20 per cent. will be required to reduce its strength. When this proportion is exceeded, the bricks become brittle, soft, and fusible at a moderately high temperature. The presence of lime in such quantities as to effervesce with acids, increases their softness, and causes disintegration in the bricks. The red colour of ordinary bricks is due to an oxide of iron ; within certain limits, this improves their quality, but more than ten or fifteen per cent. of the metal gives an almost black colour, objectionable in architectural works.

According to Dr. Ure, the following is an analysis of clay that will make good red bricks :—

Silica	50.40
Alumina and oxide of iron	24.00
Carbonate of lime	2.70
Carbonate of magnesia	1.30
Water, etc.	21.60
	100.00

Professor Black has kindly analysed a sample of ordinary brick clay, taken at random from a heap at Caversham. It contains—

Water lost at 120° centegrade	8.70	per cent.
Constitutional water lost at red heat ...	2.60	,,
Silica	61.90	,,
Alumina	21.63	,,
Sesqui-oxide of iron	6.37	,,
Lime	.30	,,
Oxide of magnesia	.32	,,
Alkalies	2.60	,,
	104.42	

This is such a close approximation to the English product in its essential constituents, that we may safely conclude there would be no difficulty in finding any quantity of clay in Otago identical in every respect with the English type.

The clays of this province are so varied in colour and consistency that, independent of their industrial importance, they form an interesting study. Two years ago I made a collection of about 40 distinct varieties from the volcanic deposits around Dunedin. Many of them were of the most beautiful colours, bright red, yellow, and blue being quite common. When separated from the sombre tints of the surrounding earths they resembled artificial dyes or paints more than natural products in a crude state. The pottery, fire, and pipe clays also demand special notice. They too exist in an endless variety throughout the province. Although their colours are seldom very bright, they are extremely fine in texture, and unctuous to the touch, like fancy soap.

Like everything else in this mechanical age, the manufacture of bricks is now done wholesale; machinery is applied in almost every stage of the process, and in many cases there is only a few minutes from the time the clay is dug till the bricks are in the kiln. I question if this is an advantage, so far as quality is concerned. The old-fashioned way of digging the clay in autumn, leaving it exposed to the action of the weather throughout the winter, and working it up in spring, is more conducive to the production of a good article.

Tempering, the next step in the manufacture, is also done in an imperfect manner; there is often no attempt made to reduce the clay to a perfectly homogeneous mass, consequently the bricks are full of cavities and other flaws, which make them twist and crack in the kiln, and impair their cohesive strength. With reference to the burning, a few years since it was scarcely possible to get a well burnt brick in Otago, but latterly a considerable improvement has been made in this respect. If the preparation and tempering of the materials were only brought to the same standard, there would be little cause for complaint.

The Hoffenan, or German perpetual kiln, of which there is a sample at Hillside, burns bricks, lime, or cement, in a very effectual manner, at a fabulously small outlay for fuel. The principle is simply the utilization of all the heat produced, which is done in a most ingenious manner. The air that feeds the fire passes through the cooling bricks, in doing which it cools them, and in exchange becomes heated, so as to act like a hot blast on the burning mass. Then the heated gases from the furnace are carried through successive stacks of unburnt bricks, by which means they are dried and rendered fit for the fire. The fuel used is dross, or dust from the Green Island lignite, and it is put into the furnace in homœpathic doses with a trowel.

An ordinary English brick, when perfectly dry, absorbs seven per cent. of its weight of water in fifteen minutes. I have made experiments to determine the absorbent property of the colonial article, and find that a hard red brick absorbs fourteen per cent., and a soft one thirteen and a-half per cent. of its weight in the same time.

The fact of the soft brick having absorbed nearly as much as the hard one, is a clear proof that the inferiority of the colonial product is attributable more to the imperfect manner in which the raw materials have been prepared than to deficient burning in the kiln.

The establishment of the pottery works at Tokomairiro, and the success which has attended them, proves in the most conclusive manner the existence and practical utility of fire and pottery clays throughout the Province. The articles manufactured there require raw materials of the most varied kind, from refractory fire clays that resist the fiercest heat to the mixed varieties that melt at ordinary temperatures. Nearly all these clays are found in the railway cuttings between Tokomairiro and Clutha, and the establishment of the pottery may be traced directly to the construction of the railway, which revealed the existence of the raw materials in that neighbourhood.

Although the bulk of the articles manufactured at an ordinary pottery have no connection with the building arts, there are many of its products that can be utilised. In addition to the common drain-pipes, chimney-pots, and tiles, we will soon want tesselated pavements for halls and hearths, and terra-cotta goods of all kinds for ornamental purposes.

The raw materials for these articles exist in considerable quantities throughout the Province, so I have no doubt a supply of native manufacture will be forthcoming whenever the demand arises.

Concrete.

At this stage concrete will be considered as a substitute for stone and bricks only; the properties of the native ingredients will be more fully discussed in a subsequent chapter on "Limes, Cements, and their aggregates."

Perhaps there is no building material in existence to which so much attention has of late years been directed as concrete, and with reference to its principal ingredient—Portland cement—the feeling in its favour is almost a mania. It is applied to every conceivable purpose, from the huge monolithic mass that resists the greatest force of the ocean in a breakwater, to the plaster on the bottom of an ironclad that prevents the adhesion of shell-fish and seaweed. In such a multiplicity of uses, it is impossible to avoid occasional failure; but this has resulted more from an erroneous estimate of the properties of the material, and its consequent misapplication, than from incapacity to perform its proper functions. Another cause of failure, particularly in house-building, is the want of skill and care in mixing and depositing the ingredients.

The use of concrete as a building material is not confined, as is sometimes supposed, to the present age; it enters into the composition of many of the pyramids of Egypt, the Roman temples, and the feudal castles of Great Britain, whose substantial appearance still attract attention. It should, however, be explained that the often quoted superiority of those ancient structures is a popular fallacy. When tested in a scientific manner it is clearly proved that their reputed strength will not bear comparison with modern masonry. In fact, there have been no mortars, ancient or modern, whose cohesive properties approach, in the most remote degree, those of Portland Cement.

Although used to a considerable extent by the ancients, and in Mediæval ages, concrete has not, for several generations, been applied to the ordinary purposes of the house-builder. The invention of artificial cements has of late years given a fresh impetus to the art, and it has already in many cases fairly supplanted stone and brick.

The advantages claimed for concrete, and the uses to which it is applied, are to numerous to be discussed here. I shall, however, take a cursory glance at some of its more prominent features. The first, and in my opinion the highest, property to which it lays claim, is the facility afforded for building massive structures without the expense of lifting or transporting heavy weights. Its superiority over all other materials in this respect is undoubted, consequently it will always take the foremost place in breakwaters, foundations, and other works of a massive character.

Durability is a property to which concrete lays special claim, and, I think, with good reason, for it increases in strength with age, while most other materials commence to deteriorate from the moment they are put into the building. Lime, which is of a perishable nature, enters into the composition of cement concrete, but, as the proportion is so small, seldom exceeding ten per cent., and as the lime is protected by the silicates and other durable ingredients that are in combination with it, the deleterious acids of the ocean, or atmosphere, can have little effect on the mass.

The advantages of cheapness, strength, dryness, and many other good qualities to which concrete lays special claim are not like those already mentioned "constant quantities." They depend so much on locality, cost of ingredients, and skill in construction that no general comparison can be established between it and other materials for which it is a substitute.

The chief drawback to the use of concrete is the difficulty of ensuring good materials and workmanship, and the risk thereby incurred. From the peculiar nature of the work, the margin of safety is very small. There is only one step from absolute security to utter failure, and that step may consist of a simple act of carelessness in selecting or mixing the materials. It is popularly supposed that any ordinary labourer can build a concrete wall; but, such is not the case, the amount of skill and attention required, particularly in house-building, is equal, if not greater, than that demanded from the tradesman.

In addition to marine works, for which it is pre-eminently suited, concrete has, within the last few years been applied to an infinitude of purposes ashore. In England it has been used for pavements, causewaying, and water-pipes, as well as bridge-building and ordinary architectural and ornamental works. Paris has thirty-two miles of sewers, and thirty-seven miles of an aqueduct in concrete. The latter is the most extensive work of its kind in existence. There are nearly three miles of arches, some of them being fifty feet in height and forty feet span.

The village of Vesenit, near Paris, has a Gothic Church entirely of concrete, in one piece from foundation to spire, and the lighthouse at Port Said, eighty feet high, is of the same character.

Concrete is either built in blocks previously moulded, and laid like stones or bricks, or in what is called the monolithic system, which consists in laying the soft ingredient between frames in the position they are ultimately intended to occupy. The former is undoubtedly the better, as it does away with the risk of using faulty materials; but the latter is much cheaper, and on that account is more generally adopted. The simplest form of blocks is that of common bricks; in England these are manufactured in large quantities by machinery, and form excellent building materials. A compressed concrete brick, composed of one of cement to six of sand, will, when six days old, resist a pressure of eighteen tons, which is about double the strength of ordinary red bricks.

Concrete is cast into blocks for arch-stones, quoins, sills, lintells, steps, and mouldings of all kinds.

In view of the interest taken in concrete as a building material, I shall devote a few remarks to the consideration of its properties. The cementing ingredient in concrete is generally hydraulic lime, or cement, or a mixture of the two. The former has not yet been discovered, or, at least, used as such in Otago, neither has the latter been manufactured, so they cannot be called native; but, as the raw materials for making cement exist in large quantities, there is no doubt its manufacture will become a colonial industry at no distant day. The proportion of cement to the aggregates varies from a fourth to a tenth, according to the nature of the work, the strength of the cement, and the character of the other materials; for house-building 1 to 6 is weak enough, particularly here, where the cement may have deteriorated by exposure on the voyage. The best aggregate is one in which the pieces are of all sizes, from two inch metal to fine sand, adjusted in such regular gradations that the cement will exactly fill the vacuities. Large metal and fine sand, with other materials of an intermediate size, does not make good concrete. The ingredients should be mixed dry, and water added in infinitesimal quantities, through a fine rose, or otherwise in the shape of spray. This is an important point, for a wash of water enriches one portion of the mass at the expense of another. No more water should be put in than sufficient to damp the cement; as a certain limited quantity only is required in setting, the excess evaporates, and leaves cavities for the reception and retention of moisture. Mixing, the next operation, is also equally important; it must be done in a thorough systematic manner, so that every piece of stone, or particle of sand, is completely coated with cement. It is almost impossible to get this work done properly by manual labour, and although machinery is constantly employed on large works, the necessity for it in ordinary house-building is not yet fully recognised.

The manner of depositing the material in the moulds, or frames, has given rise to a difference of opinion; some authorities hold that the concrete should be placed loosely, as pressure impairs the setting properties of cement, while others advocate excessive ramming. If Roman, or any other quick setting cement is used, pressure will undoubtedly do harm; but, with ordinary heavy Portland Cement, or hydraulic limes, in the proportions usually adopted, there is no risk in ramming, and the quality of the concrete is so much improved by it, that, if necessary, it would be better to retard the setting of cement by a mixture of ordinary lime, or by prolonged mixing, than omit the operation.

The large French works that I have mentioned are all built of a concrete invented by Mon. F. Coiquet, and known as "betou agglomeré ;" the composition being as follows :—

Hydraulic lime	1	or	1
Portland Cement	1·5		$\frac{1}{4}$
Sand, or gravel, not larger than a pea ...	5		4

This has been the most successful application of concrete to ordinary building purposes hitherto recorded, and the result is due almost entirely to careful manipulation.

In addition to the essentials of a proper adjustment of the ingredients, and thorough mixing with the minimum quantity of water, great stress is laid on the necessity for heavy ramming. The concrete is spread in thin layers, and hammered with iron-faced beaters till each layer is compressed to a third of its original thickness. The surface is then raked to form a bond with the next layer, and so the work is carried on continuously to the end. The result of this careful treatment is that "betou agglomere" is one of the most compact, impervious, and durable building materials at present in ordinary use.

General Gillmore, of the United States Army, in reporting to his Government on the question, made some experiments to determine the relative strength of concrete prepared in the usual way, and in the method adopted by Mon. Coiquet. I give a few of the results :—

Compressive strength.—Crushing weight of Portland cement pure and mixed with sand, in pounds per square inch, on blocks seven days' old :—

	Rammed.		Loose.
Pure cement	$2846\frac{3}{4}$	(not crushed)	2597
1 of cement to 1.7 of sand	$2804\frac{1}{2}$	...	1038
1 to 3.4	931	...	727
1 to 5	519	...	$259\frac{1}{2}$
1 to 6.8	$259\frac{1}{2}$	...	$104\frac{3}{4}$

Tensile strength under the same conditions—

1 to 1.7	138	...	109
1 to 5	66	...	33
1 to 6.8	39	...	24

Independent of these experiments, the defects of the loose method of depositing concrete in buildings is apparent to any observer. The cavities occasionally amount to a third of the whole, consequently a nine inch wall is no stronger than one of six inches in which the materials are compressed into a solid mass, and the porosity of the structure must be proportionately great. If it is possible to ram "beton aggloméré" into a third of its original bulk, it is quite obvious that the voids in the unpressed article must equal or exceed the solid parts, or that the whole mass lacks the density essential to strength and impermeability. A coat of plaster on the outside of a building will not, as is sometimes supposed, effectually keep out damp. At the most, Portland cement and its mixtures are only limestone or calcareous sandstones or grits, and, as such, are more or less absorbent; it is, therefore, necessary to convert them into the compact state by pressure, if we want it to resist moisture, and it is impossible to do so in plastering.

Although some thousands of experiments have within the last few years been made to determine the strength of Portland cement and its mixtures, under every conceivable circumstance, there is no record of any regular experiments having been made to test its powers of resisting damp. General Gillmore made one or two trials of "beton aggloméré," and he pronounces it to be practically impervious; the amount of moisture absorbed in four days was immeasurably small.

An Indian engineer, Mr. Horace Bell, found that neat Portland cement absorbed 20 per cent. of its weight in an hour, and 25 per cent. in three hours. In view of the paucity of our information on this subject, I made a few experiments with samples in my possession. The specimens were not prepared for this purpose, so the proportions of the various ingredients and mode of mixing them were not recorded with the exactness necessary in a thorough investigation; the results are, therefore, not advanced as absolutely conclusive.

	Weight of water absorbed after $2\frac{1}{2}$ hours' immersion.
Neat Portland Cement.—Lump taken from a damaged cask, the original powder having been consolidated by hydraulic pressure	2 per cent.
Neat cement from the Rangitata bridge, four years old; it had been pressed into a mould with a trowel, like ordinary mortar	$6\frac{1}{2}$,,
Neat cement, another sample like the last ...	8 ,,
Cement mortar, from Abbotsford bridge, two years old, 1 of cement to 3 of coarse sand ...	9 ,,
Concrete, one year old, made from 1 of cement to 7 of tailings, the sizes of the ingredients being well adjusted, and the concrete very compact	$4\frac{1}{2}$,,

Another experiment was made with a specimen block of concrete, made by the proprietors of the Logan Point Quarry. It was composed of one of cement to seven of fine road metal and small stuff from the stone-breaker; none of the metal was larger than an inch each way, and the other ingredients were well adjusted. The concrete was not heavily rammed like "beton agglomere," but it seems to have been very firmly pressed. Altogether, it was a first-class piece of concrete, and the greatest difficulty was experienced in breaking it up with a wedge and heavy hammer. The block measured 24 inches long, 12.25 inches high, and 10.08 inches broad, and weighed, when dry, 240 lbs., the outside being covered with a thick coat of rich cement plaster, as it is intended to have in a building.

The first experiment was to determine the impermeability of the plaster. A wall of clay was put round the edge, leaving a square foot exposed; water was poured on, and in three hours about three-quarters of a pint had penetrated the surface.

The whole block being then immersed, it instantly absorbed two and a half lbs. more, and in sixteen hours the quantity had further increased to four lbs.

On breaking, it was found that the moisture had permeated every portion of the block, and the centre was as wet as the outside.

The two samples of concrete thus experimented on were of a very superior quality; I have never seen anything to compare with them in ordinary work. Although these experiments are very crude, and the results much higher than would be obtained from less carefully prepared specimens, they go a long way to prove that the property of perfect immunity from damp, to which concrete houses lay claim, is not secured by the mode of building usually adopted in Otago, and, I believe, the experience already acquired in actual practice, fully supports this assertion.

I shall now consider the strength of concrete, in order to compare the cost of the various materials under description, which I intend to do further on. The properties of brickwork being so well known, it has from time immemorial been selected by municipal authorities as the standard from which to determine the strength of buildings, and there are regulations in every town fixing the thickness of brick walls in whatever position they occupy. I shall, therefore, adhere to the same standard.

The following table gives the crushing strength of various kinds of bricks and concrete; but, for the purposes of a more general comparison, a few examples of other materials are added.

	Crushing weight per square inch in lbs.
Brick, weak red	550 to 800
Brick, strong red	1100
Brick, first quality	2000 to 4370
Ordinary brickwork	890

Good brickwork in cement	550
Best brickwork in cement	930
Neat Portland cement, 9 months old	5970
1 of cement to 3 of sand ,,	2400
1 of cement to 5 of sand ,,	1700
Betou agglomere, 15 months old, with hydraulic lime of Argentine ...	2650
Same, 18 to 31 months old	3300 to 5360
Betou agglomerè, 21 to 30 months old, with hydraulic lime of Theil ...	5650 to 7180
Betou agglomerè, 2 months old, made from 1 of hydraulic lime and 1½ cement to 5 of sand	1690
Same, with 1 part of cement only ...	1860
Same, with ½ part of cement only ...	1450
Chalk	330
Ordinary sandstones	3300 to 4400
Compact sandstones	9800
Limestones generally	3100 to 8500
Caen stone	1100
Basalts and granites	9500 to 13,000

Smooth dressed ashlar, in large blocks, with cement mortar, is practically as strong as the stone of which it is built, but rubble masonry is three-fifths weaker. We may, therefore, assume the crushing strength of this class of work, built from our native bluestones and hard breccias, at 4000 lbs. per square inch.

From the above data the relative thickness of walls of equal strength in the ordinary building materials would be approximately as follows :—

Good brickwork	1.00
Ordinary concrete	0.33
Bluestone rubble	0.15
Betou agglomerè	0.10

Although, in theory correct, it is practically impossible to adopt this standard, for we all know that nine inch brick walls are sufficient for a one storey house; but the idea of reducing them to one inch is altogether too absurd to be entertained, no matter how strong the material may be. The objection, also, holds good with the thickest walls; for weight and breadth of bearing are as much required as cohesive strength. Those who maintain that concrete is superior to every other building material advocate thin walls, or at least, affirm that they are permissable, and many houses have been erected, the sides of which resemble monumental slabs more than the habitation of the living man; I find, however, that Mon. Coiquet, who has had more experience than anyone else, does not build excessively thin walls: those of a house of six floors and a cellar, erected by him in Paris, commence with a thickness of 19.8 inches, and terminate at the topmost story with 9.8 inches; the average being 13½ inches, which is within three-quarters of an inch of the thickness required by the Metropolitan Buildings' Act, for the wall of the same house in brick or stone. Concrete buildings in London are generally built to the same standard as brick; the walls of extensive carriage and engine sheds, lately erected for the Metropolitan District Railway Company, although only one storey in height, are eighteen inches thick, with piers at short intervals. From all this, it may be inferred that full advantage cannot be taken of the extra strength obtained by substituting concrete for brickwork, we must therefore rest satisfied in having raised the standard, by getting a stronger and more durable article.

Still, I think some little allowance might be made in the thickness of walls, perhaps the following would be a fair proportion to adopt, in building with the materials at present commonly used in Otago:—

Concrete and betou	12 inches.
Ashlar masonry	12 „
Brickwork	13½ „
Rubble masonry	18 „

The increased thickness of walls in rubble masonry is not determined by deficient strength, but by the difficulty in building thin walls with rough stone.

Cost.

Having now discussed the properties of stone, bricks, and concrete, the materials of which the walls of our buildings are composed, I shall consider shortly their relative cost. Of course, timber is still in general use for walls as well as its more legitimate functions of roofing, and internal fittings; but having properties and uses peculiar to itself it will be treated at length in another chapter. I shall, however, at this stage compare the cost of timber in the walls of buildings with those of the other materials mentioned.

It is impossible to determine a general rule on the subject of cost and suitability, as they depend so much on the resources of the locality, and the purpose in view, not to mention the wider range of individual tastes. The following conclusions are applicable to Dunedin, but they will give at least, indications of results in other parts of the province, by making the allowance due to a difference in the value of materials and labour.

It is authoratively stated that the cost of concrete in London is only one-half that of brickwork for the same thickness of wall, and the betou agglomerè sewers in Paris are calculated to have cost 20 per cent. less than any other material procurable of the same quality. It must, however, be borne in mind that in both those places the circumstances are very much in favour of this result; the cementing ingredients are manufactured on the spot, consequently concrete is on a par with brickwork, and has an advantage over stone, which comes from a distance. In Otago the conditions are exactly reversed, brick and stone being in the locality can be produced at a moderate rate, while cement has to bear the heavy charges inseparable from the importation of a low priced article.

When the manufacture of Portland cement is established in New Zealand the relative costs of the three building materials will in all probability, approach nearer the European proportion. The price of concrete in plain walls, near London, with cement at 8s. per cask, is from 9s. to 11s. 6d. per cubic yard. Betou agglomerè in Paris, for the same work, with cement 8s. per cask, hydraulic lime about half that price, and labour 3s. per day, costs from 20s. to 24s. per cubic yard.

The greater cost of the latter is a proof that there is more labour and care bestowed on its preparation than is done with concrete in England. The price of cement concrete for ordinary engineering purposes in Dunedin is about 35s. per cubic yard, and M. Petre, who has had considerable practice in building with concrete, informs me that its price in a plain wall is about 41s. 6d.; if to this is added, the cost of outside plastering, which is indispensable in any class of dwelling house, we bring it up to 50s.

I am not aware of any building having been erected in Otago in strict accordance with the method adopted in France, so there is no way of getting at the cost from actual experience; but the data at command are sufficient to fix 60s. as a close approximate. In America the price of betou is estimated at from 36s. to 44s. for labour and materials alone, and these are much cheaper than with us. The following statement gives the comparative cost of building in London and Dunedin at the present day:—

	London.	Dunedin.
Ordinary brickwork, per cubic yard...	22s.	40s.
Concrete	11s.	50s.
Betou agglomerè	22s.	60s.
Rough rubble	12s.	27s. 6d.
Coursed rubble	18s.	37s. 6d.
Freestone ashlar, per cubic foot ...	3s. 8d.	4s. 6d.
Hard stone ashlar, rock faced, per cubic foot...	10s.	4s. 6d.
Hard stone ashlar, fine dressed ...	11s.	6s. 6d.

At those prices, and the standard thickness of wall formerly established, the relative cost of building in Dunedin, with the various materials at command is as follows :—

Brickwork	1.00
Concrete	1.11
Betou agglomerè	1.33
Rough rubble	0.91
Coursed rubble	1.25
Freestone ashlars	2.70
Hard stone ashlar, rock faced	2.70
Hard stone ashlar, fine dressed	3.90
Ordinary timber work in walls	0.44

This proportion is not, however, applicable to the whole building, for the value of the masonry is generally less than half the total cost; furthermore, the high priced materials are seldom used in large quantities; the front of a business place in a street, or the facings in an isolated dwelling-house are all that is required to be of this class. Mr. Lawson estimates the difference in the cost of brick over timber in an ordinary dwelling-house, at from 33 to 50 per cent. Taking it at a mean of those rates, a wooden house worth £1,000 would cost £1,400 in brick; the cost of the walls being respectively £300 and £700. The interest of the amount saved is sufficient to rebuild the walls every ten years, which is oftener than required, but it is not sufficient to renew the whole house when the walls decay—a very probable contingency, for the renewal of the walls entails, practically, the entire reconstruction of the building. Beside, the interior of a wooden house is more subject to deterioration and injury than that of a brick or stone one, and the permanent charges, such as repairs, painting, and insurance are always much higher. Independent of the increased comfort and security obtained, I believe that even now it is true economy to build our houses with the more durable materials; and when the railways are in full working order, north and south, the matter will be placed beyond doubt.

At present Oamaru stone costs 5d. per cubic foot in blocks at the quarries, and 3s. 6d. in the same state here. When the railway is opened, it should be bought in Dunedin at 1s. 6d., the price when laid being 2s. 6d., which is a saving of 44 per cent. on current rates. The brown and grey freestones of Waihola are already within reach of railway carriage, and will be conveyed to town for about 4d. per cubic foot, so that they can be sold for 1s. 6d. As already stated, the former is too hard for fine work, but the latter is an admirable substitute for the Oamaru stone; it is a compact limestone of the proper consistency, soft enough to be easily worked, but sufficiently hard to stand the weather.

I trust, therefore, that one of the first benefits our city will derive from the establishment of railway communication is the improvement of its architecture.

Roofing Materials.

When I began to collect data for these papers, I did not expect that anything would be said on this head further than to report that no good roofing materials had yet been discovered in Otago.

I am glad to state that this blank in our resources has, within the last few months, been filled up by the discovery of a valuable deposit of slate in the Otepopo district. The existence of a seam in this locality has been the subject of rumour for some years, but it remained for Mr. Short, of the Land Office, to place the matter beyond doubt. He first discovered slate at Mount Domett, but, knowing that it was too remote to be worked to advantage, he traced the reef back towards the sea, and eventually found workable deposits on the Kauru stream and its tributaries, at which point the reef approaches nearest the coast and the settled districts.

As stated in a former paper, roofing slate should be found in the Kakaunui or Silurian formation, which, according to Captain Hutton, exists in this province in two large zones, extending from east to west across the country; that in the north begins at Otepopo, and terminates at the Hawea Lake; it embraces the Kakaunui and Hawkdun Mountain ranges. The southern belt commences at Tapanui, and sweeps round by Athol and the head of Lake Wakatipu to the Forbes Mountains. A connection between these zones, along the eastern sea-board, can be traced, in isolated patches, at Waitahuna, Akatore, Otakia, and the Silver Peaks.

Although this extensive tract of country is entirely slate, in the geological sense of the word, it does not follow that the supply of roofing material is proportionately great, for the conditions that seem necessary for the production of the slate of commerce do not occur frequently in the clay-slate formations of any country.

As already stated, Mr. Short discovered what he takes to be good roofing slate at Mount Domett, in a position tolerably accessible from the Maruwenua country, and the same quality is known to exist at the Lindis Pass. Both these places are too remote to be available at present; but it is satisfactory to know that the store of wealth is there, although it may not be realized for many years.

The value of our slate deposits is very much enhanced by the fact that, so far as can be judged, the product is infinitely superior to anything hitherto discovered in the other Australian colonies.

The West Coast has been well prospected for slate by Mr. M'Innes, a practical quarryman, but he discovered nothing better than the hard coarse variety found at Preservation Inlet, specimens of which are in the Museum.

This result is to be expected, for the rocks on that side of the island are too old and crystalline to produce a good article.

The exact locality of the Otepopo slate reef is about half a mile west from Charles Peak, at the confluence of a small tributary of the Kauru with the main stream. The distance from the township of Herbert in a direct line being about eight miles. The land has been taken up by a party of Dunedin gentlemen, who have opened out several faces to test the quality of the rock; and about 100,000 slates of all sizes have been split already. I visited the locality in February last, and although no work had then been done, I could see indications of an abundant supply of the material; and I felt satisfied that the discovery was one of the most important ever made in Otago. Of course it still remains to be seen whether the quarries will be commercially a success. They are in a very inaccessible situation, consequently a large outlay will be incurred in making a road or tramway to bring the slates to a market; and the refuse, which is very great in the best quarries, may be so out of proportion to the good slates, that they cannot be produced at a reasonable price. I understand that the proprietors intend to test the quality of the quarries in a thorough manner first; and if it is proved that the rock exists in sufficiently large blocks and faces to admit of being profitably worked, operations will be at once commenced on an extensive scale.

The locality has been named Ballachulish, after the famous quarries in Argyleshire. I trust that, like their great prototype, the Otago quarries will become so extensive and important as to prove a mine of wealth to their proprietors, and a boon to the country generally.

Roofing slate is found of all colours, from a creamy white to black, and there is also a considerable difference in the texture.

It has been found that the best slates are those of a bluish-grey colour, which is the exact tint of the Otago ones. The other essentials are, compactness of texture, impermeability, and the facility with which they can be split parallel and without twist.

The Otepopo slate possesses all these properties in a pre-eminent degree. I placed a Welsh and an Otago slate side by side in water for 48 hours, and found that, while the moisture rose from three-eighths to one-half an inch in the imported article, it did not rise at all in the colonial, which proves that the latter is the more compact and impervious of the two. The facility of splitting is also fully established, for the many samples to hand are of all thicknesses, and perfectly true to shape; and I have seen the slates split well with a common pick, instead of the broad knives used by the quarriers.

Shortly, I believe the Otago slate is little, if anything, inferior to the best "blue Bangor;" and when similarly grained specimens of the two kinds are placed together, the best judge can scarcely distinguish them.

Captain Hutton informs me that there is a considerable difference between the cleavage of the Otago and English slate; instead of being at an angle to the strata, it is parallel to them. He points this out as a probable defect in the colonial article, but at the same time states that the property of splitting readily is not due to lamination but cleavage, consequently the pressure that gave this property must have been applied in a vertical rather than a horizontal direction. Without venturing to express an opinion on such an important geological question, it seems to me that the idea of a regular vertical pressure, induced or aided by attraction of gravity, is more natural than a horizontal one; not only is the pressure abnormal, but we must pre-suppose the existence of a solid mould which prevented the lateral extension of the material.

The roofing slates in England are all extracted from beds with inclined cleavage; and those taken from a horizontal stratum, where the angle of the cleavage planes is greatest, are supposed to be the readiest split, and otherwise the best; but I do not know that there is a sound reason for this conclusion; and although roofing slate has not hitherto been obtained from strata with a parallel cleavage, the existence of a cleavage of this kind in the clay-state formation is well known. Professor Geikie says, "Cleavage may either coincide with the original lamination of the rock, or cut across it at an angle;" it is, therefore, possible that the exception in the old country is the rule at the Antipodes.

Under any circumstance, the question cannot affect the industrial importance of the Otago slate; while we are satisfied that it splits freely, and is durable and impervious, its geological peculiarities may be disregarded.

In addition to roofing material, slate quarries yield slabs for paving, hearths, mantel-pieces, and other works of a similar kind; the finer sorts are usually too smooth and soft for street pavements, but I have no doubt varieties suitable for this purpose will be found in the same locality.

Following the plan adopted with the other materials, I shall devote a few remarks to the consideration of the comparative cost of slate and its principal sustitute, corrugated iron.

It is popularly supposed that there is a great difference in the cost; but such is not the case. Having occasion lately to decide on a covering for my own house, I calculated the difference carefully, and found that with Countess slates at £15 per thousand, and galvanised iron at £37 per ton, which are about the current retail prices, the cost of the two materials was identical for the same space of roof. There is, however, a difference in favour of the iron in cartage, timber work, and labour, amounting to 10s. per square, or 16 per cent. on materials and labour combined.

This is a large proportion, as such; but when we consider that it only amounts to about £10 on a house forty feet square, the wonder is that any iron is used. Whether regarded as a matter of appearance, freedom from sound, and extremes of temperature, or durability, the superiority of slate over iron is undoubted, and were the difference in cost twice as great, the balance of advantages would be still on the same side.

From the Customs returns I find that, in 1874, there were imported into Dunedin alone—

219,800 slates, value	£1,849
and 1336 tons of corrugated iron, value	40,190
Making a total of	£42,039

Assuming that £12,039 worth of iron is used for the walls of houses, fencing, and similar purposes, we leave a balance of £30,000, as sent out of the Province for roofing materials, which, in all probability, we have at our doors. I question the wisdom of fostering, or encouraging, at this early stage of our history, every industry that may ultimately be required, or that may succeed in the colony at some future time; but, in the case of a low-priced article like slates, the value of which is doubled by freight, and the other charges of importation, there is little wanted to turn the scale in favour of the native production.

I believe the enterprise that establishes and carries on the industry, and the individual support it receives, is sufficient to do so; we may, therefore, hope to see the imported roofing materials fairly supplanted by the colonial article at no distant day.

In concluding this division of my subject, I must repeat what I said at the outset as to the paucity of our information on the building materials of Otago, and the importance of the question.

Although I hope these papers will reveal a number of new facts, the researches that I have made in compiling them enable me to say, with greater emphasis than at the beginning, that our resources are still practically unknown.

The importance that is attached to the collection and diffusion of knowledge of this kind throughout the Colony was forcibly brought under my notice a few months since, by seeing in the papers that it was proposed to build the Auckland Docks of Aberdeen granite. Undoubtedly granite is the best building stone in existence; but it is also the dearest, and for this purpose it is no better than the stone of which the Port Chalmers Dock is built. The price of granite, in rough blocks at Aberdeen, is from 2s. 6d. to 3s. per cubic foot, and, in London, from 4s. 6d. to 5s. There are no regular traders between Aberdeen and Auckland that could carry the stone in small quantities, and no large ship would take a full cargo to come direct, consequently the shipment must be made at London. The cost of the stone in the Colony cannot, therefore, be less than 7s. per cubic foot. Port Chalmers stone in the same state can be put on board a coasting craft, or steamer, for 1s. 6d. ; taking the freight and other charges the same as from London, we have the stone landed at Auckland for 3s. 6d. per cubic foot, exactly half the price of granite, and there would also be a considerable saving in labour, as the colonial stone is much easier worked. The importation of granite under these circumstances is carrying the principles of free trade a little too far. There has been no time in the history of Otago in which the choice of a building material had so much importance as at present.

To borrow the plan adopted by ethnologists, we may divide colonial architecture into periods or ages. First, the wattle-and-dab period, with its contemporaneous, but more advanced, varieties of fern tree and totara bark ; second, the timber period ; and third, the masonry period.

On the goldfields, timber is preceded by calico and corrugated iron. The Colony is now in a state of transition between the timber and masonry periods ; we are leaving the frail and ephemeral and entering on the strong and enduring. We should, therefore, spare no pains in selecting the materials that are most conducive to health and comfort, and that will remain for generations a record of our skill and good taste.

Art. X.—*On the best Line for a Submarine Telegraph between Australia and New Zealand.* By The Rev. A. G. Purchas, M.R.C.S., Eng.

[*Read before the Auckland Institute, May 17, 1875.*]

In considering this question, the points to be chiefly kept in view appear to be the following: The distance between the termini; the character of the ocean floor; and the suitability of the landing-places for the shore ends. The latter point embraces not only the natural features of the locality, but also the relative advantages of position, safety, and convenience.

All other things being equal, of course the shortest line would be the best; but, in our case, the shortest is the least suitable of all. The nearest approach between our Colony and one possessing telegraphic communication with Europe is to be found in a line stretching between the south-east shore of Tasmania and a point on the south-west coast of the Middle Island;

the distance being somewhat under 950 English miles. The extremely wild and rugged character of that portion of the New Zealand coast is, in itself, sufficient to neutralize the advantage of the shortened distance. The land line required to connect with the existing system would be both costly and liable to frequent injury from stormy weather, and there is reason to believe that the ocean-floor between the two places is much less favourable than that which is to be found in a lower latitude. An additional objection to any line from Tasmania is the fact that messages for Australia and other countries would require to be transmitted through another submarine cable, thus increasing the cost of transmission and the risk of interruption.

For these reasons the southern line must be considered ineligible.

The next, in point of distance, is to be found near the northern extremity of the Colony, and lies between Ahipara Bay, in lat. 35°, and the coast of New South Wales, near Port Macquarie—the distance is about 1170 miles. From the soundings marked on the Admiralty Chart, No. 2683, there is reason to believe that the ocean-floor on this line is peculiarly favourable, since the depths noted a few miles to the northward range from 350 to 735 fathoms; the only exception being at a point between 200 and 300 miles from Australia, where a depth of 1800 fathoms is recorded.

As regards the suitableness of the position for landing the shore-end of the cable Ahipara cannot be surpassed. A few miles above the southern end of the Bay there is a smooth, sandy, gradually-shelving beach, free from danger of every kind, and sufficiently distant from Cape Maria Van Diemen to be protected from the force of the currents, which sweep round the end of the island. The northern line of telegraph has already been completed to within less than forty miles, and has been surveyed and found perfectly practicable all the way. The track from Ahipara to the junction with the Mangonui line is nearly level. It has been reported that the point of departure from Australia has been fixed at Botany Bay; should this prove to be the case, Ahipara would still be the nearest and best terminus for New Zealand, for although the line from Botany Bay to Ahipara would be a little over forty miles longer than that between Port Macquarie and Ahipara, it would still be thirty-five miles shorter than the line from Botany Bay to Cape Farewell. The only possible objection that can be urged against the choice of Ahipara is its situation at one extremity of the Colony; but, as the new telegraph line has been most substantially constructed, and is exposed to little risk of damage from weather, the objection may be regarded as of no weight.

A third line has its New Zealand terminus at the Gap, near Waiuku, on the ocean beach between Manukau and Waikato, a site which offers the advantages of a close proximity to an existing line, ready accessibility from the Manukau Harbour, either by land or sea, and freedom from danger of all kinds. The distance, however, is some hundred miles greater than that from Ahipara—a fact which would probably be decisive against its adoption.

Of other lines which have been suggested, only one seems to require notice, namely, that which would make Cape Farewell the New Zealand terminus. In point of distance from Australia, this line takes the third place, being about 1250 miles from Botany Bay, and some twenty miles less from Cape Howe. As regards the ocean-floor, the recent soundings of the Challenger are reported as, on the whole, most satisfactory; the water gradually deepening to 2600 fathoms, "at which it remained very evenly for a long distance," and then gradually lessened to 1975, 1100, and then was quickly reduced to 400, 350, and 275 fathoms; the last being at a distance of 200 miles from land. But, however satisfactory these results may be, it would appear that the ocean-floor on the northern line is still more favourable, inasmuch as in case of repairs being required, the depth at which the cable would be found is everywhere much less. It may also be justly urged against the choice of Cape Farewell that it is on the wrong side of Cook Strait—the capital of the Colony being situated in this island—and, therefore, all messages for the seat of Government would require to be sent through one more submarine cable than would be the case if the terminus was fixed at Ahipara, or some other point in this island.

There does not then appear to be any advantage to be gained by the adoption of the line to Cape Farewell; but, looking at the question from every point of view, Ahipara appears to offer the best site for the New Zealand end of the line, whether the nearest part of Australia be chosen as the point of departure, or the preference given to Botany Bay, on account of its proximity to Sydney.

Art. XI.—*Improvement of Ships' Life-Boats.* By Robert M'Naughton, C.E.

[*Read before the Otago Institute, 28th September, 1875.*]

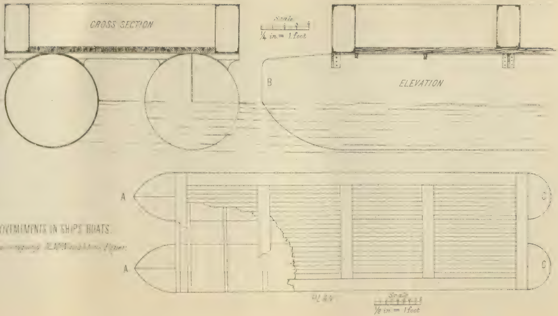
Plate V.

I may simply state that the whole arrangement consists of a deck floated upon light iron tubes. In bringing this matter before you, I do not claim any novelty in the idea of tubular floats, for, many years ago, a life-boat, something after this fashion, was tried upon the English coast. Then the American life-raft, *Non Parallel*, consisted of a staging floated upon three air-tight cases. There are also a good many more patents and inventions, mostly based upon the same principle; all that I claim for my adaptation is, that boats formed in this way, can carry more passengers, with less fear of upsetting, than ordinary boats. It is well known that upsetting is one of the worst dangers that a loaded boat is exposed to. Well, to give some idea of my notion of forming a ship's boat, the drawing shews one, 30 feet long by 10 feet beam. The first and main point is the two tubes, 4 feet in diameter, having conical bows—fig. A. It has been suggested to me by Captain Whitson, of the ship *Dunedin*, that the conical bows would be apt to bury the boat's head in a short sea. At his suggestion, I have carried the stem vertically, from the centre to the upper line of the cylinder—fig. B. The sterns of the tubes would be finished off egg-ended—fig. C; the tubes to be of 18-inch iron plate, bent to 2-feet radius, rivetted and caulked; a man-hole to be left in the stern of each tube, to facilitate repairs. These two tubes are to be attached to each other by eleven cross ties of 2-inch and 1½-inch angle iron rivetted to each cylinder, and braced by two diagonals of flat iron. To these angle irons I would then fix an iron box, 2 feet deep and 1 foot broad. This box forms the bulwarks of the boat, and, at the same time, would be used as the water tanks and bread lockers. The deck, of 1½-inch planking, is then to be laid on the cross-beams, and cross tanks put in and rivetted or bolted to the sides and bottom. I would keep the cross tanks 6 feet apart, so as to allow for the crew stretching themselves on the deck between the cross seats. The outfit of the boat would include oars, sails, etc., and a centre-board. Now, as to the number that such a boat would carry as an ordinary freight, and then the number that might be safely stowed in cases of emergency. This boat could carry 40 men more comfortably than an ordinary 30-feet life-boat could stow 20. I know of a steamer's life-boat, about 30 feet long, that carried 32 passengers safely for eleven days, and in this time made about 600 miles. All care was taken, her officer an experienced boatman, and her steersman a West Highland fisherman, which fact alone is a guarantee that she was skilfully handled, as a West Highland fisherman's experience in boats falls very little short of that of the famous South of England boatmen. Well, on her eleventh day out she upset, and only three of her 32 reached land. Another boat, of the same size, containing the same number of passengers, upset twenty minutes after leaving the ship. I have only quoted these examples to assist me in what I want to shew, viz., that the great matter to be aimed at in ships' boats is resistance to upsetting. Next to this comes, unsubmergability. In the present form of life-boat this is in a great measure attained, but only at the sacrifice of an immense amount of room; and, after all, they cannot rid themselves of the water, as it has to be baled out. Well, in my boat, the resistance to upsetting is as nearly perfect as can be had in a boat. The great danger, in a common boat, is when she gets into the trough of the sea; if she begins to mount a short sharp sea side on, she will, if she has no inclination to roll, sit on the water with her mast at right angles to the surface of the wave. She may be safe enough if you can destroy the tendency to rolling; but all boats, built as they now are, roll more or less, according to the stowage of their cargo, so that a boat, mounting the side of a wave, gains a tendency to roll over still more, so that the line of her mast is not upright to the surface of the wave. Now, in this tubular boat, before you can heel her over, you have not only to sink one side, but the other has to be lifted, that is, the one tube acts as an out-rigger to the other. Then, as to unsubmergability, I estimate that eleven tons would sink her tubes about two feet in the water; in fact she cannot be sunk, unless she be loaded till she fairly goes under.

If a sea fills one or the whole of her compartments, it will be all out again in a minute by her scuppers, as her deck is above the water level.

Then the quantity of water and provisions she can carry. The capacity of the bulwarks and seats is equal to 200 cubic feet. Now, half allowance of water, *i.e.*, three pints per diem, for 40 men for 20 days, would occupy about 50 cubic feet, leaving a space of about 150 cubic feet for provisions, such as preserved meats and biscuits. About 10 cwts. of these could be carried. This stock of provisions and water ought to be kept always ready on board, with the lockers made fast, so as to ensure their safety. In fact, the boats ought to be kept ready for instant use.

On board ship the boats could be stowed on skids, as boats are now usually carried. As to launching them, the best way I ever heard of is a patent process, by which the skids or a platform is run out to leeward, and forms ways, from which the boat can be launched, either end or broadside on. The six life-boats of an emigrant ship could carry about 180 people. Now, six boats, such as I have described, could carry at least 240, and, with a little crowding, 300 persons could be accommodated, and, not only saved from one danger to become a prey to the tortures of hunger and thirst that have befallen so many boats' crews, but they will also have food and drink for many days. Then their stability would enable them to carry sail when an ordinary boat dare not shew a stitch of canvas. At the very low average of of four miles per hour, in fifteen days she would make 1300 miles. Now, a careful officer, with 1300 miles sailing at his command, ought to make some land, or fall in with some ship, before his provisions run short. I might well go on dealing with the matter of advantages that this boat would have over the many other systems that have been from time to time brought forward; many of these are admirably adapted to save life. In cases such as the *Northfleet*, where the ship went down close inshore, the same boats or rafts, in the case of the *Cospatrick*, would have been only prolonging the misery of



IMPROVEMENTS IN SHIPS BOATS.

To accompany [illegible] Paper.

those saved from the burning ship, as, in the greater part of these boats, no arrangement is made for the stowage of provisions of any kind. Water has to be carried in a cask or flasks, and the provisions have to be stowed indiscriminately about the boat. One plan that seems to have taken some hold is that of a deck house that is capable of floating off. There are many disadvantages to this kind of house. I think the first and most important is its unwieldy character, its difficulty in launching, and also the difficulty in making it fast, so that it may stand any sea the vessel may ship, and still be able to be cast adrift in a few minutes. But if I say too much against other plans, I will not have space enough left to shew the advantages of my own. My tubular boat will not be very much heavier than a ship's life-boat. She will be easier stowed, easier launched, and not at all liable, as even the strongest boats now are, to be stove in when struck by a sea. Another advantage is that they are equally serviceable, whether used near shore or far at sea; and, by their arrangement on deck, all the boats can be launched on the lee side of the ship. Built on a larger scale, that is, with the tubes longer and wider apart, they would prove very valuable surf boats. As pleasure boats, built on a smaller scale, they would be found to be very safe.

If two of the crankest boats in the harbour were made fast together by beams from gunwale to gunwale, say one foot to eighteen inches apart, and a proper amount of canvas spread, the effect would be that she would stand up to almost any squall that ever blew; in fact, the probabilities are that she would be dismasted before she would upset. It is from the idea of the two boats that I first thought of the cylinders. The cylinders are stronger, and can be so effectually closed that no water can get into them, and so they also form perfect air chambers.

Having laid my idea of a ship's life-boat before you, I may state that, as far as I am concerned, it is not protected in any way. My idea is that many useful inventions and improvements are lost to the public, simply by their being patented with a view to money making. In this way, about 99 out of every 100 patents prove simply a loss (in money) to the patentee; and to the public they are as good as if they never had been thought of. I shall only be too happy to see my boat made use of in any way or for any purpose.

Art. XII.—*On a "Direct-vision Solar" Eye-piece for large Telescopes.*

By H. Skey.

[*Read before the Otago Institute, 12th October, 1875.*]

When coloured glasses are placed before the eye-piece of telescopes in solar observations, they intercept a certain portion of the heat, but this can only be by their absorbing it; in absorbing the heat they necessarily become heated, and when used with telescopes of greater aperture than two inches, they are liable to fuse or crack, thus endangering the eye-sight of the observer.

The screens here exhibited were devised originally for the purpose of observing the Transit of Venus, in December last.

In their construction, advantage is taken of the transparency of thin films of the metals, a film of silver being precipitated on glass, by Liebig's, or other methods, and then guarded by another glass. These films are chosen, so that part thereof is nearly transparent, and the other part nearly opaque, and by a sliding method, a suitable part can be brought over the field of view of the telescope so as to be adapted to the varying intensity of light, arising from clouds, etc. One of these films is on plane glass; the other is on a convex glass, which is guarded by a concave one. These dark screens appear to give excellent definition, and, being of a neutral tint, they allow of seeing the sun as a white globe on a black ground. In using them, the mirror side is turned towards the sun, and "light and heat being reflected in sensibly equal proportions," their excess is reflected back, while sufficient light is transmitted through the film to admit of proper illumination, after the telescope has magnified the image. Testing these films for safety, under a large condenser, they resisted the heat, while colored glasses, even if only lightly colored, were instantly cracked.

This method has an advantage over the "Diagonal mirror" in admitting of direct vision, moreover, the liability of losing an observation at the critical instant is lessened, for by merely sliding the screen, it can be adjusted to the varying illumination without removing the eye.

Art. XIII.—*An account of the Maori House, attached to the Christchurch Museum.* By James W. Stack.

[*Read before the Philosophical Institute of Canterbury 5th August, 1875.*]

This house was designed and the carving and scrolls executed by Hone Taahu, of the Ngatiporou tribe, who named it Hau-te-ana-nui-o Tangaroa. (The sacred great cave of Tangaroa—the Polynesian Neptune).

It was originally intended as a residence for the Chief, Henare Potae, of Tokomaru. During the late war, the materials prepared for it, were partially destroyed by the Hau-Haus, which delayed its erection, till it was fortunately secured for the Christchurch Museum, by Samuel Locke, Esq., of Napier.

Two natives were engaged to proceed to Canterbury to erect the house, one being the designer of it, and the other Tamati Ngakako. They arrived in January, 1874, and remained till December of the same year, when the building was completed.

It was intended at first, that the Maoris should put the house up entirely themselves, using only such materials for the purpose, as were commonly employed before the arrival of Europeans in New Zealand. That it should, in fact, be an exact representation of a native chiefs' dwelling, in the best style of Maori architecture and house decoration. Why this intention was not carried out, it is necessary to explain, as the alterations subsequently made in the construction of the building have excited so much unfavorable criticism.

The first departure from the original intention, was caused by the unexpected costliness of the materials. It was thought unadvisable to risk the speedy destruction of the carved timbers, which had already cost £290, by allowing them to be set up in the grounds after the Maori fashion, accordingly, a concrete foundation was laid for them. This alteration in the structure, necessitated the erection of a frame-work, by European carpenters, to which the Maori work was fastened. And as the building proceeded, other alterations had to be made, which rendered it still more unlike what it was meant to be. Fluted kauri boards were substituted for toe-toe reeds inside, and the outside of the building was covered with corrugated iron, instead of the ordinary covering of raupo and toe-toe, which was of too inflammable a nature to be allowed upon a building placed so close to the museum. The incongruities of style would, doubtless, provoke less remark, if the building were called what it really is, the Maori Court, instead of the Maori House.

For some months after their arrival, the two Maoris were employed completing the carving of the posts, and painting the scrolls on the rafters.

The carvings are all executed in totara, (as being both the most durable wood, and best suited for the carvers' work, and painted with red ochre). The colours employed in the scrolls, are white, black, red, green, and blue. The three first colours, are formed with pipe-clay, charcoal, and red ochre, mixed with water or fish oil, and are those most commonly used by the Maoris. The juice of the poporo, and a certain fungus, produce the blue and green, which, however, are rarely used, being less easily prepared, and less effective.

The scrolls with which the rafters and ridge-pole are covered, are confined to the pattern, called Pare-mango. The other well-known pattern, the Kowhaiwhai,* being altogether omitted.

There are fifteen carved upright slabs on either side of the building, placed exactly opposite to each other. They average seventeen inches in width and from two to three inches in thickness, and are about two feet apart. The surface of each post is divided into two equal parts, on each of which a grotesque representation of the human form is carved in slight relief, the eyes being inlaid with pawa shell. The style of carving generally employed throughout is the Ponga. At both gables there are seven posts, the middle one, on which the ridge-pole rests, being the widest and best finished. From each of the side-posts, a broad rafter, slightly convex, springs, resting on the ridge-pole, which is a broad, flat piece of timber highly ornamented. The rafters are covered with scrolls, done in white, upon a red-blue, or green ground. The artist, unfortunately, did not confine himself to ancient patterns, but introduced various novelties of his own designing, consisting, for the most part, of representations of the leaves of different plants and shrubs. At each gable end there is a board a foot wide, running up from the wall-plate to the ridge-pole, covering the ends of the uprights, and painted with grotesque faces, not unlike Chinese designs. These are intended as specimens of the style adopted in ornamenting whatas and out-door buildings. There are two posts, 9in. × 12in., supporting the ridge-pole, and covered with a modern diamond pattern. These posts, in a native home, would have been round, and the surface carved; but suitable timbers for the purpose could not be obtained. The door-way is placed at the south end, and is three feet wide, and six feet nine inches high, being at least two feet higher than was usual in former times, when the door-way was made low, in order to place a person entering with hostile intent, at a disadvantage. The wooden door, working in a socket, is replaced by a pane of glass. The window is three feet wide, and four feet high, the ancient proportions being here reversed, and glass again supplies the place of a wooden shutter. Beneath the window was the seat of honor, where the chief sat, and, this being the left hand side, was tapu, or sacred, the opposite side being noa, or common. It was through the window that the officiating priest entered to perform the purifying ceremonies which always attended the opening of a new house—an occasion looked forward to with some anxiety by the builders, for, should any mistake be made by

* Good specimens of the kowhaiwhai pattern may be seen in the church at Otaki.

him in repeating the proper charms and incantations, it was an infallible sign that either the house would be destroyed, or the builders die within a year.

The position of the window may have also had something to do with the sacredness of this part of the building, as there was a fanciful resemblance supposed to exist between the shape of the house and the human frame—the ridge-pole being the back-bone; the rafters and side-posts, the ribs; and the verandah end, the head—the most sacred part of the human body.

Passing over the door-step, called the Pae of Hakumanu, we enter the verandah formed by a continuation of the roof and the side-walls for nine feet. Here we find the best specimens of carving about the building. The ridge-pole, which is carved, rests on a support, and at its base a piece of wood stretches across from side to side, forming the outer boundary of the verandah, and called the Pae o Rarotonga. The boards round the door-way and window are elaborately carved, and inlaid with pawa shell, and so are the ends of the barge-boards, on the uncarved part of which are painted white scrolls on a red ground. Where the barge-boards meet is a carved face, surrounded with feathers, and surmounted with a small figure called a tekoteko.

The house stands with the ridge-pole pointing north and south, according to immemorial custom. The prevalent notion being that, if the spirits of the dead, in their flight northwards, crossed the ridge-pole of a dwelling or store-house, they would cause the ruin and destruction of all within.

The art of wood-carving is in greater perfection among the Maoris on the East Coast of the North Island than elsewhere. This is generally attributed to the fact that the stern-posts and figure-heads of the canoes in which their ancestors came from Hawaiki were highly carved, and were preserved and used as models by their descendants, who, having cultivated a taste for the art, have never lost it.

Tamati Taahu stated that the knowledge of carving was hereditary in his family, who have preserved the following curious legend to account for the way in which their ancestor became possessed of it:—"In ages gone by, there dwelt, by the sea shore, a chief named Ruapupuke, who had an only son; this boy went, one day, with several others to bathe. While swimming about Tangaroa, the god of the ocean seized him, and drew him below the surface, and carried him down to his house under the sea, where he placed him on the end of the ridge-pole over the door-way, as a Tekoteko. On the other boys returning to their village Ruapupuke missed his son, and asked his companions where he was. They told him that he had sunk in the sea. The father, hearing this, begged them to point out the spot where he disappeared; then, throwing off his clothes, he plunged into the sea, and dived to the bottom, assuming, as he did so, the form of a fish. At the bottom of the sea he came upon a large carved house, and, as he drew near to it, he saw his little son fixed up as the tekoteko. As he approached, the child cried out to him; but he took no heed, and continued his search for the occupants of the house. Presently he me ta woman, Hine-matiko-tai, and questioned her about her people. She told him that they were all away at their work; but that, if he waited till sundown, they would all return, but be careful, she said, to close up every aperture through which light may enter; then enter the house and hide yourself. Ruapupuke paid great attention to what the woman told him, and did exactly as she directed. By and by the occupants of the place, with a loud noise, came pouring in, till the house was quite full. Then Ruapupuke asked Hine-matiko-tai what he was to do. 'Do nothing,' she said; 'the sunlight will kill them. Only stop up all the gaps, that no warning gleam of light may call them forth before sunrise.' At the usual hour for waking, Tangaroa, the chief, asked, 'Is it not daylight?' 'No,' replied the old woman, whose business it was to watch for dawn; 'it is the long night; the dark night of Hine-matiko tai! Sleep on; sleep soundly.' So they slept till the sun rose high in the heavens. Then Ruapupuke let in the light, and set fire to the house, and it was burnt, all except the verandah, of which he brought away the four side-posts, the ridge-pole, and the door and window frames, and so introduced the knowledge of carving to the world." Hinga nga roa built the first carved house, called Te Rawe-oro, at Uwawa, the dwelling-place of Te Kani o Takirau. After him lived Te Wirakau, who was a carver of wood, and, in later times, Tukaki, and, lastly, Honu Taahu, the builder of Hau-te-ana-nui-o-Tangaroa, attached to the Christchurch Museum.

Art. XIV.—*Notes on Quartz Crushing at the Thames Gold-fields.*

By J. Goodall, C.E.

[Read before the Auckland Institute, 13th September, 1875.]

Although many of our members are well acquainted with the entire process of quartz-crushing, for the sake of those who are not conversant with the process, I will give a short account of quartz-crushing, as now conducted, before I proceed to make a few remarks on the apparatus used and the method of treatment.

Quartz-crushing comprises not only what the name implies, pulverising the quartz, but the entire system of gold extraction. At the Thames, that system may be designated as the wet crushing and amalgamating in battery process. This title will distinguish it from processes used on other fields. It is accomplished thus—the quartz, as it comes from the mine, is shovelled from time to time into a stamper box, in which usually work five stampers, of about eight cwts. each, at about seventy (70) strokes a minute. Water is conducted into the box to the amount of about eight (8) gallons per stamp per minute. The quantity of water varies according to the material operated upon, whether it be mullocky or not. A small quantity of quicksilver is poured into the box, to amalgamate the gold with which it may come in contact. In front of the box there is a perforated iron grating, through which the pulverised quartz, when fine enough, is forced by the impact of water caused by the continuous fall of the stamps. The constant outflow of crushed quartz and water from the stamp boxes is received on a table, having on it grooves or ripples, containing quicksilver and a large extent of amalgamated copper plates smoothly nailed on. This may be called the silver table; it catches a large proportion of the free or amalgamated gold which escapes from the battery. The flow then passes over blanket tables, which arrest mechanically all the heavier particles. The blankets are frequently washed in tanks, to remove the rich deposit on them. The blanket tailings thus produced are treated in large berdans with quicksilver, one berdan being allowed for five stamps. By this means a fair proportion of extra gold is extracted from them. Settling pits are provided beyond the blanket tables, so that, if deemed advisable, the tailings are saved for after treatment, or for sale to those who make it their special business to manipulate tailings. The entire battery is cleaned up at the end of each crushing, or once a week, if the crushing be continuous. All the amalgam from the stamp boxes, from the silver tables, and berdans are carefully cleaned and retorted in cast iron retorts, to separate the gold from the quicksilver. The spongy gold is then taken out, and sent to the bank for melting. Such is the usual process resorted to for private or public crushings; and the object of this paper is to criticise the *modus operandi*; to point out what I consider its errors, and to suggest a method of working which is likely to prove more profitable.

The engine-power required will vary according to circumstances, such as weight of stamps, size and number of berdans, and the amount of water required to be pumped. If each stamp be not heavier than eight cwts., and there is a berdan of five feet in diameter to five stamps, and water is required to be raised, say 20 feet, for battery purposes, one and a half horse-power to each stamp will be about the required power. I have known engines working beyond that, but it was not considered profitable, as the speed became variable, and a larger proportion of coal was consumed in comparison to the steam-power obtained.

Stamp boxes are generally constructed to hold five stamps; they are of cast iron in one piece, are three inches thick at the bottom and an inch and a half to one inch at the sides. The bottoms and sides are protected from the corroding action of the stamps and quartz by cast iron dies and linings. The boxes have two hoppers behind for feeding, and two openings in front for the gratings, to screen the crushed quartz. It has been attempted to have grating openings behind the box as well, but found not to answer, there being greater trouble to regulate the flow of water over the two tables. This remark applies to side openings also. The stamp boxes used at present are excellent, the only improvement I can suggest in them is that the openings for the gratings, which are now made vertical, should have a forward inclination on the top. This, I think, would allow the crushed material to escape more freely.

The shoes of the stamps and dies in the boxes, as well as the linings, are at present made of comparatively soft iron. They should be made of the hardest white iron, and chilled. If battery proprietors took the trouble of sending to England for their shoes, dies, and linings, they would find it to their advantage, not so much in cost as the great saving in material and time lost in changing the different parts when worn out.

The cams for raising the stamps are very seldom of a proper shape; they are either too curved or too straight. They should be so constructed that the motion of the stamp be uniform, and, as soon as the stamp is raised to its greatest height, it should drop, and not for one moment before it is elevated for the next stroke. There is no trouble in constructing a cam with the necessary curve to do exactly as required, and, if so constructed, a battery may be driven up to 80 strokes a minute, without the risk of the discs striking the cams.

The screens or grates for sifting the crushed quartz usually used are perforated iron plates; the number of perforations are from 100 to 132 holes to a square inch, the greater the number the finer the holes. It is surprising how this kind has not been superseded by the iron wire grating, which is superior in many respects, especially in allowing more material to pass through in a given time, thus causing a great saving in cost of crushing; and I am further convinced more gold would also be saved, as, by the present use of quicksilver in the boxes, the amalgam formed is unnecessarily battered and converted into black and spongy amalgam, from being pulverised with base minerals. This sickened amalgam will pass over silver tables, blankets, and even the settling pits, and no device can save it. The silver tables are sometimes made in one plane, but generally in two or three steps; the inclination is usually one in ten. The quicksilver ripples are three inches broad, three-eighths of an inch deep at the top, and half an inch at the bottom; this enables the quicksilver and amalgam to be scooped up readily when cleaning up. It is usual to keep two ripples nearly as full of quicksilver as they will hold, and, when the lower one is too full, a part of the quicksilver is lifted from it and put back into the battery box. The length of the tables is about ten feet, and they are as wide as the front of the battery box. The blanket strakes below the silver tables are about 20 feet long; they are so arranged that a part of them may be washed from time to time without stopping the flow of water from the rest, or allowing it to go on the part from which the blanket had been removed. Instead of blanket, baize and coarse plush have been used with advantage. Shaking tables were not tried excepting at one battery. They proved very serviceable, but the wear and tear was great, and, as the miners were not willing to pay an extra price for its use, it was discontinued.

The blanket tailings or blanketings, as they are otherwise called, consist mostly of iron pyrites and other sulphides, combined with quartz, and contain a fair proportion of gold and some quicksilver and amalgam that had escaped over the silver tables. These tailings are treated in berdans with extra quicksilver and ground up. The berdans now in use at the Thames, I think, exceed in size, those in use in any other gold-fields; they are generally five feet in diameter, and I have seen one six feet. At one time a couple of rotating balls were considered sufficient for the amount of crushing required; now, the general practice is to have a loose ball as well as a stationary one attached to a chain, and it is called a drag ball; this drag does more work than a loose ball, but takes more power than should be used in grinding, for the drag grinds the bowl as much as the tailings. I am convinced that grinding and amalgamation can be better accomplished in pans, such as Wheeler's or Hepburn's, than in berdans. Pan treatment, however, has the same fault as berdan treatment; in both cases the same material is continually re-ground, thus a deal of labour is lost, and quicksilver is used while grinding. This system accounts for the great waste of quicksilver at the Thames, and if quicksilver is lost, gold is lost also.

This battering and grinding of quicksilver and amalgam seem to me to be the chief fault of crushing at the Thames. It is the basis of the system there, and I fear will not be stopped for some time. How many thousands of pounds worth of gold has been carried away with sickened quicksilver, it will be impossible to calculate; but I am convinced a great proportion of it could have been saved.

Having pointed out the chief errors of quartz-crushing, I shall, on a future occasion, shew how they may be avoided.

II.—ZOOLOGY.

Art. XV.—*Notice of the Existence of a large Bat in New Zealand.* By the Ven. Archdeacon Stock.

(Communicated to the Wellington Philosophical Society by Dr. Buller, C.M.G., F.L.S.)

[*Read before the Wellington Philosophical Society, 7th August, 1875.*]

At Dr. Buller's request I send the following observations:—"In 1854 (time of year uncertain), at half-an-hour after sunset, and moon at full, I saw, at Paikakariki, a large bat. It flew across about twenty feet, and was about that distance from me. I saw it perfectly. The body was far larger than that of a mouse, and somewhat smaller than that of an ordinary sized rat. The spread of the wings was certainly not less than eighteen inches. The late Rev. R. Taylor informed me that he had seen a similarly sized bat at Wanganui. Mr. Kirk informs me that he has seen very large bats—he believes of the same size as mine—at the Clarence River. My bat may possibly have been an Australian bat, brought in some vessel, as that, also, of Rev. R. Taylor. I should have thought so, but for Mr. Kirk's observation.

Art. XVI.—*Description of the "Cow-Fish," or "Bottle-nosed Dolphin" (Tursio metis) of the Sounds, on the West Coast of Otago.* By Capt. F. W. Hutton, C.M.Z.S.

[*Read before the Otago Institute, October 26, 1875.*]

Tursio metis. Grey.

Teeth, $\frac{23}{22}$—exactly the third of an inch. Body elongate, thickest in front. The dorsal commences before the middle of the back, and its height is less than the length of the pectorals. Pectorals as long as the gape; falcate, on a constricted base. Lower jaw, longer; attenuated portion of the snout, short.

Colour.—Above and upper jaw, dark slate-blue, passing gradually into white below—the white of the under parts not reaching to the caudal. Dorsal, pectorals, and caudal, slate-blue, without spot.

Female—length, 7½-feet.

The specimen here described was presented to the Otago Museum by Captain Fairchild, of the Colonial steamer "Luna," and is one of two captured in Useless Bay, Dusky Sound, on the 10th of May, 1875.

The other specimen captured was also a female, and measured 9½-feet in length.

The following are the dimensions :—

	Feet.	Inches.
Total length along the curve of the side	7	6
,, ,, ,, back	7	6
Length from snout to blowhole	1	2
,, ,, ,, eye	1	1
,, ,, ,, dorsal	3	5
Dorsal—Width at base	1	0
Height	0	9
Anterior margin	1	3
Pectoral—Length	1	1
Breadth at base	0	5
Caudal—Spread	1	10
Anterior margin of lobe	1	1

It is remarkable how very closely these measurements agree with those given by Dr. Hector in the "Trans. N.Z. Inst.," Vol. VI., p. 85, of a porpoise that he refers to as *Delphinus forsteri.*

The following are the dimensions of the skull :—

	Inches.
Total length	19
Length of beak	11
Width at orbits	9
,, ,, notch	4½
,, ,, middle of beak	3
Length of lower jaw	15
,, ,, teeth line	8½

The skull agrees very well with the figure of *T. metis*, in the "Voyage of the 'Erebus' and 'Terror;'" but the teeth are rather closer together, owing probably to the same number of teeth being in a smaller jaw.

ART. XVII.—*Notes on the Ornithology of New Zealand.* By WALTER L. BULLER, C.M.G., D.Sc., President.

[*Read before the Wellington Philosophical Society, 29th January, 1876.*]

IN continuation of the ornithological notes, read before the Philosophical Institute of Canterbury last year, I beg to lay before this Society some further observations, relating for the most part to the nests and eggs of those species whose history is still imperfect.

As it is my intention to publish, at an early date, a new and revised edition of my "Birds of New Zealand," in a cheaper form, to serve as a hand-book for students in the colony, I am anxious myself to collect, and to encourage others to record in the pages of our "Transactions," any new facts in the economy and life history of our native birds.

Some of the nests and eggs mentioned in this paper have already been described by Mr. Potts in his usual happy style; but there is an obvious advantage in having, for comparison, the accounts of independent observers who often look at the same object from different points of view. And as the value of observations in natural history depends entirely on their accuracy, I offer no apology for the minuteness of some of my descriptions.

FALCO NOVÆ-ZEALANDIÆ.

In the fine collection of New Zealand birds' eggs in the Canterbury Museum (brought together chiefly through the industry of Mr. T. H. Potts, F.L.S., and his sons), there is a singular specimen of the egg of the above species. It is very ovoido-elliptical in form, measuring 2.25 inches by 1.4, of a warm sepia-brown, prettily freckled and spotted, more thickly so in the middle, and confluent in a large patch at the larger end, with reddish-brown, varied with darker brown.

FALCO FEROX.

There is a beautiful specimen of the bush hawk's egg in the same collection, from the Chatham Islands. It is of a rich or warm reddish-brown freckled, and slightly smudged with darker brown, presenting a close resemblance to the merlin's egg, broadly ovoido-conical in form, and measuring 1.95 inch by 1.50 inch. There is another egg of the same species, from Paringa River, South Westland, differing very perceptibly, in being of a dull cream colour, freckled and stained all over with brown. It is of the same size as the Chatham Island specimen, but is slightly more oval in form.

SPILOGLAUX NOVÆ-ZEALANDIÆ.

Mr. J. D. Enys writes me that he met with a nest of the more-pork at the Ohunga River, containing *three* eggs.*

SCELOGLAUX ALBIFACIES.

From the same correspondent I learn that the nest of the laughing owl has been discovered in the Mackenzie country. It was placed under the shelter of a boulder, and was composed of dry grass. It contained the broken fragments of a white egg.

* I have a similar report from Mr. W. Fraser, junr., who found an owl's nest in a hollow Puriri (*Vitex litoralis*), containing three young birds. The owls bred there for three successive seasons.

PLATYCERCUS NOVÆ-ZEALANDIÆ.

Like other members of the family of parrots, this species nests in hollow trees. I stated in my book (p. 60) that it deposits its eggs "on the pulverised wood at the bottom, there being no further attempt at forming a nest." Although this holds good as a rule, I ought to mention that in the Canterbury Museum there is a loose nest, formed of moss, and lined with fern-hair, and green paroquet feathers, which was taken from the hollow of a tree, and assigned (I believe correctly) to this species.

ZOSTEROPS LATERALIS.

Mr. Enys informs me that, at Akitio (in the North Island), where wild pigs are very plentiful, the blight birds habitually line their nests with pigs' bristles, as a substitute for horse hair, which is generally used by them in other parts of the country. In a multitude of cases I have found the cavity of the nest lined entirely with long horse hair, intermixed with dry bent, all carefully twined together; an example in the Canterbury Museum has the cavity lined entirely with long horse hair, and two other specimens in the same collection have a lining composed exclusively of fine grass stems carefully bent. The nests of *Zosterops* vary somewhat in size; but they all maintain the character of having very thin walls, with an unusually large cavity for the reception of the eggs. These are generally three in number (occasionally four), and of a lovely pale greenish-blue.

In my account of this species ("Birds of New Zealand," pp. 80–86), I mentioned the circumstance of a flock of these birds being generally attended by two or more sentinels or call-birds, who take their station on the topmost twigs, as a post of observation, and whose sharp signal note instantly brings the whole fraternity together. On a recent occasion, while out pheasant shooting, the sound of my companion's whistle, although more than 200 yards away, attracted the notice of a flock of *Zosterops* consorting together in the top of a lofty Kahikatea tree. The call-birds gave the alarm, and the whole flock, amidst much clamour, ascended high in the air and disappeared behind a neighbouring hill. The sentinels appear to be always on the alert; and I have seen the same effect produced on a flock of these birds by the cry of a hawk, or any other suspicious sound, although there was no appearance of immediate danger.

ANTHORNIS MELANOCEPHALA.

The nest of this species (from the Chatham Islands) is very much larger than that of the *Anthornis melanura*. A specimen in the Canterbury Museum measures in its largest diameter about eight inches by seven inches. It is composed chiefly of dry narrow flags or grasses bent in a circular form, the outer wall being strengthened with an admixture of fibrous twigs. The cavity, which is rather loosely formed, as compared with that of *A. melanura*, is roughly lined with sheep's wool, with a few small feathers intermixed. It contained two eggs, which differ somewhat from each other, both in form and colour. One of them is of a warm salmon-pink, thickly blotched at the larger end, and spotted at irregular intervals on the general surface with reddish-brown, ovoido-elliptical in form, and measuring 1.05 inch by .75 inch. The other egg is more oval in form, paler in colour, and less marked with reddish-brown, the spots being much smaller and more scattered over the surface.

Orthonyx ochrocephala.

Mr. Potts has pointed out ("Trans. N. Z. Inst.," Vol. V., p. 177) that the description of the egg of *O. ochrocephala*, given in my "Birds of New Zealand," is defective, and I take this opportunity of rectifying it. The egg of this species is of a uniform dark cream colour, minutely and faintly freckled over the entire surface with a darker tint, approaching to pale brown. It is ovoido-elliptical in form, measuring 1 inch by .7 inch, although some specimens which I have examined are slightly smaller.

The nest is similar in construction to that of *O. albicilla* in the North Island. It is a round and compactly built structure, composed chiefly of mosses, having the cup lined with fine grasses. In the specimen under examination, there are a few feathers of the Tui and Paroquet intermixed with the other materials.

The eggs differ in colour from those of *O. albicilla*, but the type is the same.

Xenicus longipes.

The nest of this bird is a compact building formed entirely of green moss, oval in form, measuring about eight inches in length by about five inches in breadth, with a small entrance on the side not far from the top, and so small as scarcely to admit the tip of the finger. (Cant. Mus.)

Gerygone albofrontata.

The nest of this bird is similar to that of *Gerygone flaviventris*; but with a larger aperture, and without any threshold projection, although the upper edge is overhanging. The green-coloured nests of the meadow spider (*Eperia*) are used among the building materials, and likewise the white cocoons of some ground species, which I have not been able to identify.

Certhiparus novæ-zealandiæ.

A nest of this species in the Canterbury Museum is of a rounded form, with a slightly tapering apex, and not unlike a large pear in shape. The structure is composed of dry vegetable fibres, fragments of wool, moss, spiders' nests, and other soft materials closely felted together. The entrance is placed on the side, about one-third distant from the top, and is perfectly round, with smoothened edges. The interior cavity is deeply lined with soft, white, pigeon feathers.

It will be seen, therefore, that the nest of this species shows its affinity to *Gerygone*, rather than to *Orthonyx*. An illustration of it was given in Mr. Pott's paper on "New Zealand Birds," Part III. ("Trans. N.Z., Inst.," Vol. V., p. 184); but no full description has hitherto been published.

TURNAGRA CRASSIROSTRIS.

There is a nest of this bird in the Canterbury Museum, from the River Waio, County of Westland. (Potts). It is a round nest, somewhat loosely constructed, composed of small, dry, twigs, shreds of bark, fragments of moss, etc., with a rather large cup-shaped cavity, lined with dry grasses and other fibres. To all appearance it is carelessly, but nevertheless firmly, fixed in the forked twigs of a small upright branch. Mr. Potts, who studied this bird pretty closely in Westland, states that the nest usually contains two eggs; but he is of opinion that the bird breeds twice in the season. The Museum collection contains four specimens of this egg, which exhibit considerable difference in form. Two of them—probably from one nest—are very ovoido-conical; one of these measures 1·3 inch by 1·05 inch, and is pure white, marked at irregular distances over the entire surface, with specks and roundish spots of blackish-brown. The other is slightly narrower in form, the white is not so pure, and the markings are less diffuse, being collected into reddish-brown blotches towards the larger end. The other two eggs (apparently also from one nest) are of a long ovoido-elliptical form, and of equal size; the one I tested measuring 1.6 inch in length by ·95 of an inch in its widest part. The shell is pure white, with widely-scattered irregular spots of blackish-brown, less numerous and of smaller size in one than in the other. Both eggs have a rather glossy surface.

CREADION CARUNCULATUS.

Captain Hutton was the first to discover the nest and eggs of this species, on the Little Barrier Island ("Birds of New Zealand," p. 151). An egg received by the Canterbury Museum, from the West Coast, in June last, is of a rather elliptical form, measuring 1·2-inch in length by ·85 of an inch in its greatest width. It is of a delicate purplish-grey, becoming lighter at the smaller end, and marked all over the surface, but more thickly at the larger end, with points, spots, and blotches of dark purple and brown.

GLAUCOPIS CINEREA.

One of the many interesting discoveries, since the publication of my work, is the finding of the nest and eggs of the Orange-Wattled Crow. The

Canterbury Museum contains two nests of this bird, both of which were obtained at Milford Sound.

One is a massive nest, with a depth of eight inches, composed of rough materials; but with a carefully finished cup.

The foundation consists of broken twigs, some of them a quarter of an inch in diameter, and placed together at all angles, so as to form a compact support; over this a layer of coarse moss and fern-hair, to the thickness of two inches or more; then a capacious well-rounded cup, lined with dry peats, intermixed with fern-hair. The general form of the nest is rounded, but at one end of it the twig foundation is raised and produced backwards, being intended, as it seems to me, to serve as an artificial support for the bird's tail during incubation. In connection with this, I may remark that, in a nest of the Lyre Bird (*Menura superba*) lately added to the Australian collection in the Canterbury Museum, I observed the same form of construction, in a more pronounced degree.

The other is a nest of similar construction, composed of numerous broken twigs, intermixed with dry moss, and the "tail-bearer" is as conspicuous as in the other, extending some eight inches beyond the nest proper, which is about a foot in diameter. The cup-shaped depression is shallower than in the other, but has the same thick lining of dry grass. Mr. Enys informed me that this nest was discovered by himself and Mr. Potts, placed among the branches of a totara, overhanging a stream of water, in the month of January, and that it contained young birds. The other nest, also, as he assures me, was found in the vicinity of water.

There are two eggs of this species, collected by Mr. Dogherty, and now belonging to the Museum collection. They are of a regular ovoido-conical form, one of them being slightly narrower than the other, measuring, respectively, 1.60 by 1·15, and 1.65 by 1.10-inches. They are of a dark purplish-grey, irregularly spotted and blotched with dull sepia-brown. These spots and markings are thicker and more prominent at the larger end, and are of various shades, the lighter ones fading almost to purple, and presenting a washed out appearance.

At the time of the publication of my work, the only information I could give on the breeding habits of the blue-wattled crow (a near ally of the present species) was contained in the following passage:—"A young settler, who, in addition to being a son of the soil, was well-skilled in all bush-craft, assured me that he once met with a Kokako's nest fixed in a mass of kareao vines (*Rhipogonum scandens*), and he described it as being of very large size, and composed of moss and dry twigs."

CARPOHAGA NOVÆ-ZEALANDIÆ.

A nest of the New Zealand Pigeon in the Canterbury Museum (received from Milford Sound) consists of a layer of dry twigs, so loosely put together that the eggs are visible from beneath.

There is another nest, however (collected by Mr. Potts, at Little River, April, 1873) which forms a very pretty object. It is placed on the lateral fork of a branch of totara, supported underneath by an epiphytic growth of native mistletoe (*Loranthus micranthus*), which, although dried, still retains its leaves. The nest is very slight, and admits the light through its foundations, being formed of slender dry twigs of *Leptospermum* laid across each other and forming a shallow depression, with the ends of the twigs projecting all round. Slight as the structure is, however, there is some appearance of finish about it. Mr. Potts suggests that "the spaces and openings of the latticed nest befit the dirty habits of the pigeon; as the excrement dries, probably, most of it disappears through the nest."

The nest described above contained a single egg, of small size in proportion to the bird, measuring 1.9-inch by 1·4-inch, perfectly oval, of the purest white, and without any gloss on the surface.

OCYDROMUS AUSTRALIS.

A nest of the South Island Wood-hen, from Ohinitahi (Canterbury Museum) is a massive bed of dry grass, measuring 20 inches by 14, with a uniform thickness of about 4½-inches. In the centre there is a slight depression, which contains five eggs. These are yellowish-white, irregularly spotted and marked with yellowish-brown and pale washed out markings of purple. In form they are slightly ovoido-conical, measuring 2.25-inches by 1.6, and presenting very little variety in colour; the spotted markings being generally thickest at the larger end. Mr. Enys states that the ground colour varies in specimens from different localities, from a pure white to a rich cream colour. I have observed that they are often much soiled, probably from contact with the bird's feet during incubation.

ORTYGOMETRA TABUENSIS.

An egg of this pretty little Rail, in the Canterbury Museum, is broadly elliptical in form, measuring 1.3 by .95 of an inch, and is of a uniform pale creamy brown, minutely and obscurely freckled over the entire surface with a darker tint. The shell is slightly glossed.

ARDEA SYRMATOPHORA.

The nest of the White Heron is a rather massive structure, with a flattened top (no appearance whatever of a cup or hollow), rounded in form, and measuring eighteen inches across. It is composed almost entirely of fern fronds by way of foundation, with a thick rough layer of dry twigs above. On this are deposited the eggs, three in number, differing very slightly in size, the largest measuring 2.2-inches by 1.6-inch, of a regular ovoid form, of a uniform pale green colour, and without any gloss.

This description is taken from a specimen in the Canterbury Museum, collected by Mr. Potts in Westland. On looking at the structure, it seems difficult to understand how the bird can incubate the eggs without their falling out of this rude flat nest, or getting broken against the rough twigs on which they lie, without lining or protection of any kind.

ARDEA SACRA.

An egg of this species, received from Hawkes Bay, is of a narrow oval form, measuring 1.9-inch by 1.35-inch, very finely granulate on the surface, and without any gloss. The colour in the dried shell is a delicate pale green, but it was no doubt brighter when fresh.

BOTAURUS PŒCILOPTILUS.

A nest of this Bittern in the Canterbury Museum is small, flat-topped, and rounded, with a diameter of about nine inches, and a depth of three inches. It is composed entirely of dry rushes and flags, and contains three eggs, ovoido-elliptical in form, and of a uniform delicate creamy stone colour. There is a specimen of the egg, however, in the Museum, of a delicate dull green, and three others of a greenish-cream colour. The green tinge is no doubt more pronounced in the shell when fresh.

CASARCA VARIEGATA.

Mr. J. D. Enys writes me that, in the Upper Waimakariri, he met with a brood of thirteen young birds.

LARUS DOMINICANUS.

A remarkable nest of this species, in the Canterbury Museum, affords, to my mind, an explanation of a point raised about the nesting habits of *L. bulleri*, in my controversy with Captain Hutton in 1874 ("Trans. N. Z. Inst.," Vol. VI., pp. 126-138). In my account of this species, I had stated that "its attempts at forming a nest are of the rudest kind, a few bents of grass or other dry materials loosely collected round the edges being deemed a sufficient preparation." Captain Hutton contradicted this, and stated that it "forms a very good nest."

As a rule the Black-backed Gull forms a very rude nest, and as often merely deposits its eggs in a depression in the sand. In some localities, however, where the ground is damp or swampy, or liable to be overflowed, the bird appears to adapt its building to the requirements of the situation. The nest in question is a massive agglomeration of sea-weeds, rushes, twigs, grasses, and other rubbish, closely pressed together, and forming a flattened globular cushion two feet in length by eighteen inches in breadth and nine inches in thickness. In the centre there is a slight depression, for the reception of the eggs. Mr. Enys (who was present when this nest was found) informs me that it was placed between the roots of a drift stump of totara, near the river mouth (Milford Sound), being surrounded by water at every high tide.

In the Museum there is a similar nest of the small gull (*L. scopulinus*) formed of dry twigs, grasses, and sea-weed, a foot long by eight inches across, and raised five inches from the ground. This was found under similar conditions with the other. And we may fairly assume that the same would happen in the case of the closely allied species, *L. bulleri*.

DIOMEDEA EXULANS.

The following is a description of a perfectly mature example of the wandering Albatros, the fresh skin of which was received at the Canterbury Museum from one of the emigrant ships. The whole of the head and neck, as well as the upper and lower parts of the body, of the purest milk white. On each side of the nape, or upper part of the neck, there is a broad longitudinal mark, of a beautiful roseate pink, covering an area of about six inches in length by two inches in breadth, which fades soon after death, and ultimately disappears altogether in the dried skin. This is, I believe, quite a new fact in natural history, for I have never seen it before myself, nor have I found it recorded in any history of the species. Another specimen obtained at the same time shewed traces of this feature, but in a very diminished degree; and I conclude that it is to be met with only in very old birds, or at some particular season of the year. The only dark markings are on the tail and wings; on the former, each feather has two sub-apical irregular spots of black, larger and darker on the other webs. (It is probable that these spots ultimately disappear, leaving the tail entirely white, for I observed that on some of the lateral feathers there is only a single irregular spot on the outer web.) Two of the upper tail coverts (which otherwise are perfectly white) are crossed transversely with delicate vermiculations of dark brown; the under linings of wings and the axillary plumes, pure white. At the insertion of the wings some of the upper feathers have delicate vermiculations; the inferior secondaries are broadly marked in this manner, and the longer ones have a broad terminal patch of black. Along the edge of the humerus there are spots of black, having a very pretty effect, each feather having a broad angular spot on the outer vane. At the humeral bend of the wing the white plumage predominates, the spots appearing again like irregular inky patches, and becoming thicker and larger towards the carpal flexure. The secondaries are white in their basal portion, greyish-black towards the tips. The primaries are brownish-black, with white shafts fading to grey on their inner webs, and white at the base.

Mr. J. D. Enys writes me that the Albatros is said to breed on rocks north of the Chatham Islands, and that the Maoris go out periodically to collect the young birds as an article of food.

An egg of this species in the Canterbury Museum is ovoid or slightly ovoido-elliptical in form, yellowish-white, with a roughly granulate shell, wholly devoid of gloss or polish, but without any excrescences. It measures on its axis, 4.8-inches in length by 3.3 in width. Its longest circumference is 12.6-inches, and its widest 10-inches.

PHALACROCORAX BREVIROSTRIS.

In the Canterbury Museum there are two nests of the White-throated Shag, differing entirely in their construction. One of them is very compact, rounded in form, with a diameter of more than a foot, and a thickness of five inches, and presenting only a slight depression for the eggs, and composed of weeds, grasses, and dry flags, on a foundation of broken twigs. The other is formed entirely of broken twigs, with the leaves attached, closely interlaced together, with a deep cavity for the eggs, the whole being securely placed in the fork of a small tree. It is, in fact, a compact structure, of a round symmetrical form, and very firmly put together. Each of these nests contains three eggs, all of which have the surface much soiled.

PHALACROCORAX NOVÆ-HOLLANDIÆ.

A nest of this species, in the same collection, is a massive bed of flax leaves, toe-toe, and dry grasses pressed together into a thick flat layer, measuring about 20 inches by 15 inches, with a thickness of 3 to 4-inches, and with a slight depression on the top. It contains three eggs, elliptical in form, greenish-white, with chalky incrustations, and measuring 2.5-inches by 1.6-inches.

PODICEPS RUFIPECTUS.

The frequency of albinos, of various species, is a very noticeable feature in New Zealand ornithology. We have now to add to the list an albino Dabchick, presented to the Canterbury Museum by Mr. Thomas Waters, of which the following is a desciption:—General plumage pure white, the sides of the head and throat shaded with brown; crown, nape, and hind neck streaked and spotted with black; fore-neck and breast varied with pale rufous; shoulders, back, and scapulars with numerous scattered black feathers, giving the upper surface a pied appearance; wings dusky black, more or less varied with white; bill and feet of the normal colours.

ART. XVIII.—*Note on Gerygone flaviventris.*

By WALTER L. BULLER, C.M.G., D.Sc., etc.

[*Read before the Wellington Philosophical Society, 7th August*, 1875.]

THE last volume of "Transactions of the New Zealand Institute," contains, at page 524, an interesting note by Mr. Justice Gillies, on the habits of

Gerygone flaviventris. The learned author describes, in very pleasing language, a nest of this warbler, which he met with at the Bay of Islands, when travelling in company with Dr. Hector and Professor Berggren, and he concludes with these words :—"How the long-tailed cuckoo (*Eudynamis taitensis*) can, as stated by Dr. Buller, ('Birds of New Zealand,' p. 75) deposit its eggs in such a nest, I can scarcely understand. On the 22nd instant (October), one of my children discovered, under a large *Cupressus macrocarpa*, in my garden, a specimen of the *Eudynamis taitensis*, recently killed, apparently by a hawk. It would have been impossible for the *Eudynamis* to have entered the opening in the nest of the *Gerygone*."

On referring to the page of my work, cited above, it will be seen that, so far from making the supposed statement, I expressed a very decided opinion to the contrary. My language was as follows :—"Very little is at present known of the breeding habits of this species (*Eudynamis taitensis*). As I have mentioned above, it is parasitical; but to what extent, is not yet determined. My own belief is, that it performs itself the duty of incubation, and then abandons its young to the grey warbler, which instinctively accepts the charge, and caters untiringly for its support. In the first place it is difficult to conceive how a bird, of the size and form of the Long-tailed Cuckoo, could deposit its egg in the domed nest of the last-named species, and, even supposing it did, it would seem almost a physical impossibility for so small a creature to hatch it, and, again, even were this feasible, it is difficult to imagine how the frail tenement of a suspension-nest could support the daily-increasing weight of the young cuckoo. Over and above al this, there is the significant fact that I once shot an adult female of the present species, in which the underparts were quite denuded of feathers, as if the bird had been long incubating. Strange as such an hypothesis may appear, we are not altogether without a parallel instance in bird-history; for, in the case of the *Chrysococcyx smaragdineus*, of Western Africa, it is alleged that this cuckoo hatches its single egg, and then, utterly unmindful of its parental obligations, casts the care of its offspring on a charitable public, and that almost every passing bird, attracted by the piping cry of the deserted bantling, drops a caterpillar, or other sweet morsel, into its imploring throat. My artist, Mr. Keulemans, assures me that he often witnessed this himself during his residence on Prince's Island."

It will be seen, therefore, that the line of my argument was entirely opposed to the theory of the *Eudynamis* entering the nest of *Gerygone*. Where it lays and hatches its egg I do not pretend to say; but that the young cuckoo is attended and fed by the grey warbler, is a fact established beyond all doubt. The plate facing page 73 of the "Birds of New Zealand," which represents this little bird performing this parental office to its foster-child of another species, and about ten times its own size, is no fanciful representation, but a true picture of bird life.

Art. XIX.—*On the Nesting Habits of the* Huia (*Heteralocha acutirostris*).

By Walter L. Buller, C.M.G. D.Sc., etc.

[*Read before the Wellington Philosophical Society, 29th January*, 1876.]

Five years ago, I had the honor of placing before this Society a somewhat complete account of the Huia (*Heteralocha acutirostris*), with special reference to its habits in a state of captivity. This account was reproduced in my "Birds of New Zealand" (p. 63–68), together with such further information as I had been able to collect; and in the introduction to that work (p. 17–18), I gave an exhaustive description of its osteology and anatomy, from the pen of Mr. A. H. Garrod. I was unable, however, to give any information on the nesting habits of this singular bird, beyond what is contained in the following paragraph:—"Of the nidification of the Huia, nothing is at present known. I have been assured, however, by a native, that he once found the nest of this bird in the cavity of a tree; that it contained two young birds (a male and female), and that they differed from the adults in having the wattles flesh-white instead of orange."

It will be gratifying to lovers of natural history to hear of the recent discovery of a nest of the Huia in the Orongorongo Ranges, near Wellington. A Maori, named Mikaera, who has been a very zealous collector for the Museum, brought to Mr. Buchanan, about the 20th of October last, an egg of this species, which he had taken from a cavity in a dead tree. Observing the old birds passing in and out of the opening, he concluded that there was a nest, and, climbing up, attempted to reach the bottom with his arm; finding it too deep, he cut a yard of "supplejack" (*Rhipogonum scandens*), and, bending this into a loop, he thrust it down the opening, and by this rude means endeavoured to hoist the contents of the nest. He at length succeeded in bringing up an egg, although in a somewhat broken condition. The egg contained a young bird, apparently just ready for extrusion, and both embryo and shell are now in the collection of the Colonial Museum. The egg is ovoido-conical in form, measuring 1.45 by 1.05 inches, and is of a pale stone-grey, irregularly stained, freckled and speckled with purplish-grey, the markings in some places running into dark wavy lines. The chick is apparently a male; the bill being very stout, with the caruncles at the angles of the mouth well developed, and of a flesh-white colour. The whole of the body is bare, with the exception of what appears (in spirits) to be strips of coarse hair-like filaments, from one-half to three-quarters of an inch in length, and perfectly black, but are in reality tufts of extremely fine downy feathers. A strip of these filaments encircles the crown, a line passes down the course of the spine, and there is another along the outer edge of each wing and behind each thigh.

I would venture to suggest to the Museum authorities that, as Mr. Garrod has carefully studied the anatomy of this singular bird, and is now devoting his attention to embryonic ornithology, it would be very desirable to place this unique specimen at his disposal for more critical examination.

I have only thought it necessary to place the general facts on record, as furnishing an interesting addition to our knowledge of the habits and life-history of the rare and beautiful Huia.

ART. XX.—*On the Occurrence of* Apteryx oweni *at high altitudes in the North Island.* By WALTER L. BULLER, C.M.G., D.Sc.

[*Read before the Wellington Philosophical Society, 12th February, 1876.*]

WE have been so accustomed to speak of the *Apteryx oweni* as a strictly South Island species, and, as representing these, the Brown Kiwi of the North Island (*Apteryx mantelli*), that the discovery of its existence, under certain conditions in this Province is an interesting fact in geographic distribution. The fine specimen which I now exhibit, and for which I am indebted to Mr, Morgan Carkeek, of the Survey Department, was obtained by that gentleman, on Mount Hector, at the head of the Hutt River, in December last. It was caught by his dog among the snow-grass, at an elevation of about 3000 feet. At a higher altitude he found the species comparatively abundant, and he met with it occasionally below the snow-line, frequenting mossy places in the bush free from undergrowth.

This peculiarity of range, as compared with the distribution of the species in the South Island is very suggestive, and it will be interesting to discover whether this bird inhabits the summits of mountains further north.

In connection with the *Apteryx*, there is another matter to which I will take this opportunity of referring.

Captain Hutton, in his valuable essay on the "Geographical Relations of the New Zealand Fauna" ("Trans. N.Z. Inst.," Vol. VI., p. 232) says :—"The *Apterygidæ* have a more generalised structure than the other struthious birds; they, therefore, belong to an older type, and cannot, with any degree of correctness, be said to represent the extinct race of Moas."

And, again, in his review of my "Birds of New Zealand," in the "New Zealand Magazine," p. 99, Captain Hutton says:—"We must take exception to the Kiwi being considered as the living representative of the Moa, or as Dr. Buller puts it in his preface, 'the only living representative of an extinct race.' No doubt the Kiwi and the Moa have several features in common; but it is certain that both the Emu and the Cassowary are far more nearly related to the Moa than is the Kiwi." It will be interesting to the meeting to learn that Professor Mivart has recently read a paper before the Zoological Society of London, on the axial skeleton of the Struthionidæ, which effectually settles the question at issue. The learned professor pointed out that, judging by the characters of the axial skeleton, the Emu presents the least differential type, from which *Rhea* diverges most on the one hand, and *Apteryx* on the other; that the resemblance between *Dromæus* and *Casuarinus* is exceedingly close, while the axial skeleton of *Dinornis* is intermediate between that of *Casuarinus* and *Apteryx*; its affinities, however, with the existing New Zealand form very decidedly predominating.

It will be seen, therefore, that I was fully justified in referring to the existing species of *Apteryx*, as "the diminutive representatives of colossal ornithic types that have disappeared."

Art. XXI.—*Remarks on Dr. Finsch's Paper on New Zealand Ornithology.* By Walter L. Buller, C.M.G., D.Sc.

[*Read before the Wellington Philosophical Society, August 7, 1875.*]

I have read with interest Dr. Otto Finsch's valuable contribution to the last volume of the "Transactions," (pp. 226–236,) which is merely a precursor of his promised "Synopsis of the Birds of New Zealand," and I find we are still at issue on several points:—

1. *Stringops greyi* is undoubtedly a mere variety of *S. habroptilus*. It is no more entitled to recognition as a species than the handsomely marked specimen in Brogden's Collection, of which I have recorded a description. ("Trans. N. Z. Inst.," Vol. VII., p. 201.)
2. I do not believe in the existence of *Acanthisitta citrina*, Gmelin. The plumage of *A. chloris* differs in the male, female, and young.
3. I entirely dissent from Dr. Finsch's present view that the so-called *Orthonyx albicilla* and *O. ochrocephala*, of the North and South Islands respectively, belong to "totally different families." In one of his earlier articles ("Journ. für Orn.," July, 1870), he

expressed his conviction that they belonged not only to the same family, but to "the same genus." (See my Notes, pp. 203–204, "Trans. N. Z. Inst.," Vol. VII.)

4. In a former paper ("Trans. N. Z. Inst.," Vol. V., p. 207) Dr. Finsch pronounced *Myiomoira longipes* and *M. albifrons* to be hardly separable, but he now acknowledges that he has never examined the latter species. The two birds are quite distinct, and represent each other in the North and South Islands.

5. Dr. Finsch appears to consider *Gerygone sylvestris* a good species. Unfortunately, Mr. Potts has not deposited his type with the rest of his collection in the Canterbury Museum, and I am unable to qualify my former opinion respecting it.

6. Dr. Finsch professes to put the synonymy of our New Zealand Godwit right; but it was I who did this, as the following passage will show:—"Drs. Finsch and Hartlaub, in their excellent work on the birds of Central Polynesia, have correctly referred our bird to the species described by Mr. Gould under the name of *Limosa uropygialis*; but as will be seen on reference to the historical synonymy given above, this name has no claim whatever to recognition. There are no less than five recorded names of antecedent date; and in settling questions of nomenclature, I shall, as far as possible, adhere to the established rule of adopting in every case the oldest admissible title. There can be no doubt that this was the species originally described (Naum Vög. Deutschl., viii., p. 429—1836) as, *Limosa baueri*: and I have accordingly restored its original name. But even supposing that, as the authors already cited have contended, Naumann's description is too vague to fix the species, and that Gray's *L. brevipes* is open to the same objection, then *Limosa Novæ Zealandiæ* (Gray) would undoubtedly stand in reference to a name bestowed by Gould at a later period."—"Birds of New Zealand," p. 199.)

7. Dr. Murie has cleared up the question of *Rallus modestus* being distinct, by an examination of the skeleton. (See Prof. Newton's Notes, Trans. N.Z. Inst., Vol. VII., p. 511.)

8. A comparison of Gray's type of *Eudyptes pachyrhynchus* with the specimens of *E. chrysocomus* in the British Museum satisfied me that they ought to be united. With regard to *E. nigrivestis*, I think I am right in stating that Mr. Gould, who distinguished the species, agreed with me that it could not stand.

9. I do not admit Dr. Finsch's new Penguin from Akaroa Heads *Eudyptula albosignata*, and I feel sure that on receiving a larger series of specimens, he will himself relinquish it.

10. Dr. Finsch's observations on the coloration of *Apteryx haasti*, in which he declares that it "entirely agrees with *Apteryx oweni*, and is by no means darker, as Dr. Buller says," is another instance of the danger of generalizing from a single specimen. There is now an example of *Apteryx haasti* in the Canterbury Museum, in which the chestnut coloring is almost as dark as in *Apteryx mantelli*.

There are other points on which I am hardly inclined to agree with the learned author, but I have no wish to provoke a controversy by pursuing the subject further.

ART. XXII.—*Remarks on various species of New Zealand Birds, in explanation of Specimens exhibited at meetings of the Wellington Philosophical Society, 1875-6.* By WALTER L. BULLER, C.M.G., D.Sc., President.

1. *On varieties of Carpophaga Novæ Zealandiæ.*

DR. BULLER exhibited two remarkable specimens of the New Zealand Pigeon (*Carpophaga Novæ Zealandiæ*.) One of these was a beautiful albino, the entire plumage being of a pure milk white, the small wing coverts alone presenting a slight tinge of yellowish-brown; bill and feet carmine red. It was obtained in the Wairarapa by Mr. Kelcher, who has presented it to the Colonial Museum. The other specimen was a partial albino, shot by Capt. Mair, of Tauranga, and presented to the exhibitor. In this bird the shoulders, back, rump, and upper tail coverts have a rich appearance, the white predominating. Some of the wing feathers and their coverts are wholly white, with bronzed edges and clouded with grey, while others again present the normal coloration. The distribution of colors, however, is quite irregular, the white largely predominating in the right wing. In remarking on these specimens, Dr. Buller referred to some other accidental varieties described at page 158 of his "Birds of New Zealand," and more particularly to an example presented to him by Mr. Edward Hardcastle, of Hokitika (now in the Colonial Museum), in which the head, neck, fore part of the breast, and all the upper parts are pale yellowish-brown, more or less glossed with purple; the wing coverts and scapulars stained towards the tips with coppery brown; the quills and tail-feathers uniform pale yellowish-brown, tinged with vinous, the tips of the latter paler.

2. *On a Specimen of Thalassidroma nereis.*

DR. BULLER exhibited a specimen of the Grey-backed Storm Petrel (*Thalassidroma nereis*), obtained on the coast near Cape Campbell, by Mr. C. H. Robson, a member of the Society, and forwarded by that gentleman to the Colonial Museum.

Dr. Buller stated that there are two examples of this rare Petrel in the Canterbury Museum, but that hitherto, so far as he was aware, it was a desideratum in all other local collections. Mr. Robson's donation would therefore prove a valuable addition to the collection of birds in the Colonial Museum.

3. *On the occurrence of Nyroca australis.*

DR. BULLER exhibited also a specimen of the White-eyed Duck (*Nyroca australis*), obtained in the Manawatu district, and purchased from Mr. Liardet. He stated that the existence of this well known Australian species in New Zealand was first ascertained by Captain Hutton, who, in 1869, obtained a specimen in the Waikato, and forwarded it to him for determination. (Trans. N.Z. Inst., Vol. II., p. 78.) It has since been met with at Canterbury and further south; but the present is the first known instance of its occurrence in this Province.

4. *On a supposed New Species of Shag.*

DR. BULLER exhibited to the meeting three specimens (male, female, and young) of a species of Shag, collected by Mr. Henry Travers, in Queen Charlotte Sound, and which, although in some respects closely resembling *Phalacrocorax carunculatus*, is probably a distinct form. Dr. Buller pointed out the distinguishing characters, and stated that if, on a further examination and comparison of specimens it should prove to be a new species, he proposed (with the concurrence of the discoverer) to name it in honor of Dr. Otto Finsch, of Bremen, who has made many valuable contributions to New Zealand Ornithology.

5. *On Prion banksii as a Species.*

FIVE examples of the adult and young of *Prion banksii*, together with a specimen of the egg, were exhibited, and Dr. Buller pointed out the characters which, to his mind, sufficiently distinguished this species from *Prion ariel* on the one hand, and *Prion vittatus* on the other. The specimens exhibited were obtained at the small islands off the New Zealand coast, known as "The Brothers."

6. *On a remarkable variety of Porphyrio melanotus.*

DR. BULLER exhibited a very singular example of the Pukeko (*Porphyrio melanotus*), shewing a tendency to albinism, which he had purchased from Mr. Liardet. Both this and another very similar specimen (of which a full description is given at p. 186 of "The Birds of New Zealand) were obtained in the Manawatu district. He remarked on the frequency of albinism in this species, and invited the attention of the meeting to the plate of *Porphyrio stanleyi*, in Mr. Dawson Rowley's "Ornithological Miscellany," which bears unmistakable indications of being merely an albino. The Canterbury Museum contains a specimen in partial albino-dress, very closely resembling the one exhibited.

7. *On the validity of Aplonis zealandicus.*

Dr. Buller read to the meeting an extract from a letter which he had recently received from the well-known ornithologist, Dr. Otto Finsch, of Bremen, to the following effect :—

"It will interest you to hear that the specimen of the so-called *Gerygone igata*, in the Museum at Paris is positively *Gerygone flaviventris*, and that *Aplonis zealandicus* is a good species, of which there are undoubted specimens from New Zealand in the museums of Paris and Leiden. I have been working several weeks at Leiden, and have gathered some further material on the ornithology of New Zealand."

Dr. Buller remarked on the singular fact that since this species was collected by M.M. Quoy and Gaimard, at Tasman Bay, during the voyage of the "Astrolabe," it has never been met with in any part of the country. There is no confirmation, however, of the allied species *Aplonis obscurus** as a New Zealand bird, and *A. caledonicus*, Bonap. (which is a native of New Caledonia and Norfolk Island) has apparently been admitted into our list by mistake.

8. *On the specific value of Eudyptula undina.*

Dr. Buller exhibited a specimen of the small Penguin (*Eudyptula undina*) with remnants of down adhering ; to show that this species assumes the full plumage from the nest, the blue on the upper surface being very bright. He compared it also with specimens of *Eudyptula minor*, and pointed out the specific characters—the latter form being readily distinguished by its larger size, duller plumage, and more robust bill. As to whether *E. albosignata* (Finsch), can be considered distinct from this species, Dr. Buller referred to his former remarks ("Trans., N.Z. Inst.," Vol. VII., p. 210) and quoted the following passage from the last letters he had received from Dr. Finsch :—

"Very likely it may turn out to be only a variety of *E. minor* ; but, if the latter, I have seen many other specimens, and not a single one showed the peculiar markings on the wings characteristic of *albosignata*. Besides, it has a white spot on the upper tail-coverts, which I have not observed in *E. minor*."

* Dubus, *Bull. Acad. Sci. Brux.*, 1839. Part I., p. 297.

Dr. Buller exhibited a drawing, which Dr. Finsch had sent him of the wing of *Eudyptula albosignata*; but he still maintained the opinion that it was only an accidental variety of the common species.

ART. XXIII.—*Notes on Birds observed during the Voyage to England, in a Letter to the President.*

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

[*Communicated to the Wellington Philosophical Society by* DR. BULLER, *C.M.G.*, *7th August*, 1875.]

"ON board the 'Howrah,' 18th May, 1875.—I hope we shall be in London in a week, and may as well write a few lines in readiness to post to you. Our voyage has been slow, but pleasant, with very little rough weather. We did very well to the Horn; but since then have had very light winds, and but little help even from the Trades. * * * * I have been rather surprised at the small number of birds we have seen. For some days out from New Zealand we had *Diomedea melanophrys* and another small species with a white head and brown mottled body. These were very common near the Bounty Islands; but were not seen afterwards. The Mollymawks we had till we reached the South Tropic. It was not till we rounded the Horn that we saw any of *D. exulans* or *D. fuliginosa*. The latter species I am positive we never saw in the Pacific, as it is so easily recognised by the blue streak on the mandibles. It is very abundant between the Falkland Islands and latitude 30° S. Off the Western Isles two or three birds like albatrosses, but much smaller, with white bellies and white ring round the throat, were seen. I dare say I shall recognise it in the British Museum. *Thalassidroma nereis* followed us almost to the Horn; but, after entering the Atlantic, *T. melanogastra* took its place, at first in large flocks, but, since latitude 35° S., only a few stragglers have been seen. In the Pacific I saw one *Lestris*, and large flocks of "whale-birds" as the sailors called them—which were the Blue Billy (*Prion turtur*); but, in the South Atlantic, we met flocks of another but larger-sized grey bird, which they also called "whale-birds." These were evidently *Procellaria glacialoides*. When 100 miles off the Horn, a specimen of the White-throated Shag (*Graculus brevirostris*) flew on board. We never saw a single Cape Pigeon during the voyage. Where can they be at this season—February–March? Only two Tropic Birds, one Frigate Bird, and a few Noddies were seen near St. Paul's Rocks, and these complete the list of birds. I am anxious to get to the end of the voyage, as it is a waste of time after ninety days, and we are now out ninety-four days, and have still 1000 miles to the Lizard. * * * * The birds are all well, except the loss of one Kiwi and two Woodhens. The specimen of *O. nigricans*, from the Snares, is all right, however; also the pair of *Ocydromus earli*, and *O. australis* (the large yellow variety). The Cassowary and the Cranes are in fine condition. * * *

"London, 30th May.—Arrived last night by rail from Falmouth; 105 days in all."

Art. XXIV.—*Further remarks on some New Zealand Birds.*

By Otto Finsch, Ph.D., of Bremen; Hon. Mem. N.Z.I.; Hon. Mem. Brit. Ornith. Union.

[*Read before the Otago Institute, 7th February, 1876.*]

Circus approximans. Peale.

A comparison of specimens in the Leiden Museum from Australia, New Zealand, Fiji, and New Caledonia, has fully convinced me of their identity. The specimen from New Caledonia (*C. wolfii*, Gurney) does not show a single character by which it can be specifically distinguished. As the true *C. assimilis*, Jard. and Selby, is undoubtedly the same as *C. jardinei*, Gould (which, therefore, must bear the former appellation), the New Zealand Harrier must stand as *approximans*, Peale. I also compared specimens of *C. assimilis* (= *C. jardinei*) from Australia and Celebes, and found them entirely alike.

Scops novæ-zealandiæ. Bp.

An accurate description of this curious owl has been given by Mr. Sharpe ("Erebus" and "Terror," 2nd edition, p. 23) from the type in the Leiden Museum. Having also carefully inspected this unique specimen, I must state that the label gives no evidence of the true habitat, and that the notice "New Zealand" remains only a supposition.

Strix delicatula. Gould.

Mr. Sharpe includes this species in the avifauna of New Zealand ("Erebus" and "Terror," 2nd edition, p. 23) on account of my statement ("Journ. für Ornith.," 1867, p. 318). But I long ago stated ("Journ. für Ornith.," 1870, p. 245) that I had made a mistake on this point.

Platycercus novæ zealandiæ. Sparrm.

I had the pleasure of seeing a very rare variety of this species, which, instead of green, was of a uniform marine blue, with dark blue wings; the front and rump spots being isabelline-whitish instead of red.* Another

* This is the specimen referred to by Mr. Potts ("Trans. N.Z. Inst.," Vol. VI., p. 148.—F. W. H.

instance of uniform cyanism in Parrots is found in *Brotogerys subcærulens*, Lawr., which is, I think, only an accidental blue variety of *Br. tori*.

Platycercus rowleyi. Buller.

As this small form of *Pl. novæ-zealandiæ* will be scarcely separable from those small-sized specimens which Bonaparte called *Pl. aucklandicus*, I suspect that the new appellation must give way to the older, if, indeed, this small bird can be considered as a valid species at all.

Acanthisitta citrina. Gml.

Having compared again a good series of specimens, I am now inclined to believe that the characters pointed out by me, as separating these supposed different species are not constant, and I do not hesitate to unite *A. citrina* with *A. chloris*. (Sparm.)

Gerygone igata. Quoy and Gaim.

Mr. Sharpe declares, after a careful comparison of the type in the Paris Museum, that this species is different from *flaviventris*, and gives some distinguishing characters. Dr. Hartlaub, also, during his recent visit to Paris, was kind enough to compare the type with specimens of *flaviventris*, and this learned ornithologist, in accordance with Dr. Oustalet, declares *G. igata* to be positively, and without any doubt, identical with *flaviventris*, so that this latter name will sink to a synonym of the former. The French travellers, therefore, who collected the bird in Tasman Bay, have the merit of discovering this species, which Dr. Buller, notwithstanding the positive statements of Messrs. Quoy and Gaimard, refused to allow a place in the New Zealand avifauna.

Aplonis zealandicus. Quoy and Gaim.

Is an excellent and typical species which I had the pleasure of seeing in the Leiden Museum, being one of the typical specimens brought home by the Astrolabe expedition. Dr. Hartlaub informs me that there are three specimens in the Museum in Paris, all marked Tasman Bay, New Zealand, and collected by the French travellers, so that there can be no doubt as to the locality. In order to make this remarkable bird known in the Colony, I append a description of the Leiden specimen :—Head above, hind neck, back and shoulders, obscure earth-brown ; sides of the head and neck and under parts, lighter olive-brown grey, paler on the chin and throat ; flanks, anal region, and lower tail-coverts, rusty-brown (the feathers with pale, rusty, apical margins) ; rump and upper tail-coverts darker than the lower, the light margins nearly obsolete ; first primary, uniform dark brown, the remainder to above the basal half on the external web, dark red-brown, internally, light rusty ; coverts of the primaries, dark brown, those of the secondaries and remainder of wing coverts, lighter ; wings from beneath, light rusty, the third apical, grey-brown ; lower wing coverts somewhat lighter than the under surface; tail feathers, dark brown, with a narrow and not very distinct red-brown basal margin; lores, velvetty-black; bill, reddish-brown; legs, brown.

Wing.	Tail.	Culmen.	Tarsus.	Mid-toe.	
4-inch.	2-inch, 1 line.	7 lines	1-inch.	7 lines.	(English).

Ocydromus troglodytes. Gml.

To this species belongs *O. australis*, Schleg. (Mus. P.B., *Rallus*, No. 2 et 3), which, although a young specimen, agrees with the adults. *O. australis* (Cat. No. 1, in the Leiden Museum, formerly B. M., *Gallirallus fuscus*, Temm.) will prove to belong to a new species.

Ocydromus brachypterus. Schleg.

(Cat. No. 1.) Said to come from the Chatham Islands, but without evidence, is the same as *O. hectori*, Hutton.

Ortygometra pygmæa. Naum.

A specimen received from Dr. Haast, under the name of *O. affinis*, belongs really to this widely distributed species. I compared it with specimens from various parts of Europe, Australia, and Japan, and cannot detect the slightest constant character to keep it separate.

Procellaria incerta. Schleg.

A specimen (Cat. No. 2.) labelled by Temminck "*Procellaria lessoni*, Astrol. and Zel., par Mons. Beligny, Nouvelle Zelande," is most probably *Pr. lessoni*, Young*.

Procellaria gouldi. Hutt.

To this species belongs *Pr. fuliginosa*, Cat. No. 1 ("mers antarctigues") in the Leiden Museum.

Procellaria griseus. Gml.

Pr. carneipes, Schleg., in the Leiden Museum, is identical with this species.

Procellaria affinis. Bull.

I suggest that this new species will turn out to be *Pr. mollis*. Dr. Buller's description agrees very well with specimens in the Leiden Museum, showing only a difference in the length of the wing of seven lines, in the length of the bill of two lines, and in the tarsus of one and a half lines. I have already introduced *P. mollis* as a New Zealand bird, from a specimen captured by the Novara expedition.

Puffinus tenuirostris. Temm.

I compared Temminck's type from Japan, in the Leiden Museum with specimens from Sitka (labelled in Temminck's handwriting "*æquinoctialis*, Pall. and *curilensis*, Temm.") which agreed in every respect with the New Zealand specimens.

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* This has been also pointed out by Dr. Coues.—F.W.H.

Prion vittatus. Gml.

A careful comparison of the specimens in the Leiden Museum has led me to believe that *Pr. banksii* will be found to be inseparable from *Pr. vittatus.* On the other hand I convince myself of the validity of *Pr. turtur* and *ariel.*

Graculus chalconotus. Gray.

I have lately had the pleasure of examining a specimen of this excellent species, forwarded to me through the kindness of Captain Hutton. *Graculus glaucus*, in the Leiden Museum, which is labelled (but most probably erroneously) "Terre magellanique," and is a specimen collected by the French Expedition, belongs also to this species.

Graculus finschi. Sharpe.

Mr. Sharpe has separated the specimen in the British Museum with a white spot on the wing-coverts from *G. brevirostris.* I long ago suspected that this would not be a true *G. melanoleucus* nor *brevirostris*, which latter I cannot distinguish from the former. My *G. melanoleucus* ("Journ. of Orn.," 1874, p. 223) does not belong to *G. finschi*, of which I have not yet seen a specimen.

Sula serrator. Banks.

Captain Hutton kindly sent me a New Zealand specimen, which agrees with those from Australia.

Eudyptula albosignata. Finsch.

Dr. Buller, without having seen a specimen, declares this species to be identical with *Eu. undina.* I must refer him to my description ("Trans., N.Z. Inst.," Vol. VII., p. 236) which will show that it is not the difference in size as Dr. Buller thinks, but the strongly marked difference in the coloration of the flippers that induced me to make it a new species. As soon as I get intermediate specimens, I shall be the first to withdraw this species. *Eu. undina* I know very well, but cannot separate it from *Eu. minor.*

Eudyptes vittata. Finsch, and

Eudyptes atrata. Hutton.

Are two new species lately added to the New Zealand Ornis (*vide*, "Ibis," 1875, p. 112–114).

Eudyptes chrysolopha. Brant.

To this species belongs *diadematus*, Schleg. (Cat. No. 2), said to be from New Zealand, but only on the authority of a dealer (Parsudaky), and therefore uncertain.

I append the description of a new Penguin from the Macquarie Islands, in the Leiden Museum, as being connected with the New Zealand avifauna.

Eudyptes schlegeli, Finsch. = *Eu. diadematus*, indiv. No. 3, Schleg., in Mus. P.B.

General coloration, size, and form of bill as in *chrysolopha*, but front margin, slate-black; a broad frontal band, bright orange, with narrow black shafts. This orange band runs to above the eye, and here the hair, like black shafts, forms a small tuft of about 2¼-inches in length, which runs backwards; round the eye, and the temporal region, pale brownish-grey; lores, and a narrow rim round the mandible, pale sulphur-yellow; cheeks, sides of the head and neck, and the whole under surface, white.

Culmen.	Rictus.	Height of Bill.	Flipper.
2-inch, 7 lines.	3-inch, 3 lines.	10 lines.	7-inches.

ART, XXV.—*An account of the Maori manner of preserving the Skin of the Huia*, Heteralocha auctirostris, *Buller*. By J. D. ENYS.

[*Read before the Philosophical Institute of Canterbury, 3rd June, 1875.*]

WHILE spending the latter part of the last winter (1874) on the East Coast of the Wellington Province I had the opportunity of observing the way the Maoris preserved the skin of the Huia (*Heteralocha auctirostris*). The party I saw most of were two brothers, whom I met at the edge of a large forest, on their return from their expedition. Their equipments were few, consisting of a small blanket, a gun, and a slight stock of provisions. So provided, they started off into the bush, and calling the birds by an imitation of its note, which is well expressed by the native name Huia, they bring them within range of their guns. Formerly they killed them with small sticks. The bird is skinned, leaving both mandibles as well as the wattle attached, but both wings and legs removed. The skin is then stretched by three small sticks, placed one above the other, and stuck on a forked stick inserted in the ground in front of a fire, the inside of the skin is turned towards the fire so as to dry the skin ready for packing; the tail is carefully bent back behind so as not to dirty the white tips of the feathers. When dried, the under side of the quills of the tail feathers are cut away carefully, so as to render the feathers more flexible.

A piece of Totara bark (*Podocarpus totara*), about two feet long and five feet wide, is prepared and bent double in the middle, the ends being rounded off. The dried skins with the tail feathers bent back over the back as dried, are placed between these thin pieces of bark, and are then ready for being sent away to the Waikato and Taupo country, where they are most valuable articles of exchange.

The slaughter that came under my notice last year was so large, that I fear, when the country is more opened up the poor Huia will become extinct, a fate I shall much deplore, as any one who has once seen this most graceful bird alive can only regret that he has not oftener a chance of doing so.

I am glad to say, one inducement to its destruction is wanting, as it is reported by all who have cooked it, to be a tough morsel. I ascertained that over 600 skins were procured last year, from the back ranges of the East Coast of the Wellington Province, by the natives. I may mention, that, part of the ranges had been *tapu* by the natives, for the last seven years, so as to protect the Huia from being killed off.

I exhibit a specimen, obtained with some difficulty, from one of the brothers mentioned in the beginning of this paper.

Art. XXVI.—*Notes on the Introduction and Acclimatization of the Salmon.*

By James Stewart, C.E.

[*Read before the Auckland Institute, 6th December, 1875.*]

The recent importation into Auckland of healthy Salmon Ova, and successful distribution of them by Mr. Firth in the upland tributaries of the Waikato and Thames, has drawn renewed attention to the subject of the introduction of this splendid fish into New Zealand. Happening to be on my way to Waikato on the morning on which Mr. Firth left with his charge, I can bear testimony to the completeness of his arrangements, and the care and forethought brought to bear on the most minute details of the enterprise, which, favoured by very unseasonable weather, but, on that account, all the more favourable to success, enabled him to distribute the living ova in waters over a wide area of country, and, so far as possible, with the present venture, secure many chances of success.

The subject and discussions naturally arising from it on that journey, awakened, in my mind, memories of almost forgotten scenes and experiences in pisciculture in the old country. At intervals, during my absence of a week in the Waikato, I was enabled to recall my early observations, and study the matter in the light of present requirements, and as a small contribution to the cause, I have now the honour to lay before this Institute, and my fellow-colonists these notes, in the hope that the work will not be allowed to rest with the present venture, but will be prosecuted anew, and with the certainty of the same success attending it as has been achieved in the introduction of the Trout.

By way of explanation of what may be deemed interference with the work to which many able minds and hands are devoted, I must premise that I have had the honour of being early and much connected with the artificial propagation of salmon. I believe all who have ever felt interest enough to enquire into the natural history of this fish, and keep in mind the facts now admitted as the singular points of its development and growth, have heard of the great salmon-breeding establishment at Stormontfield on the Tay, and many are, no doubt, quite familiar with the plans and details of it. The Stormontfield Salmon Works were designed in the latter end of 1853, by Mr. P. D. Brown, M. Inst. C.E., of whom I was then a pupil. I was honoured with a large share in the arrangement and design, and was entrusted with the whole of the details and supervision of the contracts. These works have been often described, and their results debated. Savants from many countries have visited them, conversed with the careful and intelligent Superintendent, Mr. Peter Marshall, widely known as "Peter of the Pools," and the results of these observations have been given to the world of science year by year. But to one who had the interests and anxiety inseparable from the execution and working of so novel an undertaking, the opinions, deductions, and criticism of naturalists had an interest different from that with which the public in general could receive them; and now, on reviewing the doings in the way of introduction and acclimatization in the Australian and New Zealand Colonies, carried on during the past twelve years, with as yet but partial success, I am led to the conviction that the subject is by no means a very difficult one, and that, if a truly Colonial attempt is made, with proper arrangements, the result will be thoroughly successful.

An important point, bearing on the transit of the ova, was observed during the first winter's incubation at Stormontfield, and is, I find, not generally known. This is, the possibility of freezing the ova solid with the water for considerable periods without destruction to their vitality; and another well-known fact, on which I am sure the whole success of the acclimatization depends, has, in the recent venture in the Waikato and Thames —from the unexpected nature of the case—necessarily been dispensed with, I refer to the necessity of keeping the young fish for one or two years safely in streams and ponds. Regarding the first point above mentioned, I wish to guard against holding it as absolutely proved, beyond the extent to which my own observation went; and I am not aware of having observed any public notice of the facts, which are these:—In the design of the works it was foreseen that the shallow water in the hatching-boxes, would be, if unprotected, frozen solid in winter, and it was assumed that such an event would destroy all chances of incubation. With this in view preparations were made for the use of a fine stream of spring water, rising in the woods to the eastward, and on the opposite side of the lade, or canal, from which the works draw their water. The pipes from this spring were not, however, laid when that season's stock of ova was deposited in the boxes, filling, I think, 276 of them and leaving twenty-four empty. The frost set in with severity before the spring-water—which had a constant winter temperature of about 45° Fah.—could be turned into the filtering-pond, and the boxes began to freeze. Immediate steps were taken to cover them with hurdles and straw, and with the rough woollen blankets used by the fish-merchants in despatching their salmon packed in ice to the London market. Before this was accomplished, however, two lines of boxes were frozen to the gravel, and were soon shapeless masses of ice. The frost lasted one month, and, in the thaw, the ice in these two lines of frozen boxes was broken up into lumps, in which the ova were seen retaining their natural appearance. Such an opportunity for experiment was not to be overlooked. The lumps of ice and imprisoned ova were deposited in the water of the boxes which had not been stocked. From the protected boxes, 252 in all, much ice, containing more frozen ova, was gathered and put with the rest, all of which quickly thawed, and the eggs were found in the gravel presenting a perfectly healthy appearance. The result was, the ova, which had been frozen during one month, was one month longer in the incubation, and, so far as I remember, produced just the same proportion of fish as the others which were kept above the freezing point. It was then remarked that, if the ova would keep safely in solid ice during one month, they would most likely do so for three or four, and so solve the problem of transit through the tropics. Although I am not aware of this circumstance having been remarked by writers on the subject, I notice that, in one instance, it is taken for granted that the freezing of the ova for a few days, or at most for a few weeks, is certain destruction to its vitality. It will most likely be found to depend on the period at which they are frozen. In the case mentioned the weather had been freezing from the date of spawning; but not with severity sufficient to freeze running water, so that, practically, the process of incubation had not commenced.

The possibility of, by this means, transporting healthy ova to the antipodes, became so familiar to my mind, and I judged it to be so well known, that when the (I believe) first attempt was made to effect it in the ship "Beautiful Star" in 1862, and failed, from the length and generally unfavourable voyage causing the ice to give out, I attributed it to the method of solid freezing having been ignored.

It is sufficiently proved, however, that the method of packing in moss and ice, and stowing in an ice-house, is capable of preserving the ova in vitality sufficiently long to land them here in safety, so far as incubation is concerned. But I am convinced that it is a most important point to cause the period of incubation after deposit in the boxes on the breeding-grounds to be as long as possible, or at all events as near to the natural average period as can be attained. I believe the average at Stormontfield is 120 days, and nothing quite so long can be looked for; but it seems natural to suppose that ova landed here, with the certainty of being hatched in a few days, perhaps hours, will not have the same chance of producing healthy fish as those which experience the acclimatizing influence of two months in a cool southern stream during incubation. It may be admitted, however, that, by the exercise of very great care in the non-freezing method, the temperature may be kept so low as will effect the above end. But, if the solid method could, with certainty, be resorted to at the time of spawning, the trouble, bulk of stowage, and anxiety on arrival in the Colony would be reduced to a mere nothing.

The management after incubation, and the nursing, is the most important point, and is a subject fraught with some difficulties. If it is an essential part of the Stormontfield scheme—where the young fish or par, are in their natural waters—that they should be carefully tended for one and two years, how much more so is it important that they should so cared for here, when, acclimatization has in addition to be effected. Remembering the helpless state the young fish are in for nearly six weeks, with the ovum adhering as an umbilical sac, the numerous enemies in the eels and crayfish, of which they have to run the gauntlet, and above all, that for one and two years they must remain in a helpless condition, before migrating to the sea, it is not probable that, of the ten thousand ova which have now been distributed in the Waikato and Thames waters, there is a reasonable good chance of one returning from the sea as a grilse. Very helpless indeed, the young par are, as they are to be seen in the lower canal at Stormontfield, in thousands, during May and June, ready to pass into the nursing pond, and such, in unprotected waters must suffer fearfully. This points to the true cause of the Stormontfield success. It is not so, because it is a breeding place merely. Its nominal capacity is for 300,000, its utmost power of production under half a million, the produce of perhaps fifty fish, from one spawning bed out of a hundred or two beds equally good. Millions of fish are, no doubt, hatched naturally in the Tay each year, and that the comparatively small number bred at Stormontfield, told favourably on the river, can only be explained on the supposition that of the numbers of *smolts* reared in the river and artificially, the latter bears to the former a high ratio. In the ponds, the mortality is small, and loss from enemies nil. The smolts when sent to the river, remain there only so long as enables them leisurely to reach the sea, where in their natural feeding grounds they rapidly attain size, and return to their rivers again as grilse.

Although par are exceedingly difficult to transport with safety, it has been accomplished; and to considerable distances. But it would be better to prepare nursing streams and ponds, even at every river-basin whose waters it is intended to stock. It is well known that the salmon do not, as a rule, return to any stream, but that from which they proceeded to the sea. These ponds and streams need be of a very simple design, the requirements being, plenty of cool, clear, and well aerated water, with good current over basaltic shingle. And of course, protection from floods and the entrance of eels. In this manner a colonial scheme ought to be entered into and carried out. But the details of the scheme are by no means few, and would necessitate careful study. The introduction should not be confined to one year, but a second, or even a third lot of ova would be desirable. The scheme could be capable of sending to sea each time, through every river selected as suitable in the colony, not less than ten thousand smolts, and perhaps 200,000 in all each year. And if some doubt attaches to the suitability of such rivers as the Waikato and Waipa, none can be expressed in regard to the magnificent shingle beds of the rivers of Canterbury and Otago, and other Southern Provinces. I can see no reason against these grand counterparts of the Tay, Dee, and Spey, becoming waters teeming with salmon, descended from progenitors which have not their equals for combined size and quality in the world, Salmon of 71 lbs. and 64 lbs. have been taken in the Tay. Fish like these are worthy to be the ancestors of future denizens of the Clutha and Waitaki, and let us hope, if only hope, of the Waikato also.

ART. XXVII.—*Contributions to the Ichthyology of New Zealand.*

By Captain F. W. HUTTON, C.M.Z.S.

[*Read before the Otago Institute, October 26, 1875.*]

THERAPON (?) RUBIGINOSUS. sp. nov.

D. $\frac{11}{12}$, A. $\frac{3}{10}$, L. Lat. 80, L. Trans. 12/23.

Length three times the height of the body, or four times the length of the head. The diameter of the eye goes three and a half times into the length of the head. Scales ctenoid. Body compressed, the greatest height under the third dorsal spine. Mouth small, nearly vertical. A series of very minute teeth in each jaw; palate, apparently toothless. Praeoperculum denticulated on its posterior margin, smooth below. Operculum smooth, armed with two small flat spines. Dorsal single, deeply notched, the third spine, which is the longest, goes nearly two and a half times into the length of the head. Spines of the dorsal and anal very strong. Anal and soft dorsal half covered with scales, the spiny parts scaleless. Caudal and exteriors of pectorals and ventrals partly covered with small scales. Caudal forked, each lobe about equal to the length of the head. The dorsal commences at the base of the ventrals, and ends at a distance from the caudal, equal to about two-thirds of the length of the head. Pectorals pointed, the upper rays the longest, but not so long as the head, and not extending so far back as the points of the ventrals. Ventrals inserted behind the pectorals, and extending to about one-half the distance to the vent.

Colour apparently reddish, fading to greyish-yellow.

Total length of the specimen, sixteen inches.

Otago.

This fish is described from a single stuffed specimen in the Otago Museum. It differs from *Therapon* in the oblique cleft of the mouth, the forked caudal, and the greater development of scales on the vertical fins; but I hesitate to draw up generic characters for it, until I can get a fresh specimen.

TOXOTES SQUAMOSUS.

D. $\frac{5}{23}$, A. $\frac{3}{23}$, P. 20, V. 1/5, L. Lat. 85, L. Trans. 11/18.

Length two and a third times the height of the body, or nearly four times the length of the head. Length of the snout equal to the width between the orbits. A single row of teeth on each palatine bone, none on the vomer. Teeth in the jaws cardiform, the exterior row on the inter-maxillaries larger. Diameter of the eye goes three and a half times into the length of the head. Maxillary extends back nearly to the vertical from the centre of the orbit. Operculum, præoperculum, and maxillary, scaly, their margins smooth. Dorsal and anal fins covered with scales. The first soft ray of the dorsal and anal longest, behind which the fins suddenly contract, and then maintain a uniform level along the tail. Pectorals, long and pointed. Ventrals, small, with a set of elongated scales just above the base of each. Caudal, deeply forked, the lobes equal to the length of the pectorals. Colour, uniform, silvery, getting darker on the back.

Total length of the specimen, 22-inches.

Habitat, Cook Strait.

This description is from a stuffed specimen belonging to W. T. L. Travers, Esq., who kindly sent it to me for description. He informs me that several years ago he saw other specimens of this fish on the shores of Massacre Bay.

In general appearance it much resembles *T. jaculator*; but, besides the differences in the fin rays and scales, the anterior superior profile of the snout is more blunt; the vertical fins are more deeply contracted behind the first soft rays; the anal spines are much more slender; and the spinal portions of the fins are covered with scales equally as much as the soft portions.

HAPLODACTYLUS MEANDRATUS. Solander.

Granite Trout.

Sciæna mæandrites, "Sol. Pisc. Aust.," p. 2; *Aplodactylus meandratus*, Rich., "Trans. Zool. Soc.," Vol. III., p. 83, and "Dief. New Zealand," Vol. II., p. 207; *Haplodactylus donaldii*, Haast, "Trans. N. Z. Inst.," Vol. V., p. 272; *Chironemus georgianus*, Hutton, "Cat. N. Z. Fishes," p. 7, *non*.

Specimens of this fish, both from Dunedin and Bluff Harbours, are in the Otago Museum. They answer very well to Solander's description, as given by Richardson in the "Trans. Zool. Soc.," except that Solander makes only one anal spine, instead of three. However, his description of the peculiar colouring leaves no doubt as to the identity of the fish.

AGRIOPUS LEUCOPŒCILUS. Richardson.

Pig Fish.

General colour, brownish. A band along the lateral line, pink, with irregular transverse black blotches. Above and below this band the sides are more or less tinted with orange, and irregularly marbled with black. Opercles, pink. Dorsal, dark, with a broad medial white band, beginning at the third spine, and gradually tapering away towards the end of the spinal portion; tips of the spines, orange. Soft dorsal, tipped with white. Caudal, whitish, with a dark vertical band in the middle. Anal, dark, anteriorly; whitish, posteriorly. Pectorals and ventrals, brownish, the rays tinged with orange.

XIPHIAS GLADIUS. L.

A Sword-fish was caught in the Waitemata Harbour, Auckland, on the 19th January, 1874, and, from the careful drawing and measurements sent me by Mr. T. F. Cheeseman, I agree with him in referring it to this species. The total length was eleven feet three inches, and the height of the dorsal fin one foot three inches.

SERIOLELLA POROSA. Guichen.

D. $5/\frac{1}{34}$, A. $2/\frac{1}{24}$.

This specimen agrees with the description quoted by Dr. Gunther ("Cat. Fish," Vol. II., p. 407) from Guichen, except that the coloration is steel blue on the back, passing into silvery white on the belly, and with a dark spot over the pectoral fins. The whole body is covered with minute pores. All the spines and rays of the dorsal fin are very feeble and difficult to count. The pectorals are shorter than the head, and twice the length of the ventrals. I can find no teeth on the vomer.

Dunedin, not uncommon.

TRACHICHTHYS TRAILLI. sp. nov.

B. 8, D. $\frac{5}{13}$, A. $\frac{3}{10}$, V. $\frac{1}{6}$, P. 12, C. 7/22/6, L. Lat. ca. 95.

Length two and a quarter times the height, or three times the length of the head. Snout, about half the diameter of the eye, which goes two and two-thirds into the head. Upper maxillary, extending to posterior of orbit, dilated at the end. All the teeth on the jaws, palate, and vomer, very small. Interorbital space equal to the diameter of the eye, convex; scales ending before the middle of the eye. Nostrils and ridges on the top of the head, as in *T. elongatus*. Snout, with two spines, directed forward, one from each ridge. Infraorbital slightly crenated along its inferior margin. Præoperculum divided by a deep channel, which is crossed at the angle by a strong rough projecting spine, which extends to the gill opening. Operculum, with radiating rough ridges and a single spine. Cheeks scaly. Scapular, with a spine equal to that on the operculum. Spines of the dorsal, short and smooth; the third soft ray the longest, as long as the pectorals, which are rounded, and one-fifth of the length of the body. Caudal, forked, composed of 22 soft rays, with seven spines above and six below. Spines of the anal small. Ventrals situated on either side of the vent, slightly behind the pectorals; they extend back to the end of the pectorals. Ventral keel, with eleven scales, each armed with a strong spine directed backward. Colour, greyish-yellow; fins, yellow.

Total length, seven and a half inches.

Stewart Island.

Presented to the Otago Museum by Mr. C. Traill, after whom I have much pleasure in naming it.

LEPTOSCOPUS (?) ANGUSTICEPS. Hutton.

This fish belongs to Dr. Günther's genus *Crapatalus* ("Ann. Nat. Hist." 3rd series 7, p. 87), and is perhaps identical with *C. novæ-zealandiæ*, the description of which I had not seen when describing the species.

NOTOTHENIA MAORIENSIS. Haast.

N. coriiceps (?). Hutton *non* Rich.

B. 6, P. 16, L. Trans. 6/18.

Breadth of the head rather more than three times the interorbital space, which is twice the diameter of the eye. A row of strong teeth in the front in the jaws, inside of which is a band of villiform teeth. Blackish olive above, the base of each scale being darker. Top of the head black. Chin and lower part of the operculum olive-yellow. Belly whitish.

NOTOTHENIA ANGUSTATA. sp. nov.

B. 6, D. 4–5 | 28–29, A. 22–24, V. $\frac{1}{5}$, P. 19, L. Lat. 52–58, L. Trans. 6/13–15.

Length, four and a quarter times the height of the body, or three and a half times the length of the head. Breadth of the head equal to the height of the body. Interorbital space rather more than twice the diameter of of the eye. Top of the head flat, roughened; a bony ridge over each eye extending back to the posterior margin of the præoperculum. Eyes lateral. Mouth wide with rather strong teeth in the jaws, and a band of villiform teeth behind them; vomer and palate smooth. Preoperculum sealy behind the eye, its margin denticulated. Operculum with two points above the shoulder. Lower jaw slightly longer. Nostrils tubular. Spines of first dorsal, flexible. Ventrals in front of the pectorals. Caudal rounded.

Variable in color from dark olivaceous-black, to olive-green slightly mottled with blackish on the back. Lips speckled with white. Axil of the pectorals yellow. Caudal and dorsal blackish. Total length about 14.5-inches.

Dunedin and Bluff Harbours. Not uncommon. Type in the Otago Museum.

This fish and the next differ from the rest of the species of *Notothenia* in having the head not so broad, and the eyes lateral.

NOTOTHENIA MICROLEPIDOTA. sp. nov.

Black Cod.

B. 6, D. 7/26, A. 23, V. $\frac{1}{5}$, P. 18, L. Lat. 91, L. Trans. 12/32.

Length four and a half times the height of the body, or three and a half times the length of the head. Breadth of the head not much more than half its length. Interorbital space, flat, slightly roughened, rather less than twice the diameter of the eye. Præoperculum scaly behind the eye, margin entire, straight, Operculum with a semicircular notch above the shoulder. Eyes, lateral. Teeth, as in the last species. Lower jaw, larger. Ventrals, a little in front of the pectorals. Caudal, truncated. No pores on the head.

Purplish-brown above, greyish below. Throat, gill membranes, axil of pectorals, and opercles yellowish. Total length, about 17 inches.

Dunedin and Moeraki. Not so common as the last. Type in the Otago Museum.

TRYPTERYGIUM COMPRESSUM. Hutton.

This fish belongs to the genus *auchenopterus* of Günther.

TRACHYPTERUS ALTIVELIS. Kner.

A specimen of this fish, preserved in alcohol, is in the Otago Museum, and I am thus enabled to confirm my identification of the dried specimen in the Auckland museum.

PSYCHROLUTES LATUS. sp. nov.

B. 7, D. 9, A. 9, C. 10, V. 2.

Length, nearly three and a half times the height of the body, or about two and three quarter times the length of the head. Breadth of the head equal to its length. Height of the head, about four-fifths of its breadth. Snout rounded, jaws equal; maxillary not extending to the middle of the eye. Anterior nostril with a very fine tentacle. Diameter of the eye about one-third of the interorbital space. Top of the head and operculum covered with soft skin. Operculum produced into a flexible posterior process. The gill opening commences above that process, and is not continuous with that of the other side. Body compressed posteriorly, covered with soft, rather loose skin. Pectorals rounded, the middle rays longest, and extending beyond the vent. The ventrals very short, situated below the middle of the base of the pectorals, and at a distance from one another rather more than the length of the fin; each is surrounded by a fold of loose skin. Dorsal and anal opposite to one another, situated far back on the tail, almost entirely enveloped in skin. Caudal rounded. Vent situated rather nearer the origin of the anal than the root of the ventrals. Dark greyish-brown, irregularly spotted with white.

Dunedin and Bluff Harbours. Type in the Otago Museum.

The following are the dimensions of a specimen :—

	Inches.
Total length	8
Length of the head	2.5
Breadth of the head...	2.5
Height of the body	2

DIPLOCREPIS PUNICEUS. Richardson.

The colour of this fish is olive, but it turns to rose pink when placed in spirit.

TRACHELOCHISMUS PINNULATUS. Forster.

Pale yellowish-brown, marbled and streaked with olive-brown; turning pink in spirit.

ODAX VITTATUS. Solander.

Fresh specimens obtained at Dunedin enable me to complete the description of this fish.

B. 4, D. 34–35, A. 14–15, P. 15, L. Lat. 88, L. Trans. 10/28.

The height of the body is rather more than the length of the head. The distance between the dorsal and caudal is twice the least depth of the tail. Operculum with a rounded point. Small scales on the upper part of the operculum and behind the eye. Top of the head naked. Lateral line feeble, but continuous. Upper surface orange-brown; lower, bright orange marbled, with whitish-brown between the anal and ventral fins. Throat, white. Lateral streak, bright silvery salmon colour. Posterior portions of dorsal and anal, white; the rest concolour with the back and belly respectively. Pectorals, colourless. Caudal, with the membrane, colourless, and the rays getting salmon-coloured near the tip. A few violet spots on the sides.

AMMOTRETIS ROSTRATUS. Gunther.

B. 6, D. 80, A. 57, P. 12, V. Dext. 6, Sin. 4, L. Lat. 90, L. Trans., 34/49.

A fish not uncommon in the Dunedin market, where it goes by the name of "Lemon Sole," agrees so well with Dr. Günther's description of *A. rostratus*, from Tasmania, that I have no hesitation in considering it that species. The chief difference is that, in the New Zealand fish, the height is rather more than half the length.

RHOMBOSOLEA LEPORINA. Gunther.

The New Zealand fish referred by me to this species appears to belong more properly to *R. flesoides*, Günther ("Ann. Nat. Hist.," 3rd series, Vol. XI., p. 117); but the difference between the two species seems small.

RHOMBOSOLEA TAPIRINA. Gunther.

In the "Trans. N.Z. Inst.," Vol. VI., p. 106, I described a flat-fish doubtfully under this name, as the eyes were on the left side. Since then I have examined several specimens in Dunedin, and find that the eyes are sometimes on the right side, and sometimes on the left; consequently my determination is good.

GONOSTOMA AUSTRALIS.

Maurolicus australis. Hector.

A specimen of this fish, presented to the Museum by Mr. C. H. Robson, shows that it is covered with two longitudinal rows of thin scales, and therefore that it should be placed in the genus *Gonostoma*, instead of *Maurolicus*. The teeth, however, are not unequal in size, as in *G. denudatum*.

LEPTOCEPHALUS ALTUS. Richardson.

Glass Eel.

Several specimens of this curious fish have been picked up on the Ocean Beach at Dunedin.

STIGMATOPHORA LONGIROSTRIS. Hutton.

Specimens obtained in Dunedin Harbour were sometimes of a brilliant green colour.

SCYLLIUM LATICEPS. Dumeril.

During a cruise in the West Coast Sounds, in March, 1874, a specimen of this fish was caught in Dusky Bay, and it is now preserved in the Otago Museum. This, therefore, confirms my identification of this species from Mr. Buchanan's sketch in the Colonial Museum.

RAJA NASUTA. Solander.

Snout long and pointed, the interorbital space being less than one-third of the distance from the eye to the end of the snout. Anterior profile, concave; but with a convex sinuosity situated rather nearer the snout than the angle of the pectoral. Teeth in eight or nine series in the upper jaw. The male is rarer than the female, and apparently always much smaller. A specimen obtained last May, from Oamaru, is yellowish-white above, and white below, with distant black spots, which are more numerous towards the anterior end.

Female: Length of body, 24-inches; of tail, 17-inches; breadth, 31-inches.

Male: Length of body, 17-inches; of tail, 13-inches; breadth, 18-inches.

TRYGON BREVICAUDATA. sp. nov.

T. thalassia (?) Hutton. "Cat Fish, N.Z.," p. 85, *non* Columna.

Female: disc, rather broader than long; the anterior margin forming a very obtuse angle, which is interrupted by a short projection of the snout. Body smooth. A single small oval tubercle in the centre of the back. Tail not longer than the body, with a cutaneous fold along the lower side, and no upper ridge; armed with two serrated spines, the anterior of which is the smaller, and in front of these a row of large ossifications. Sides of the tail, with smaller stellate ossifications. Brown above, whitish below.

Length of disc, 44-inches; breadth, 48-inches; tail, 32-inches.

Dunedin Harbour. Type in the Otago Museum.

The end of the tail of this specimen is broken off; but it is probable that it only extended a few inches further.

The tail described in the "Cat. Fishes of N.Z.," p. 85, may probably belong to a male of this species.

GEOTRIA CHILENSIS. Gray.

This species has a broad band of green down each side of the back; the median line and the whole of the lower surface being pale brownish-white.

HISTIOPHONUS HERSCHELLII. Gray.

A specimen of this fish was caught in Dunedin Harbour on the 17th

January, 1876. It agrees very well with the figure given by Gray in "Ann. Nat. Hist.," Vol. I.; but differs slightly in some of the details of the fins and proportion, as given both by Gray and Günther. The head is of the same size and proportions as the one in the Colonial Museum, described in the "Trans. N.Z. Inst.," Vol. II., p. 13.

The total length from the end of the snout to the end of the central portion of the caudal-fin was nine feet eight inches. The height of the body is rather less than half the length of the head, and about one-sixth of the total. The length of the upper jaw from the nostrils is five-eighths of the length of the head. The fin formula is :—

$$D. \frac{4}{35}|6, \ A. \frac{1}{11}|6, \ V. 1.$$

In all other respects it agrees with the description in Dr. Günther's catalogue.

The back and sides are dark slate-blue, the belly whitish. The following are the principal dimensions :—

	Feet.	Inches.
Length	9	8
Snout	2	4
Head	3	6
Snout to nostril	2	2
" " gape	2	8
Lower jaw to gape	1	4
Length of ventrals	1	2½
Height of dorsal	1	3
Diameter of eye	0	2½
Interorbital space	0	7
Height of body	1	7

The skin is preserved in the Otago Museum.

ECHENEIS BRACHYPTERA. Lowe.

A specimen of this fish was obtained on the Sword Fish just mentioned.

D. 16|25, A. 23.

The length of the disk goes four times into the total length, and the width of the body between the pectorals eight times; the caudal is very slightly crescentic, and the upper jaw is angular. The colour was uniform slate blue, and the total length of the specimen 5¼-inches. It is preserved in the Otago Museum.

DINEMATICHTHYS CONSOBRINUS. sp. nov.

D. 75, A. 45, C. 14.

Height of the body not quite equal to the length of the head, two-ninths of the length of the body. Ventrals one-sixth of the total length. Snout, obtuse, longer than the eye, which is small. Nostrils, about half the diameter of the eye in advance. Interorbital space equal to the length of the snout. Palatine teeth confined to an anterior patch only. Operculum with a long spine over the shoulder directed backwards; head naked. The dorsal commences above the anterior portion of the root of the pectoral, and the rays both of it and the anal project beyond the membrane. Anus, with a papilla, but no claspers.

Brownish, paler on the abdomen. Total length of the specimen 3 inches. Collected by Mr. C. H. Robson, at Cape Campbell. The type is in the Colonial Museum, Wellington.

Art. XXVIII.—*Notes on the Habits of the Frost Fish* (Lepidopus caudatus). By C. H. Robson.

[*Read before the Wellington Philosophical Society, 6th September*, 1875.]

These remarks on the habits of the Frost Fish are presented to the Philosophical Society of Wellington, not so much in the belief that they shed any great amount of light upon a hitherto obscure subject, as in the hope that they may incite other members, who have opportunities of doing so, to make observations, so that we shall at last find out why it is that this curious fish commits suicide, or appears to do so. Dr. Hector, in his notes on the edible fishes, attached to Captain Hutton's "Catalogue of the Fishes of New Zealand," and under the head of the Frost Fish, or Hiku of the Maoris, remarks, "Nothing is definitely known of the habits of this singular fish, or why it should be cast up on the land, the probability being that, on the calm nights, when the sea is smooth, it pursues its prey too close to the shore, and is left by the long swell during ebb tide." This hypothesis is, I venture to think, though very ingenious, incorrect. It is true that the Frost Fish usually comes on shore during the cold moonlight nights of winter, but it also frequently lands in Clifford Bay, near Cape Campbell, during the daylight, always when it is calm or with a southerly wind, and smooth water. It has been my good fortune to witness several such landings, and though unable to determine the reason of them, I can state positively that the fish is not cast up by the sea, but that it deliberately forces itself on shore, selecting a shallow sandy beach for that purpose. My first thought was that it came to rid itself of some external parasite, by scouring on the sand; but a careful examination of some fish thrown out of the water by hand, before they could touch the sand, showed me that this was not the case, and that the only parasite with which the Frost Fish seems to be troubled, is an internal one, of which I send herewith a specimen for your inspection. It is a yellowish-white worm, about two inches long when alive, and is usually found inside the fish, not far above the vent, with its head firmly fixed in the flesh, to which it clings with great tenacity. Having discarded the idea that the fish came to rub off parasites, I next thought that it might be blind and not know where it was going, but I soon found out that it could see as well as myself. On two occasions I stood between a Frost Fish and the beach, and, as he came on, turned him with a long stick head to sea, making him swim out, but in a minute or two he turned again for the shore, going up high and dry as fast as possible, so, as he seemed to have set his mind upon landing, I gave up the attempt to influence his decision, and just took him home for breakfast. All the Frost Fish which come on shore here are in fine condition; they seem to be in perfect health, and their landings appear to be deliberate acts of self-immolation. Their food, I believe to be the young of *Clupea sagax* or *Clupea sprattus*, but I have only found one specimen with food in its gullet sufficiently perfect for identification. I have seen one Baracouta forcing itself on shore in the same way as the Frost Fish.

Accompanying this paper, I forward for your inspection a specimen in spirits of the internal parasite of the Frost Fish, and with it specimens of a recent addition to the interesting class of phosphorescent fishes, hitherto represented in the Colonial Museum by *Phosichthys argenteus* and a small fish obtained by Dr. Hector in Milford Sound. A specimen similar to those before you was forwarded to Captain Hutton for identification, and he has written to say that it is certainly a new species.

Art. XXIX.—*Notes on the Sword Fish* (Ziphias gladius).

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 16th August, 1875.*]

Dr. Hector, in a valuable contribution to New Zealand icthyology, printed in last year's volume of "Trans. N. Z. Inst.," introduces the well-known Sword Fish of the North Atlantic (*Ziphias gladius*) as an inhabitant of the New Zealand seas, on the authority of a dried snout obtained by Mr. G. M'Leod from the natives at Ngunguru, and presented by that gentleman to the Auckland Museum. During the last year I have been able to collect some additional evidence of the occurrence of this curious fish that appears to me to be worthy of record.

In the early part of last January an adult specimen was stranded at Shelly Beach; and, through the kindness of Mr. T. Jenkins, I was enabled to secure the greater portion of the skeleton for the Museum, and to obtain the following measurements while the animal was still entire :—

	Feet.	Ins.
Total length from tip of snout to end of caudal fin	11	3
Length of snout from tip to centre of eye ...	3	11½
,, ,, ,, ,, to gape	4	1
,, ,, ,, ,, to free edge to operculum	4	6
,, ,, ,, ,, to nostrils	3	7
,, of lower jaw from point to gape ...	0	11
Projection of upper jaw over lower	3	2
Height of dorsal fin	1	3
From dorsal to caudal	4	0
Length of pectoral fins	1	5
Length of anal	0	8
Height of second dorsal	0	2½
From anal to caudal	1	8
Width across the tail	2	3
Girth just behind the eyes	2	11
,, behind dorsal	4	8
,, ,, caudal	0	11
Diameter of eye	0	3

The extreme point of the snout (or so-called sword) was broken off, about three inches being wanting. This, of course, will require to be taken into account in considering the above measurements.

About two months ago a paragraph appeared in the *Southern Cross* newspaper stating that a Sword Fish was then being exhibited in Auckland. This proved to be a second specimen of the *Ziphias*. On enquiry, I found that it had been washed by a heavy gale into shallow water inside the mouth of the Waikato River, and, being noticed by some sailors struggling among the breakers, was killed, and brought to Auckland for exhibition. Its length was slightly under that of the first example, being less than ten feet, but the proportions were about the same.

A second species of Sword Fish has occasionally been observed on our coasts, belonging to the genus *Histiophorus*, distinguished from *Ziphias* by the round snout and the presence of ventral fins. A good skull is in the Museum, obtained by Captain Mair near Opotiki ; and I recently observed two nearly perfect skeletons not far from the mouth of the Waikato River, but unfortunately had no means of removing them.

Art. XXX.—*Is Access to the Sea a Necessity to Eels?*

By James Duigan.

[*Read before the Wellington Philosophical Society, 4th October, 1875.*]

I have had my attention drawn to a paper by Mr. W. T. L. Travers, F.L.S., published in Vol. III. of the "Trans. N. Z. Inst.," in which that gentleman argues that, inasmuch as there is an absence of Eels in the upper waters of the Waiau-ua and its tributaries, it is necessary that Eels should be able to go down to the sea during the spawning season. Dr. Hector, in his notes on the edible fishes of New Zealand, also alludes to this belief, and gives an extract from a letter written by Mr. Maling, a Surveyor, to Mr. Travers on the subject, in which the writer says, "from my own observations, I think it is absolutely requisite for that fish (the Eel) to have access to the sea. There are three notable instances of it here (Taupo). 1st, In the Waikato River, Eels are found as far as the Maungatautari Falls, and in all the streams that flow into it below them. 2nd, In the Kaituna River, which drains Rotorua and Rotoiti Lakes, Eels are caught as far as the Falls below the Taheke, and no further. 3rd, They are caught in Lake Tarawera, but not in Rotokakahi, the waters of which run into Tarawera Lake, but have a perpendicular fall in one place of 100 feet."

That there is something more than the physical difficulties alluded to at work to account for the absence of Eels from the places named by both Mr. Travers and Mr. Maling, I am firmly persuaded, as I have caught Eels in places more completely isolated from access to the sea than any of those named by the above gentlemen; and, as one instance is quite sufficient to establish the fact that Eels not only can, but do live, in waters having no access to the sea, I shall merely state that they exist in large numbers in Virginia Lake, a sheet of deep water close to the town of Wanganui. This lake has neither inlet nor outlet from the surface, and is some three or four miles distant from the sea, and at an elevation of about 250 feet the above sea level. The natives look upon it as one of their best fishing grounds, and catch large quantities there every season. The fact of the lake, which is in places very deep, having no visible source or overflow, and keeping its level and purity throughout the droughts of summer, at once struck me as indicative of subterranean sources of supply and drainage. On examining the strata in the vicinity, I found the lake had its bed in just such a position as to bear out the hypothesis above mentioned. As a section of it would shew first a greater or lesser extent of blue clay, forming an impervious bottom; next, a varying thickness of gravel lying in the blue clay, which dips at a gentle angle to the sea; above the gravel follows yellow clay, or rather a volcanic mud, containing rolled lava stones, over which a post tertiary deposit of a few feet in thickness has accumulated. It is evident from this that the gravel bed acts as both inlet and outlet, as it drains and filters the water from the high lands to the north of the lake, and carries it down to keep the water of the lake both pure and at a permanent level. When the lake is full, as it always is, the weight of water in it regulates the supply to compensate exactly for what has passed away through the gravel-stratum and been lost by evaporation. It will thus be seen nature has supplied the lake with what is, to all intents and purposes, a "ball-cock," and has further placed it just where it can be best utilised by the people of Wanganui as a source of water supply. I may mention, in support of my hypothesis as to the supply and drainage of the lake, that, where the blue clay bed is exposed on the sea-beach, water flows continually from the overlying gravel.

Returning to the question whether eels can exist without free access to the sea, I may mention that, in Australia, I have caught them in swamps and lagoons hundreds of miles from the sea, and utterly cut off from any possible communication therewith. It is, therefore, plain that there are other reasons than those advanced by Messrs. Travers and Maling, why eels cannot live in the localities they mention. It is more likely that low temperature of the water is the real cause, as eels are notoriously fond of warm, sluggish water, not that the water of Lake Virginia partakes of that character, being always both cold and pure; but even in Lake Virginia they can escape extreme cold by burying in the mud at the shallow end; that they do so is more than probable, as during very cold weather they are seldom seen or caught in the lake. There is one thing quite certain, they cannot leave the lake, which is quite sufficient to controvert the theory of their being unable to exist without having access to the sea.

Art. XXXI.—*On the Habits of the Trap-door Spider.*

By R. Gillies.

[*Read before the Otago Institute, 14th September, 1875.*]

Plates VI., VII., VIII.

Preface.

There are always two departments in the domain of Natural History, the one, that of observation and collection in the field, the other that of classification and description in the study. The cabinet naturalist undertakes the latter, and by his microscope examines and reveals the various functions of the different parts of the animal, their relation to one another, and to other species; measures, records, classifies, and makes drawings for the use and instruction of others. The field naturalist, on the other hand, undertakes the former, and by patient research and observation, studies the animal in its native haunts, finds out what it does, how it does it, when it does it, and why it does it; observes its habits, its food, its enemies, the localities where it is found, and its geographical distribution over the world. To the special training and intimate knowledge of science necessary for the prosecution of the work of the cabinet naturalist, I lay no claim whatever, and therefore on that side of the subject, I shall have little to say. I may mention, however, that through the kindness of Captain Hutton, specimens of these spiders have been sent to the Rev. P. Cambridge, the greatest living authority on spiders in England, and no doubt, in due time, we shall have exact descriptions of each of them, and their precise species and places in their family assigned to them. Any original remarks I may have to make to-night, refer entirely to the other side of Natural History, and I have only to express my regret, that my opportunities for observing these animals during the two years since I first discovered them, have been so few and scattered, that it is with hesitation I bring this paper before you. It has, however, been pointed out to me, that by making known what little I have observed, it may be the means of inciting others more favourably situated to take notice of, and record what they do observe of their habits and skill, and so instead of one observer working at the subject through a long course of years, we may have the recorded observations of a dozen individuals in different localities available for the study of the cabinet naturalist, in a very short space of time.

The great Order *Araneæ* or true spiders, have been divided into seven sub-orders; of these, the fourth, or *Territelariæ*, is the one with which we have now to do. The *Territelariæ* are easily recognised by any one, even apart from their nests. Their falces (mandibles or fangs as they are commonly called, work vertically downwards and are parallel. In other spiders they work horizontally, and cross each other like nippers. They have also four whitish spots or blotches on the under side of the abdomen, near its junction with the sternum, which are supposed to be branchial tubes, whilst other spiders have only two. The specimens now exhibited, clearly show both these characteristics.

How first found.

It may be interesting to note how my attention was first drawn to the subject. My discovery of their existence in Otago was purely accidental. Rather more than two years ago, I was riding slowly through an English grass paddock, near Oamaru, when, on a bare patch of ground, my eye accidentally rested upon a very large spider. Attracted by its size, I kept steadily looking at it, when suddenly, as if by magic, it disappeared. I got off my horse so as to carefully examine the ground, which was very dry and dusty. My suspicions that the spider had rolled itself up in the dust, were soon confirmed, by observing that the earth was a little raised or bulged up at one part, so I took my knife to turn it out of its dirt heap. Judge of my surprise and delight, when no sooner had I applied the point of my knife, than up sprang a beautiful trap-door, revealing a large hole going right down into the earth, lined with beautiful white silk that shone in the sun, and lining the inside of the door, forming a clever and remarkably good hinge. I had no doubt now, where the spider had gone, but having no tools I could not dig it out. I examined this strange novelty for some time, lifting up the wonderful door, and admiring the exactness with which it fitted, the perfect mobility of the hinge, the spring with which it immediately shut down on slipping from the knife, and the marvellous adaptation of the outside of the lid to the existing conditions surrounding it. It was literally peppered on the outside with loose soil, exactly the same as that around, so as to defy detection by any one unacquainted with the way of finding such nests. In fact, though I carefully marked several things near by, so as to find it again; when I returned with a spade I could not find it, and never afterwards came upon this particular nest. Since that time I have taken every opportunity of my being in the Oamaru District, to observe and record what I saw of them, and in the months of October and November of last year, being detained there through illness, I had some weeks of leisure to pursue my investigations, the results of which I now propose to place before you.

Distinctions in the Spiders themselves.

Unfortunately I am not in a position to say what is the name or names of the *Territelariæ* now before you, or to determine whether there is more than one species. Distinctions of species in the *Araneæ* are very minute, and require the skill of an expert to unravel them. Eighteen months ago, Captain Hutton kindly sent home to the Rev. P. Cambridge, a few specimens in a bottle. His reply was, that he thought there were at least two new species previously unknown to science, but his exhaustive examination of them has not yet, through want of time, been transmitted to us. In the meantime, other and better specimens have been obtained and sent home; some of them to Rev. P. Cambridge, and some with the nests they inhabit to the Paris Museum, through the kindness of Dr. Filhol, who was recently amongst us. Captain Hutton, however, permits me to say, that after a careful examination of the specimens now before you, he is inclined to believe that there is only one species, and that the slight differences observable in individuals, will only result in the separation of varieties. One specimen is marked with greyish spots different from others. It was found in

Palpus

Eyes

nat. size

½ nat. size

TRAP DOOR SPIDER AND NEST.

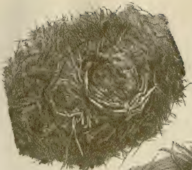
the same locality as the one I first discovered, and may have had a double branched nest, as the soil was so loose and friable, that in digging it out, it was impossible to tell through the nest getting spoiled. Another from the same locality was one of those which were sent home to Rev. P. Cambridge, and it had a side gallery and double trap-door, as shown in sketch No. 1, Plate VIII., which I will describe further on. This is the only instance of this peculiarity which has been observed, and as it was not seen by myself, but by one of my servants, I do not attach great weight to it. It may, however, account for the two different species referred to by Rev. P. Cambridge. Another specimen, and the pieces of the nest, had a peculiar greyish colour different from others. It was found in a different locality, in a very peculiar situation, the foot of the corner post of a stable, and had its trap-door depressed under the general surface of the ground as afterwards described. The *cephalo-thorax* in another, is peculiarly large and broad, and its nest is figured in Plate VII. It was got from a different locality, called the Bobbin Creek, and all the nests in that locality have this peculiarity—they are lined with silk about two-thirds down only, the bottom part being unlined. Specimens of part of this nest are also before you. The spider and young ones in the bottle were from a different locality, the Stable Gully, and several of the young ones had a greenish-blue spot on them, and some of them brown, before they were put into the spirits. Another from the same locality, had a slightly different nest, as seen in Plate VII., and all those from this locality had by far the most ingeniously concealed trap-doors, though the nests were smaller than those elsewhere. Another from the same locality was much darker in colour, and larger, and had a very peculiar nest, figured in Sketch No. 6, Plate VIII., and afterwards described. Another lot of about half-a-dozen, with several young ones, from the same locality, are all of smallish size. They were of a dark olive tint, and turned lighter in colour in the spirits. Some of these were actually got crawling about outside of their holes, and some were dug out. One little one of these was of such a peculiar colour, that I kept it distinct. It was mostly of a pale bluish-green or greenish-blue colour, and some parts colourless. It was quite different in colour to every other one I ever got, so I hope it may be a male, as males are very rare, and difficult to get. These are really the only differences readily noticeable in the spiders themselves, beyond differences of size. There are greater differences, however, in their nests and trap-doors, &c., which will be noticed further on, and which may help in the determination of their species.

Nests, how detected.

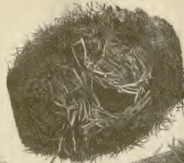
We come now to their nests, and I think I cannot do better than at once give the clue whereby to detect the presence of their nests. The spider tunnels down a comparatively deep hole, through the surface soil into the clay or differently coloured subsoil beneath. This subsoil it brings up last, and generally carries to some distance from its hole (from one to eighteen inches), and forms a spoil-bank there; the excavated stuff is all cemented in a peculiar way, afterwards described, but this does not prevent the rain from gradually washing it away, more or less, thereby discolouring the surface soil, for a short distance, with the differently coloured sub-soil. For instance, if the surface loam be black, and the subsoil yellow clay, there is no difficulty whatever in detecting them, as the yellow mark remains, even after the spoil-bank has been washed away; and, as the spoil-bank is always on the lower side of the nest, all you have to do when you see such a mark, is to look from six to eighteen inches above it, according to the lay of the ground, and it will be strange indeed, if you do not detect somewhere, a little round ring on the ground, or amongst the herbage, marking the lip of the trap-door, where it fits to the beveled mouth of the nest. I do not say you will find every one this way, for some are so skilfully concealed, as to defeat every search made for them, and others (specimens of some of which are before you), were only discovered by accident, and would never, I believe, have been discovered in any other way; the above, however, gives a clue which aids immensely in the search for them.

Nests and their distinctions.

The nests are in reality, tunnels of varying size, dug into the ground, and lined more or less with silk of varying thickness and consistency, and with a lid or trap-door hinged to the mouth. Moggridge distinguishes four types of trap-door nests (see page 79), in the world at large, and names them. First, the single-door cork nest, or shortly, the cork nest; second, the single-door wafer nest; third, the double-door unbranched nest; and fourth, the double-door branched nest. The distinction here drawn, between the first and second type consists in the thickness of the door; the cork nest, having a thick door beveled at the edges and fitting tight; the wafer nest, having a thin door. I am inclined to think, that so far as the Oamaru species are concerned, this distinction will not hold good, that is, on the supposition that the individuals forming a colony in any one place are likely to be of the same species, for, notwithstanding that I had this distinction always in view, I never was able to detect any such marked differences in the thickness or fitting of the lids in different localities, or in different colonies in the same locality, as to be specially noticeable. Cork nests and wafer nests were found in all localities, and, in fact, amongst the scores of nests I have examined, this distinction does not hold good. Doors of all degrees of thickness are to be found, and of all degrees of neat-



Trap door shut.



Trap door open.

Trap door shut

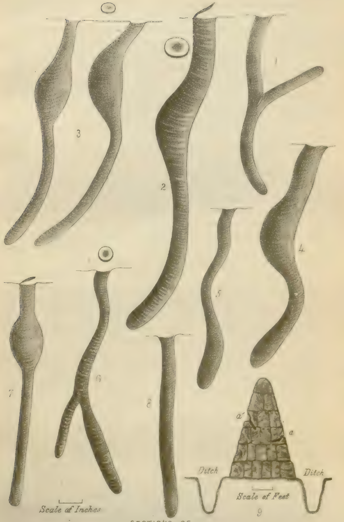
Trap door open.

NESTS OF TRAP DOOR SPIDERS.

ness of fitting and workmanship. As to the third type—the double-door unbranched nest—I can say nothing at all, as no instance of this peculiarity has come under my notice. It may, however, be found, and, if found, might, I think, prove a good distinction. Of the fourth type, the double-door branched nest, only one specimen has been found, and that not by myself. One with a branch filled up, but, apparently, with no door fitted to it, was found by me, and is figured in Sketch No. 1, Plate VIII. So far, therefore, as my investigations go, these distinctions as to the types of nests are of little use. There are other distinctions, however, in the Oamaru nests, which, if I felt myself in the position to generalise, I should be inclined to take as the basis of different types of nests. One of these distinctions is, nests with enlargements, or bellied nests (as represented in Sketches Nos. 3, 5, and 7, Plate VIII.), and nests of a somewhat regular width (as represented in Sketches No. 6 and 8, Plate VIII.) This distinction I found almost always to hold good between two different localities, the Bobbin Creek, and the Stable Gully. Another distinction I found also to hold good between these localities. In the Stable Gully, where the nests are regular shaped, they were always lined to the very bottom, and the silk lining was always decided and good; whereas in the Bobbin, with bellied nests, the lining only extended two-thirds down the nest, and was neither so regular, nor so like silk. There is also a marked distinction in the degree of sinuosity, in the shape of the nests in the two localities—those in the Stable Gully, as a rule, being much straighter. There also the trap-doors are much more ingeniously constructed, and concealed, than in the larger and bellied nests in the Bobbin, as will be more fully described further on. I do not put these differences forward as distinctions arrived at after mature study; for, as I have said, I do not feel myself yet in the position to generalise. We want more facts, and more observation, to enable us to classify, but I only indicate them, as far more marked distinctions in the Oamaru nests, than those put forward by Moggridge. I am very much inclined to think also, that locality, the nature of the soil, the existing conditions of the surface around, have very much to do with the type of the nest, and that it will yet be found that the same spider, in different localities, under different conditions of soil, and with different descriptions of covering on the surface, will construct an entirely different type of nest. Moggridge, himself, in one place (page 85), seems to have had some such thought present with him, as he says: "We shall find, we cannot as yet, make any rule as to the kind of nest which we may expect from a given spider. It will be seen that species belonging to the same genus, and closely resembling one another, sometimes build dissimilar nests, whilst others belonging to different *genera*, and unlike in many important respects, construct almost identical nests." If I am right in this idea, of the varying type being the result of different conditions of soil, etc., it opens up a wide field for thought, for it carries with it, the ability on the part of each individual spider, not only to estimate the conditions under which it is about to pursue its work, but to adapt the mechanical contrivances it makes use of, to the varying conditions that arise, displaying an amount of artistic and engineering ability and judgment, that quite transcends all our ordinary ideas of habit and instinct—but I must not enlarge on this.

Localities where Observed.

The locality where I have observed the *Territelariæ* is in the Oamaru district, North Otago, about ten miles in from the coast, and the particular situations there, in which my observations have taken place, are six, known locally as follows :—The Cultivation Paddock, the Stable Gully, the Woolshed Fence, the Bobbin Creek, the Awamoko River Terraces, and the Waiareka Valley, at Elderslie. The distances of these places from each other vary from one quarter of a mile to eight miles. In the Waiareka Valley they were observed on the flat in the bottom of the valley as well as on the sunny faces of the terraces above. This fact seemed very peculiar to me, as undoubtedly they are within the reach of ordinary floods of the Waiareka, when the river overflows its banks. At the time I observed them, the ground was very spongy and damp, and had been recently flooded, and yet the holes had no water in them. They bore evidence, however, of recent labour having been expended on them, in the fresh-excavated subsoil not far from the holes. They were very numerous, large, sinuous, and deep, and easily distinguished by the different coloured sub-soil showing on the surface. Now, the question immediately suggests itself, what became of the inmates whilst the ground was covered with still water? Did they migrate to the terraces, not very far off, or did they remain in their holes? From what I have observed since of their habits (as afterwards described), I am inclined to think that they will rather die than desert their nests, and that, therefore, the owners of these nests remained in them under water. This necessitates that the silk lining acts as cement, and is capable of keeping out wet, and also that the lids fit so closely as to prevent water passing between the lips of the mouth. It, also, would require that the occupants should be capable of existing in their nests for a considerable time without more air than happens to be in the particular nest. As to the nests keeping out water, I confess that I cannot very well see how the spiders could exist in these earth-tunnels in our wet climate, and with the soil in many seasons saturated with rain and snow, unless it were so. It is difficult, on any other hypothesis, to account for the nests remaining free from water, and from the damage inseparable from the presence of water and hard frost. Let



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NESTS OF TRAP DOOR SPIDERS.

any one just bore an inch augur-hole a foot into the ground, and cover it, to prevent the actual beating of the rain on the mouth, and see how long the hole will remain perfect, or free from water, even in a very ordinary season. It must be borne in mind, too, that almost always the mouth of each hole is on flat ground, even though it may be on the face of a terrace, and though I have watched narrowly to detect if there were anything in the configuration of the ground, or in the spots selected, that might act in the way of turning off surface water from the mouth of the nest, I never could detect any; on the contrary, instances were not unfrequent where the actual surroundings of the mouth of the nest made it a matter of certainty that, during heavy rain, the surface drainage would be directed towards the nest, and would lodge there. An instance of this, on a small scale, is seen in one case, where the depressed mouth of the nest was underneath the drip from the stable-roof. As to the other necessity alluded to above, that of the spider existing for some considerable time with very little air, it will be seen further on that I have repeatedly found the living spider in its nest with the trap-door sealed up and plastered over with clay on the outside, and specimens of the lids so sealed up are now before you, and with no other visibile means of ingress or egress. This, I think, indicates the same thing—that the spider can exist with a very small supply of air.

Aspect of the situations where found.

With regard to the general situation of the nests. Those found in the Woolshed Fence, as represented in Sketch No. 9, Plate VIII., were always found on the southern or shady side of the sod wall. But it must be remembered that a sod wall gets heated up very much with the sun's rays, and is peculiarly dry and warm. In the sketch a nest is drawn on each side, but this is to show the two styles of mouth without drawing another fence. In all the other situations, where I have observed them, the nests are always on northern or sunny slopes of greater or less steepness, never in stony or rocky ground, and never actually in the face of a bank so as to be the cause of the trap-door shutting to by its own weight, but always each nest on a little bit of flat, or almost flat, ground. So much is this the case that, even in the sod wall (Sketch No. 9, Plate VIII.) the nest is not tunnelled in at right angles to the slope of the wall, and the trap-door does not hang at the angle of the wall, but a little platform is excavated flat, or nearly so, out of the wall, and on this flat the nest is excavated vertically at first. These may appear to you minute distinctions; but they are such as distinguish the Otago species from those found elsewhere, for Moggridge, writing of the Mediterranean species, says (page 88)—"All these Trap-door Spiders seem usually to prefer rather moist and shady places and sloping banks, or loose terrace walls, where the interstices between the stones are filled up with earth, etc. ;" and again, (page 91)—" I have very seldom seen nests on the flat ground, where the door would lie horizontally when closed ; a sloping or nearly vertical bank being usually chosen, where the door will fall to by its own weight ;" and Costa, in his " Fauna del Regno di Napoli," *Aracnidi*, page 14 (translated by Moggridge, page 138) says they live " in shady places, and for the most part, turned to the north, or to the west, seldom to the south ; hence cool and rather damp." So that you see the habits of the Oamaru species, in regard to the situation of their nests, so far as observed, are exactly contrary to those recorded from other parts of the world.

Shape of the Nests.

The nests, though cylindrical, are often very irregular in form, as you may see by the specimens before you, and in this they evidently differ from those described and beautifully drawn by Moggridge, all of which, whatever their type, seem to be even and regular in form. The direction of the holes is always downwards, no instance of one turning up having been observed ; but they are all more or less sinuous, those in the Bobbin Gully, especially, being very tortuous, and bend in all four directions, north, south, east, and west. In this there would appear to be a difference from all other recorded species, as the rule with them would appear to be that they are mostly straight, and only in the case of the double-branched nests are they " double-bent." But the great difference between the Oamaru nests and others in general form, is in the enlargements which occur frequently in the tubes. This is a very marked feature, especially in the nests in the Bobbin, where the enlargements are often double the normal diameter of the nest. Sketch No. 3, Plate VIII., shows one in which the normal diameter of the hole is under an inch, and the enlargement is fully two inches. These enlargements are sometimes nearly up at the top of the nest, within an inch of the trap-door, as in the nest No. 2, Plate VIII., now before you, and sometimes half-way down. In only one case (figured in Sketch No. 5, Plate VIII.), was there any marked enlargement in the bottom of the hole, and this nest was the only one from that particular locality (the Stable Gully), which had any enlargement at all. The enlarged chamber is generally of an elongated form vertically, and more extended on one side than on the other ; but this latter characteristic may be only apparent, as from the sinuous outline of the nests, it is not easy to tell the exact form when cutting out a vertical section of them. In Sketch No. 7, Plate VIII., is an instance of a nearly straight nest, with a chamber extended pretty equally on all sides, and with a very long and narrow tube (proportionally) descending from the enlargement.

Use of Enlargement.

For some time it was a great puzzle to me what this enlargement was for; but, accidentally one day, I had the puzzle completely solved, as will be seen from the following extract of my note-book:—"In digging one out, we cut across another large hole about two or three inches below the surface of the ground, the trap-door of which we did not detect on the surface. We had cut it across, just at the top of the wide part, and there inside, we saw suspended by silk threads to each side, in the centre of the enlargement, a beautiful, dazzling, white cocoon, with the golden-yellow eggs shining through the silk covering of the cocoon. It was fully distended, and glistening bright white and yellow in the glare of the sunlight, which shone full upon it. The spider was embracing the side of the cocoon, and there was room left for her to pass up or down the nest on either side (of the cocoon)." Part of this nest, with the cocoon in it, is now before you; though the cocoon got torn and soiled in digging the nest out and subsequently in transporting it here. I found cocoons suspended in the same way in the enlargements of many other nests, so that there is little room to doubt that the wide part is for the purpose of suspending the cocoon, and giving free access around it; and here I may remark—though it is somewhat anticipating what I have to say further on as to cocoons—that we must not jump to the conclusion that only nests with enlargements will have cocoons or young ones in them, for I found many nests with young ones which had no enlargements whatever, and some with cocoons without any decided chamber. As a rule, almost all the nests at the Bobbin had enlargements in them, whilst those in the Stable Gully had none. I may mention, also, that the nests at the Bobbin had often horizontal markings, or small ridges, running round the tubes like rings, or like the marks left by a large augur in boring through wood, and that the mouths of them all, but especially the large ones, and their trap-doors, are most decidedly oval, and are beveled off in the lips, so that the lid fits like a flap, and is often depressed in the centre.

Size of the Nests.

As to the sizes of the nests, they vary from eight inches deep to fourteen inches vertically, or fifteen inches round the bends, whilst the width of the mouth, and of the trap-door, varies from half-an-inch to an inch, at least in those I examined. There were also many narrower; but they are more difficult to detect, and to examine. Sketch No. 3, Plate IV., you will notice, is about half-an-inch at the mouth, widens out to an inch and a-half at the enlargement, then suddenly narrows in to three-eighths of an inch, and then widens to half-an-inch to the bottom of the hole. Another was fourteen inches deep, one inch wide at the mouth, widened out to about two inches, and then narrowed to three-quarters of an inch down to the bottom.*

How they occur and numbers.

They occur in large numbers, scattered more or less all over the ground, but more frequently in colonies in favoured spots facing the sun. I have counted seven near each other, within a radius of two feet, and on another occasion, five within a radius of a foot, and, again, seven within a foot and a-half; and almost invariably, in digging out a nest, we cut across others which we had not detected on the surface. In any of the localities I have mentioned they are to be got literally by the hundred. They are more numerous where clay is the subsoil, or at any rate they are more easily seen there from the discoloration caused by their excavations, and very hard-baked clay does not seem to discourage them, as you will see by the nest No. 4, which was just as hard and compact when it was dug out as it is now. Loose friable soil, or even soil that has been stirred and cultivated with the plough, does not inconvenience these clever engineers; but it is almost impossible to obtain specimens of nests from such soil. Indeed, I may say, that the work of obtaining specimens of the nests is at all times one of considerable labour, patience, and often of disappointment, and occupies a great deal of time. I have tried stuffing the nests with wool, as recommended by some authorities; but found the experiment not satisfactory, as you will see by the specimen No. 28. This is, however, the only way I know of to obtain nests in loose friable soil.

Lining of the Nests.

The silk lining of the nests I always found continuous to the bottom of the holes, with the exception of those at the Bobbin, where it generally ended about two-thirds of the way down. The silken cloth was generally tougher and thicker here than elsewhere, being more like fine leather than spider's web. It was generally thickest at the mouth, and became thin as it extended down the hole, till it ended altogether before reaching the bottom. Some parts of the nests were double lined, the old part of the nest being outside and the new patch inside. This probably indicates where some weakness in the wall of the tunnel had shown itself, or where some water found access to the dwelling of this sturdy miner, and how it was shut out by a coffer-dam. In nest No. 2, the lining was very thick silk, and generally in the Stable Gully the nests are well lined and well woven, although they are generally of small size; whilst in the cultivation paddock, they are much thinner and more fragile to handle, even in the case of large specimens. This is all the more remarkable, as there the soil is loose and friable, and has been cultivated, and it is there we would naturally expect the toughest and best woven webs, to prevent the soil tumbling in,

* Since writing this, Mr. John Reid informs me he has obtained nests three feet deep.

whereas, the nests at the Bobbin, and the one at the Stable, had, by far, the toughest and best lining, though the soil is such as to remain secure and solid without any protecting web. This leads me to think that the lining of the nest serves other, and more important, purposes in the household economy of the inmate, than protection from the clay tumbling in. Probably prevention of damp, or exclusion of worms, ants, and other under-ground intruders, and the age of the nest, have all something to do with it. The lining is always more or less incorporated with the soil, so that it is difficult quite to separate them, and it is invariably neatly finished off, and fitted to the bevelled mouth (when it occurs), as seen in the specimens before you. The lining is continued up on one side forming the hinge, and widening out in a circular form into the trap-door. At the hinge, and for a short distance below it, the lining is often double, or thickened, but this is not the only, or principal cause of the spring which all the doors have, as indicated by some writers.

Hinge of the Trap-door.

That the trap-doors have always a decided spring causing them to fall quickly, and with force, into their position, and preventing them from tumbling back open, is beyond question, as any of you can test for yourselves, by lifting up any one of those now before you, with the edge of a pen-knife. But this is caused mainly, I feel sure, by the peculiar shape of the hinge, and not by its thickness. The hinge and trap-door is formed, as I have said, by the extension upwards of the silk lining of the nest, and by its being folded over at right angles to the tube. The mouth of the nest is, you will recollect, circular and the hinge is not simply a tag connecting the lining with the door, but extends along from a fourth to a sixth of the whole circumference of the mouth. It is therefore in reality an arc of a circle of from 90° to 60° in length. If the circular lining of the nest were simply folded over, as I have said, it would cause a fold or loose crease at both sides of the hinge, though it would be tight in the centre. Now this is not the case, but the hinge is equally continuous and tight at all parts, it is, in fact, woven into a bend like the heel of a stocking, and not merely folded over. The consequence is, when the trap-door, which is stiff, is lifted, the outer edges of the hinge are opened further than the centre, and are strained tight, and when the door is let go, the elasticity of the material of the hinge brings down the door with a spring. It is almost impossible to turn the trap-doors right over backwards, without injury to the hinge, or to keep them open, without tying them back to something near. I feel sure you cannot but be struck with wonder at this ingenious mechanical contrivance, so simple in construction, and yet so well adapted to the materials and circumstances of the case, and so effective for all the purposes for which it is designed. Easily opened by the inmate for all the distance which his necessities require, and yet presenting increased resistance to every attempt to open it beyond that.

Spur or stay to the Trap-door.

There is another appendage to some of the trap-doors, which aids materially in the spring with which they shut, or at least prevents them from turning right over backwards, or remaining open. It is in reality a sort of spur or stay constructed on the outside of the lid close to the hinge, and with its thickest edge next the hinge, and it acts as a choke against the ground outside the nest when the lid is opened up. This choke is formed sometimes of soil, and sometimes of other materials. In one case, No. 11, it is evidently formed of several old trap-doors of different sizes, the upper one at the top of the choke, and goes to show that when a nest is increased in size, it is always enlarged at the mouth, on the side opposite the hinge, and that these descriptions of trap-doors are extended somewhat like the growth of a shell, always at the lips. This explains the tiled appearance of these trap-doors, which has been likened, and very correctly so, to the outside of an oyster shell. Or probably it would be more correct to say, that as the old doors had, one after the other, become useless through some accident, or through the expansion of the mouth of the tube, a new one was constructed below the previous one, and joined on to the lining of the tube always at the same spot, the hinge. This accounts also for the fact, that such trap-doors are generally depressed below the surface of the ground at the hinge.

Bevelled mouth of the Nest.

All the nests found, had the mouth of the tube more or less beveled and the lid corresponding, and there were always varying degrees of perfection in the workmanship; some doors fitted exactly to the cup-like form of the tube, over which the lining is always extended, so that the lid may fit tight down. Others not fitting so exactly, and being a mere flap, covering over the mouth of the tube. But in no case was there anything like what Moggridge describes and figures, as "cork-nests, with the thick lid going down into, and filling up the mouth, so as to require some degree of force to take the plug out."

Distinctions in the Trap-doors.

Apart altogether from these variations, and from the oval or circular outline, there are two distinctions that may be noticed, in the form of the trap-doors. First: Those that are slightly raised above the surrounding surface, that is, in the middle of the lid, and thin off at the edges; and second: those that are flat, and exactly coincident with it, or slightly depressed. You have now before you twenty-eight specimens of trap-doors, and of these, by far the larger number belong to the latter or flat class.

This is, however, largely owing to the difficulty of transporting the raised ones, they get broken off so easily in carrying and packing them. Some also that are really flat, appear as if the whole mouth of the tube and the trap-door were raised above the ground, in consequence of the breaking away of the loose soil round about. Of the true raised trap-doors, Nos. 1, 2, 5, 30, and 22, may be taken as fair specimens. Nos. 1 and 2 have this specialty, that the trap-doors are larger than the mouth of the nest, and overlap somewhat. No. 1 especially, overlaps very considerably. The mouth of the nest is only five lines in diameter, whilst the trap-door is eight lines, and the long way of the lidis from the hinge to the front. The cause of this is, that the nest itself, goes into the ground at an acute angle, and not straight down, and consequently the section of the cylindrical tube is elongated thus where the trap-door covers it. The spider has evidently calculated upon this, and so made its trap-door elongated in order to meet the requirements of the sloped section. It is quite likely too, that these are instances where the spider intended to enlarge her nest, and like a prudent and wise builder, provide before hand against rain, and enemies getting in by the hole, whilst it was being enlarged, and so made her trap-door to extend over the area which she intended should ultimately form the mouth of her nest; but that like many other intentions with referencet o houses, it was never carried out. Either this, or it is an instance of bungling workmanship, or over calculation on the part of the architect, of the length of a sloped section of a cylinder, and the Trap-door Spider is not the only architect or artificer that commits this sort of blunder. In any case, it is a variation from the general rule, and displays a remarkable capacity on the part of the spider, for estimation and foresight, and for adaptation to special circumstances as they arise. The second distinction, those that are flat, is more often accompanied by the beveled or cup-like form of the mouth of the tube, and the majority of clay or soil covered trap-doors are exactly coincident with the surface of the ground. Some (though only a few), are depressed, but this, I suspect, is an evidence of incomplete or bungling workmanship, and consequent weakness, more especially as in such cases, the excavated soil is always close by the mouth of the nest.

Trap-doors, what made of.

The trap-doors are made of several layers or plies of web, between which earth, grass, or other substances are woven to thicken and stiffen them.

General remarks on mode of concealment.

We come now to what is by far the most wonderful thing about these spiders, and that is the modes of concealment which they practise for the prevention of the discovery of their nests. This is accomplished in two ways—first, by so ornamenting the outside of the trap-door itself with a selection of materials corresponding to those around, as to ensure complete similarity, and thereby immunity from discovery by its enemies, and second, by so altering the conditions of the surroundings of the nest, as to draw attention from the nest itself, and mislead as to the position of the door giving access to it. In both modes of concealment there are endless varieties of ways in which it is effected, and the materials used are as numerous and various as nature or accident have provided in the neighbourhood. In some, simplicity is the principle depended upon by the cunning artificer ; in others, bold imitation of prominent and noticeable features of the surface landscape is made to do duty as a skilful and adroit piece of deception. But in all, the evidences of thought, ingenuity, and reason are displayed in the selection of the particular materials used in special places in the calculation of the probabilities of certain contingences happening, and in the apparently careless arrangement of both living and dead matter, so as to make what is in reality the highest art appear to be the result of natural and ordinary circumstances. For instance, in cultivated ground, where the soil has been stirred, and bare patches occur amongst the plants of artificial grass, you will find the outside of the trap-door simply strewed over with loose soil of the colour of the adjoining surface, or perchance with a small plant of green grass of the sorts growing in the neighbourhood, planted artificially, and growing on the lid. Where clay, hard, and baked by the sun and weather, has remained on the surface, you will find clay on the outside of the lid, plastered and smooth, or possibly with an imitation crack introduced, apparently at random, and, in such cases, no great trouble is taken to remove the excavated clay away from the hole. Whereas in virgin land that has never been stirred by cultivation, and where the carpet of natural vegetation is undisturbed, you will find the greatest care taken to remove to some distance away every trace of the soil and clay that has been excavated from the subterranean dwelling, and, as in such cases, the vegetation has been removed from the space occupied by the mouth of the tube, and as the simple covering of the trap-door, in such circumstances, with only soil or clay would result in drawing attention to the nest, there the skilful artist brings to his aid all the taste and knowledge of the practical gardener, selects plants suited for his purpose, brings them from a distance, and actually transplants them to the top of his trap-door with astonishingly natural variety and arrangement. If the soil around is covered with lowly mosses, you will find mosses of various hues and colours, growing green, and sometimes brown and dead upon the lid, or sometimes you will find this tiny parterre brilliantly ornamented with parti-coloured patches of lichens and cryptogams, or, possibly, sprigs of lycopods, ferns, or heathveronicas and white berry plants are introduced to correspond with the the bolder herbage around, or, if the common white tussock is the prevailing vegetation in the locality, and decaying and dead grass is frequent amongst the plants, there you will find the same condition repeated on the lid, the dead bits of grass being adroitly woven into the trap-door, or round its mouth, so as to deceive the most practised eye. So, too, where roots or woody fibres, or bits of dead stick are scattered over the ground, or protrude from the soil, this clever imitator will repeat the conditions on his lid, weaving these hard, foreign, and often clumsy materials into his trap-door in an irregular and apparently undesigned way. This is specially noticeable on bare, burnt, ground, where the herbage is short, and the action of the wind and the rain has bared the rootlets of the woody plants, and there, too, you will find bits of grass, etc., with the ends blackened and burnt, which the fire in passing over has merely scorched, utilised as the similarity of the surroundings demand; so, too, hard seeds and anything whatever covering the ground are reproduced in their natural attitudes in these clever pieces of deception. In fact, you will never find any two trap-doors exactly the same, even in any one locality, and belonging to the same colony of spiders, except where surface soil or clay simply is the covering. Nor let it be supposed that the animal simply makes use of the materials found most abundantly to his hand, and that long habit has taught him the selection of his materials; for, in the case of the mosses and lichens, and it may be safely said in the case of all the other materials too—though the proof of it is not so apparent—the spider never takes the plants that are growing immediately around, for that would be the means of drawing attention to the neighbourhood; but the wily creature, with his characteristic craft and cunning, selects what will suit some distance, comparatively speaking, from the scene of his operations, and brings it to his home and plants it; and what shows, too, that this is something more than the unerring fatalism of what we are accustomed to call mere instinct, is, that instances are found of bad and blundered work of various degress of perfection, and even of laziness and neglect. For samples are before you where the nests were in rough ground, where the herbage grew thick and close, and where the labour of carrying the excavated soil in minute pellets in its little hands to some distance away from its nest seems to have been too much for the energy of the individual, and consequently its "muck" (to use a mining phrase) is all deposited in a heap at the mouth of the hole, easily drawing attention by its prominent unsightliness; and yet, in exactly the same circumstances, you will find in by far the greater number of cases that every particle of soil that would command attention has been carefully and scrupulously removed; or, again, as showing that it is not mere instinct in the individual, but the power of adaptation to circumstances, and of selection to suit the emergencies as they arise, take the case of a nest in bare burnt ground; such ground is invariably coated with a thick covering of herbage before the fire runs over it; it may not be very rank and long, but it must be close and continuous, or the fire will not run on it. The spider, in such circumstances, must have had its trap-door planted thick with herbage also, and would know nothing of roots or pieces of stick, or bits of half-burnt grass, and yet in the altered condition of the surface, when rain and wind have done their work in removing the loose surface loam and exposing the roots and stumps of woody plants and burnt grass leaves, there you find this master conjuror alter his mode and materials of concealment to suit the altered conditions in which he finds himself placed.

Specimens of Trap-doors not the same as when obtained.

It would be too tedious, after this general discussion, to describe in detail each one of the twenty-eight trap-doors now before you, though each one has some peculiarity of detail which makes it differ from every other, and supplies it with an interest of its own. It will be better, I think, to select one or two of those differing most, and to which special interest attaches; reminding you that the shaking and jolting of a journey of 100 miles over rough New Zealand roads has not tended to improve their appearance.

Description of specially deceptive Trap-doors.

Trap-door No. 6 is an instance where brown-clayey loam is the sole covering of the lid, to correspond with the same bare soil around. The web forming the lid is thin, tough, and leathery, and of a brown colour; but it is thickened by the covering soil, cemented on the outside. It is small, but fits accurately. This trap-door is the trap-door of nest No. 4, and spider No. 2, alluded to before as found at the foot of the corner of a stable. The ground is rather sloping, but the trap-door is constructed level, and for this purpose a portion of the minature bank is excavated out, half-an-inch deep at the back part where the hinge is placed. This is a further illustration of what I have referred to in page 229, of the Oamaru species never taking advantage of a slope of a bank, or of a sod-wall, to assist the trap-door in closing to, as mentioned by Moggridge and others as characteristic of the species in other parts of the world. It is also an illustration of the case alluded to in page 229, where water must have been caught, and must have lodged round about the mouth of the nest. But yet, in this very peculiarity of formation, we have an instance of how observant these insects are of peculiarities of situation, and of their power of exact imitation of these peculiarities. This nest was situated exactly under the line of drip from the stable-roof. The roof is shingled with what are colonially known as Hobart

Town splits, and being rather old, they are curled up slightly at the edges by the sun. The consequence is that, at the drip, the line of roof is wavy like the corrugations of iron, though wider, and all the water from the roof falls from a row of spouts, and being thus concentrated, makes a row of holes in the ground all along the building corresponding to the corrugations. This nest was just at the corner where the minimum of water falls; but this cunning observer, seeing the row of holes in regular succession, completes the series by adding one at its proper distance at the corner, which exactly imitates such holes, as you will see on examining it. So complete was the deception that, though I and others must have seen this hole scores of times during a course of years, being in a much frequented and prominent position, we never thought it was anything else than a rain drip-hole, and it was not till the accident of my having dropped something at the spot led me to examine the hole narrowly, that I discovered it was in reality a trap-door spider's nest. With reluctance I refrain from commenting upon what this marvellous piece of deception teaches us. The simplicity and prominence of its mode of construction were the very perfection of concealment.

Somewhat akin to the principle brought into operation in concealing this nest, is that displayed in No. 5, though the materials used are quite different. This nest was got in ground that had been burned not very long before. Those of you who have lived in the country, must have noticed that where the white tussock is the prevailing herbage, after a fire has run over the ground, there remain lots of bits of dead grass leaves, which on flat exposed situations get blown about by the wind, till they are caught in little heaps by some protuberance on the ground, or some twig or plant left unburned. Against these they are blown by the prevailing wind in a sort of semicircular form, round the protuberance, and the action of the rain on the dust, which also collects there, mats them together, and they remain there till they decay. In bare ground, therefore, these little semicircular collections of grass are decided features in the aspect of the surface. This trap-door, No. 5, is an exact imitation of that natural phenomenon. The mouth of the nest, and the ground in front, is neatly planted with bits of dry grass, some with the ends burnt, and all arranged in a semicircular form with the ends free, precisely as I have described, and, as many of you must have observed a hundred times over on such ground. And what makes the concealment more complete is, that the lip of the lid is not placed, as you would naturally expect, at either edge of this little heap of grass under its shelter, but about the middle of the heap, so that when you go to open the trap-door you have to insert your knife in the middle of the grass, and one-half of it opens on the trap-door, while the other half remains stationary in front of the mouth of the tube. In fact I may safely say, that even now the exact position of the mouth of the nest defies detection. Nor is this, as you might at first sight, suppose, purely accidental, the result of bits of grass having blown against this particular nest, for you will find many similar, in such ground, and the fact that the nest itself is not raised sufficient to cause a protuberance without the grass, and that the bits of grass are all carefully woven into the lid, and tied together, and to the ground, and also are so systematically arranged, proves that it is the work of a cunning artificer, it is the result of design and not of mere accident. This trap-door, also gives evidence that its owner did not always conceal the entrance to his dwelling in this particular way. For on the top and back part of the trap-door you will see the remains of lycopods and mosses, which had been planted on it, and no doubt grew vigorously, when the surface around was thickly coated with a carpet of similar plants, before the destroying fire had passed over it. Considering that it is not over twenty years since this part of the country has been inhabited by man, so far as we know, and that fires must have been few and far between, it is not easy to understand how this tiny insect could have so soon arrived at such perfection in this particular mode of concealment.

Trap-door, No. 4, is of the same type, only with bits of burnt grass and rootlets all over the lid, but it has the same mode of deception on the outside of the mouth of the nest, as the previously described one, and with this addition, that there is a root of grass overhanging it, and also the burnt stumps of a grass-tussock immediately in front of it, which at once takes away the idea of the grass having been accidentally blown into its present position, for if it had been blown by wind, this natural break-wind, being much higher, would have caught the bits of grass and detained them.

Trap-door, No. 7, is also splendidly concealed, though in a different way, suitable to the circumstances. It is flush with the ground, which is pierced by little rootlets, and accordingly little twigs and roots are woven in and left sticking up, whilst seeds and bits of grass are not wanting to the covering of the lid. By a bold stroke of artful deception, a sprig of heath, an inch and a half long is laid, as if carelessly, across the mouth of the nest and fixed there, rendering it almost impossible to discover the exact spot where the mouth enters.

In trap-door, No. 3, we have a repetition of this plan of drawing a herring across the scent, by the attachment of a piece of twig half-an-inch long to the lip of the trap-door, the natural curve of the twig being taken advantage of to conceal the opening of the lid, the surroundings on the surface being rootlets, and twigs of heath and grass, the whole affair being most deceptive by its very simplicity. It is flat with the surface of the ground, and is covered with clay into which grass is woven. It is thickened at the back, and has a great spring, and the mouth of the nest is beveled in front to which the door fits exactly.

No. 16, is also a flat clay-covered one with some roots woven into it, but the lip of the trap-door is so adroitly made to simulate a crack in the ground, as to diminish the chances of its being taken for the mouth of the nest. No. 24, too, has a lump of clay on its top, and on this is impressed an evidently, artificial crack, so as to distract attention from the real mouth of the tube. Unfortunately, however, this which was a very interesting specimen, has got broken in the carriage.

Trap-door No. 30 was a very neat one, thick in the centre, without any apparent tiling, well-lined inside, and on the outside planted in the most artistic fashion with small mosses and lichens and minute herbage, exactly the same as the adjoining ground. It is the trap-door of nest No. 6, and, unfortunately, got broken off in the journey down to Dunedin. The nest itself, with the spider in it and a number of young ones, stood the journey well, and I had them alive for some time, as I shall relate further on; but the trap-door soon lost all its beauty; still, as I have it in a phial, it is easy to hand round, and you will still see the remains of the various plants on it, and you will be able to understand that, when it was fresh and green, it was really a minutely-beautiful object from the thickness of its coating of plants, and the exquisite variety and gayness of their colouring.

No. 9 never could have been discovered by any amount of search, if accident had not revealed it. I had occasion to pare off some grass tussocks from a piece of ground, when a stroke of the spade showed a hole of about half-an-inch in diameter, going down into the ground. I immediately searched the grass tussock; but even then I could not find it on the surface, and it was not till I took a stick, and pushed it up the hole from the under side of the sod, that the exact position of the trap-door became apparent. You will see it is in the middle of a high grass tussock, and part of the tussock was growing on and around it, and over the rest of it was strewed the *débris* of dead and decaying grass and ferns, similar to what you will always see lying about the roots of such tussocks. It is now very much destroyed, through packing in a box and carrying so far; but when got it was one of the most valuable specimens of the whole lot.

No. 14 is also a little gem. The herbage is thick and close on the surface of the sod; but there is not the faintest trace of the soil and clay that must have been excavated from the hole to be seen near it. The ingeniously artistic, and yet natural way in which the grasses, ferns, mosses, seeds, etc., are arranged on the lid, and are made to correspond with those around, challenges detection, and excites our admiration. What increases the interest attaching to this one is, that it is a small nest and trap-door, and the question immediately suggests itself—how came this young spider to make such a gem? No matter how well its education had been attended to in the parent home; no matter how great its powers of observation of the conditions of things around, and how well able to reason upon them; all these qualities must in this case have been largely supplemented by the transmission of qualities enabling the cunning artificer to construct such a perfect piece of workmanship.

Habits of the Trap-door Spider—New Zealand Species.

I must now proceed to refer to the habits, etc., of these spiders, and in doing so you must remember that, though my remarks may seem tedious and uninteresting, they will embody what I have actually observed, and as in some matters these observations differ widely, and in others are quite opposed to what is recorded of species in other parts of the world, it is absolutely essential to notice them, so that by the accumulation and comparison of facts, the truth may be ultimately arrived at; and in this connection, also, let me say that my observations of their habits is by no means exhaustive. Such observations require ample opportunities, much time and careful study, before the truth is arrived at, and were it not for the reason already given, I would fain delay this part of my subject.

Live in Colonies; but not sociable.

I have said these spiders live in colonies in favoured localities; but it must not be inferred from this that they are sociable animals. On the contrary, they always lead a solitary life, one adult spider in one hole, and invariably they adhere to their own nests with a tenacity that is something surprising, and never desert them for others under any circumstances. Of this I will give some instances further on. Only in one instance have I ever found two spiders in one nest, and then there were two galleries to it; but this, also, I shall describe further on, when I come to refer to their breeding. On the contrary, I believe they are a most savage race. Repeatedly, when I had occasion to put more than one into a box or bottle together, there was invariably a fight, ending in the fluids of one or both coming out, and not long after, in the cramping up of their limbs and death. They are sometimes much fiercer and more pugnacious than at other times, but you can always, by teasing them with a straw, or otherwise, make them do battle.

How they fight.

It is very amusing to see how they show fight. They rear themselves straight up in a threatening attitude, bending the body at the joint between the abdomen, and the cephalo-thorax, with the abdomen resting flat on the ground, steadied by the hinder pair of legs, whilst the cephalo-thorax is quite erect, and all the other legs, palpi and falces all stretched out ready for action. They paused in this attitude for a little, and then suddenly in a moment, legs and fangs strike downwards, with all the celerity and force which the weight of the cephalo-thorax can impart. In fact you would be surprised to see with what force and quickness these tiny animals can strike. On one occasion I found in the bottom of a nest, the legs and hard case of a spider, and I have very little doubt, but that he was killed and eaten. An intelligent and trustworthy servant of mine, who has largely assisted me in digging out nests, etc., informs me that on one occasion he put two Trap-door Spiders together in a tin match-box, at night, and in the morning he found that the one had eaten the other, as evidenced by the remnants of the cannibal feast, in the shape of legs and hard indigestible bits that were left as the only memorials of the corpse of the departed one. They will frequently show fight, and strike at you, when digging out their nests. There is no difficulty, however, in securing them as they never run away, and are not quick in their movements. Even when placed on a bare table, they will only run quickly for a few inches, and then stop, their style of running being jerky, and by fits and starts. The only difficulty is in digging out their nests without injury, as from their sinuous character, you never know which direction they will take. I always found it best to sound the depth of any nest, by passing a straw down, and then by observing the way I had to turn the straw in order to get it past the bends, I could estimate the general direction taken by it. I then dug a deep trench on the side from which this general direction tended, till I was sure that I was below the bottom of the nest, and then with a knife, carefully scraped away the exposed face of the sod till I came upon the nest, and in this way got a vertical section displayed without injury, and after that it was an easy matter to know where and how to dig, so as to secure the whole complete. But even then you will find it a difficult matter to preserve the sod from breaking, and at the same time secure it in a sufficiently portable form for carrying a mile or two. I generally found it best to leave the sod with the nest in it, exposed to the sun where it was dug out, till it was somewhat dried and hardened. All this takes considerable time and labour, and you will be astonished how large an excavation is necessary to get one large nest out complete.

Mainly nocturnal, but not always.

I believe with Moggridge, that these spiders are mainly nocturnal in their habits, as when I confined any of them in tin match-boxes at night, I could hear them moving about and making a sort of clicking noise, probably caused by trying to dig through the tin with their mandibles, but I never heard any noise or movement during the day time. But contrary to his experience of the Mediterranean species, I have frequently seen them out of their holes in the day time. You will remember that my discovery of them was caused by my seeing one (a large one), on the ground as I rode slowly through a paddock. Repeatedly afterwards, while hunting for them, I saw individual spiders outside their nests, and on one occasion, a bright sunny-day about noon, I observed three different instances of this. On another occasion, my children collected about half-a-dozen in the evening, all of smallish size, and several young ones. They told me they got some of them crawling outside their holes, and some they dug out, but they could not distinguish which. They are all in bottles, Nos. 7 and 8.

Never set their doors ajar.

Several times, when examining their nests, I have detected them "peering out of their doors," as described by Moggridge, but on no occasion have I ever seen the door "set ajar for the purpose," or "set open in the day-time, and the tube empty," as mentioned by Moggridge, and by M. Olivier. On every occasion where I saw the spider outside, she immediately on being disturbed, ran to her hole, quickly and cleverly lifted up her door and ran in. This is done so nimbly, that you have hardly time to see more than the spider disappearing down the hole, and the lid falling flap. They never seem to stop when they come to the hole, but glide in between the lid and the ground in a moment, down falls the door, and they are out of sight. On one occasion my wife saw a spider run into its nest, by quickly and cleverly lifting its trap-door and running in. She called to me, and while we were both watching it, the trap-door opened again slightly, and the legs of the spider became visible between the door and the ground, but evidently in consequence of seeing us, the cunning creature ran down its hole again, and the door sprang into its place, and though we watched it some time, and tried to get it to show itself, it did not again hazard the experiment. Nor have I ever observed anything approaching to what Moggridge describes, on the authority of Mr. Hansard, about a species inhabiting the island of Formosa, in the China Sea, of these spiders "staring at any one who might approach," still less have I ever seen amongst the hundreds of nests I have observed, anything like what the same author mentions, on the authority of Lady Barker, about some black Trap-door Spiders, which are common about Paramatta, near Sydney, Australia, "that the eye of the passer-by was attracted by the open doors which fell over backwards when the spider made her exit." In fact I think you will agree with me, that from the construction of the specimens of nests now before you, it is physically impossible for the trap-doors "to fall over backwards," or even to remain "set open," without something holding them. No doubt the statements quoted have been correctly observed, of the particular species in these countries, but they do not apply to the Oamaru species, and it is somewhat interesting and useful to note such essential differences.

Spider shamming death.

Another matter in which my experience seems to differ from Moggridge's, is in the spider being generally found in the bottom of her nest shamming death. He says (page 100) :—" More frequently when the spider finds that resistance is hopeless, and sees the earth crumbling in, she drops to the bottom of her nest and lies there helpless, with her legs folded against her body, like an embryonic creature ; some, however, more savage than their neighbours, fly out and strike at the intruder with their fangs." In only one case, spider No. 2, the occupant of nest No. 4, found at the stable corner, have I ever got the spider in the bottom of the hole as if dead. In all other cases, wherever the spider was got, it was lively and wide-awake, sometimes more savage than at other times ; but always alert and on the defensive.

Spider found in all parts of the nest.

I agree with Costa that the spider does not remain at the bottom of her burrow, as related by Sauvage, Olivier, and Latreille ; but, on the other hand, I equally disagree with him when he says that " she always stands at the door as sentinel," and that " the light seems to offend her so much, that, if exposed to the full day, she remains so stupified as to appear dead, nor does she move even if shaken, but constantly stops still, and holds herself with her feet pressed against her body." On the contrary, I have found the spider at the door doing sentinel in the wide part of her nest, embracing her cocoon of eggs in any one of the bends at the bottom, and quite as often in one part of the nest as in another.

Effect of light.

Nor have I ever seen her stupified by the light, or appear as dead, except in the one case I have mentioned, and unless you teased her, say with a straw, when, after striking and fighting with the source of annoyance ineffectually, she would become as if exhausted, curl in her legs " like an embryonic creature," and not move for some time. No doubt the light must incommode her ; but it is not noticeable, as I have had specimens in the glare of the sunshine scores of times, and never could detect any difference in their actions from other times under a subdued light.

Holding down Trap-door.

But to whatever extent the Oamaru species may differ from others, in these minor details of their habits, there is no doubt about their being exactly the same in regard to what is, I think, the most wonderful thing in the habits of these animals, namely, that they have such a knowledge of the effects of mechanical resistance, as to apply it in the defence of their "hearths and homes." I confess, when I first read of this, I thought it partook so much of the Baron Munchausen style of marvel that I did not believe it, and it was not till I had repeatedly seen it with my own eyes that my scepticism was vanquished. The trap-door is used in two ways, not only as a means of concealment to the mouth of the nest in the modes I have already fully described, but also as a means of defence against the intrusion of enemies. This is effected by the spider actually holding down the trap-door from the inside, and by its obtaining a purchase for this purpose with its body against the sides of the nest. That there may be no doubt in your minds on this point, I transcribe from my note-book what actually occurred on one of these occasions, and was noted by me on the spot:—"26th November, 1874. Another well-made, but thin, trap-door was near at hand, and on my touching it, I saw it visibly become depressed in the centre and shut close, as graphically described by Moggridge, 'like the movement of the tightening of a limpet on a sea rock.' So I took my knife and raised the trap-door a little, when I saw the spider clinging to it, feet uppermost, and felt her holding down the door with some degree of resistance; her body being placed across the tube and filling it up, with her extremities planted against the sides of the nest. The trap-door slipped off my knife with the force, and on my raising it again more firmly, she let go her hold and ran down the hole out of sight. I raised back the lid, so as to examine the inside of it for any marks of its claws, such as described by Moggridge; but could not detect any regular markings. Whilst eyeing it, up came the spider to the mouth of the hole; but, on seeing me, she ran back, and though I waited and watched some time, she did not again come up." I then dug out the spider, and have her now in bottle No. 9. From the looseness of the soil, it was impossible to preserve the nest; but it was nearly straight, with an enlargement immediately below the trap-door. I measured a section of it, however, and it is depicted in Sketch No. 7., Plate VIII. I also secured the trap-door, and you have it now before you, No. 26.

Holes in the Trap-door.

On examining the under side of the lid carefully with a glass at the time, I could make out two or three holes or places where the silk lining of the lid was raised and wraggled, irregularly placed towards the centre of the lid, as if they were the marks of the hooks of the spider's claws, but not very distinct, as the texture of the silk was rather coarse and open, and certainly not so regular, nor placed round the edges, as shown by Moggridge, in one of his beautiful sketches. If you examine the lid now with a glass you will see these holes even more distinct than they were when freshly made; but they are nothing like in appearance to what has been described by Moggridge and others. I have examined several other trap-doors, which

I saw held down by the spiders; but always with the same result; but I should be sorry to hazard the opinion that what has been observed by so many eminent naturalists never does occur in Otago. My opportunities of observation on this point have been too limited to generalise, for though I have seen hundreds of nests; it is only sometimes the spider can be caught in the act of holding down the trap-door. I have repeatedly tapped the lids of nests with my knife, and have observed the spider come up and hold down the lid (and I may mention here that one of the spiders first sent home to the Rev. P. Cambridge was one of these); but I have also tried this device scores of times without the inmate of the nest taking the slightest notice. Much difference of experience, and of opinion, has been recorded about these holes in the lids; but I am not in a position to decide the point. I must say, however, that the suggestion of Gosse, that they are air-holes, is untenable, so far as the Oamaru species is concerned, for, if air-holes are required, they would be found in every lid, or at least in every tight fitting one; but this is not the case, as in the large majority of trap-doors that I have found, no markings or holes whatever are discernable, and on no occasion, even when the lid had been seen to be held down, was there anything in the least like what he describes in the following passage:—"A row of minute holes such as might be made by a very fine needle, pierced around the free edge of the lid, and a double row of similar ones just within the margin of the tube. There are about fifteen or sixteen punctures in each series, and they penetrate through the whole substance, the light being clearly seen through each hole. I do not think, as I have somewhere seen suggested, that they are intended to afford a hold for the spider's claws when she would keep her door shut against the efforts of an enemy, for what would be the use of having them in the tube *close to the lid*, so close that not an eighth of an inch intervenes between the surface of the lid and that of the tube when the former is tightly closed." I would suggest whether they may not be air-holes, for so tight is the fitting of the lid, and so compact the texture of the material, that I should suppose the material would be impermeable to air but for this contrivance. It is evident that Mr. Gosse, in this passage, refers to holes in the tube that are not observable in the Oamaru nests, and in this respect my experience coincides with that of Mr. Moggridge, as stated at page 96 of his book.

Nests, how long to construct.

On the question of how long time these spiders take to make their nests, I can throw very little light. The first nests I found nearly three years ago, were situated in the middle of a three hundred-acre paddock which had been laid down in English grass less than two years before, and had been in cultivation for several years previous. When I discovered them there were a great many in that spot, but not over the paddock generally, and some of the nests and the spiders were of large size. These nests must have been constructed since the ground was last ploughed and harrowed, as the soil is very free and breaks down very fine under culture, but I am not prepared to say that the spiders themselves may not have been there in the soil for some time before, as from what I will relate presently, I believe they are very reluctant to abandon their habitations, and I suspect that year after year they constructed temporary dwellings, till the revolutionary period of cultivation was passed, and then they formed their permanent nests; with all the advantages of repeated experiences in house-building to help them in making the large and complete nests they now have. This is a point, however, that I intend making some experiments upon, when opportunity offers, by carefully marking a piece of ground containing one large nest, destroying this nest, but leaving the spider uninjured, and then watching carefully for any new or large nest that may be excavated in the vicinity. That good sized nests are constructed in less time than I have mentioned, is proved from the following entry in my note-book :—" 15th November, 1874. Found a Trap-door Spider's nest in the grass-paddock above the Stable" (this is a different paddock from the other, and fully a mile away from it.) "Its hole was about half-in-inch wide, and about eight inches deep. The trap-door itself was of several plies, three tiers at least being easily discernible by the unassisted eye, and with the hinge was very thick, the silk lining of it, and of the nest, being close, compact, and tough, and of a brown tinge like leather. This land was cultivated last (ploughed and harrowed repeatedly) in the month of January, about ten months ago, so that the spider must have constructed this nest and trap-door since. I cut out the trap and a small portion of the top of the nest, and marked the place." This trap-door is now also before you, No. 19, I scarcely think these spiders migrated during the time the ground was being lacerated and pulverized, or that they only took up their abode in these places, after these operations were over, for in the case of the nests found at Elderslie, Waiareka, the country for miles round had been under cultivation not very long before, and yet in the middle of this large area of cultivated ground, the nests are to be found by the score, and many of them that I examined measured half-an-inch wide by fifteen inches deep. The trap-doors were, however, generally thin and not planted. At page 127 of his book, Mr. Moggridge makes a calculation, to show that the largest nests he has observed (some sixteen lines across), would take four years to construct. In general, I believe, that the construction of the nest is a gradual process, that it is first small, and then is from time to time widened and deepened, but it is probable from the above facts, and from the fact, that frequently immense quantities of freshly excavated soil are found accumulated near the nests, corresponding in bulk very much to the size of the hole, that the spider is able to dig out and construct a full sized nest at once, in new ground. For if the process were always gradual from day to day, the excavated soil would be, every now and again, washed away by heavy rain, preventing any large accumulation of soil, and leaving only the stain of the different coloured earth, as is the case in general. It must be borne in mind, however, that the clay or soil in front of the holes is all in little pellets, like what passes through a worm, and often all the bits are cemented together hard, and that this cement hinders the action of the weather upon soil which otherwise would very quickly powder into fine dust. This cement is, no doubt, produced by the saliva from the mouth, and the spider in forming its hole, moulds the excavated clay into these little pellets with the viscous secretion, and then carries each little ball up to the surface, and deposits it on its dirt heap. Some faint conception of the enormous labour and activity of which this little creature is capable, can be obtained from this fact, when we consider the extreme minuteness of the pellets, as compared with the size of such a hole as No. 3, one inch in diameter at the mouth, two inches further down, and fifteen inches deep.

Renewing the Trap-doors.

So far as the trap-doors are concerned, the spider has the power of renewing them in a single night. This I have proved over and over again, by cutting out the trap-door and taking it away, and invariably there was a new one on the next morning. As samples of this, I extract the following from my note-book :—"9th November, 1874. In the afternoon I went down the Bobbin, and found the nests, the trap-doors of which I had cut out yesterday, all repaired, or in course of repair. One new door had pieces of dried grass woven across the lid and extending to the ground on each side, as if to prevent the lid tumbling in, till it was finished, which it evidently was not." "16th November, 1874. The nest in the Stable paddock, from which I yesterday cut off the trap-door, and sod, about two inches below the surface, has to day a new trap-door woven on it." The new door was thin, but complete in every way, with fibres and clay, and earth all woven into it. The sides of the nest have also been added to, the silk lining being extended over the adjoining ground in a cup-like form, to make the proper over-lap for the lid to fall tight down." Again : "29th November, 1874. On going this morning to inspect the nests, the lids of which I dug out yesterday, I found they all had new doors and mouths constructed to them, quite perfect, though the earth, etc., had not the compact hard consistency noticeable in older nests. It is quite clear therefore, that the spiders can, and do, construct their trap-doors in a single night."

Reluctance to desert their nests.

I have several times throughout this paper referred to the reluctance shown by these spiders to desert their nests. I am not aware that there is any difference of opinion amongst observers upon this point; but, at the risk of wearying you, I will relate an experiment carried out by me, which bears on the point, and at the same time illustrates some other interesting habits of spider. In the end of the month of February last, I was at Awamoko, and a servant of mine showed me a nest in clay, got in the bank opposite the stable, containing a spider with a number of young ones. He had cut out the trap-door and top of the nest before he dug out the nest. Being in hard, dry, clay, I determined to take the nest down to Dunedin with its occupants. On opening the box in Dunedin, I found the spider still lively and well, and so were the young ones." The lid, or trap-door, however, had got broken off from the top of the nest with the severe shaking in travelling; but the lid itself was sound, and has already been described as trap-door No. 30. I kept the sod containing the nest in a shallow box, without any lid, in my vinery, so the spider and its young ones could have escaped, if they so pleased—the floor of the vinery being dry soil. During the first week after its arrival in Dunedin, I brought it out several times on to the verandah to let friends see it, and I always found the spider lively and well. A hole had been cut in the side of the sod into the nest, exposing about two inches of the tube, just above the *débris* of fibres, etc., always found in the bottom of their nests. You will see this hole in the sod which is now before you, No. 6, and, by putting a straw in at this hole, I could always tease the spider and her young ones to come out at either end. Finding that she did not feel inclined voluntarily to leave her nest, I determined to leave her alone undisturbed, hoping that she might weave a new trap-door to her nest, or perhaps join on the old one. So I took a piece of soft clay and moulded it to fit the hole in the side of the nest, and stuck it on, so as to close up the hole. (I have the clay here beside the nest, and you will understand better when I fit it on). I also laid the old trap-door in a convenient position for the spider to join it on, and for several days placed dead flies and moths round the mouth of the nest, and some in it, and did not disturb the nest in any way. In a few days, I noticed that no attempt had been made to make any use of the old trap-door, but that the flies put into the hole were put out, apparently untouched, and that the lining of the nest, just below where the trap-door had been cut out, was drawn in from each side, completely closing in the nest and sealing it. A few days after this the clay that I had stuck on to close up the hole in the side was either forced off, or had fallen off in drying, revealing the fact that the spider had completely woven a patch over the hole from the inside, the materials used were the fibres from the bottom of its nest, all woven together. Hoping that some further work was going on, either in the way of making a trap-door for the old hole, or digging out a new entrance through the sod in some other place, I left it quite undisturbed for some weeks, only laying down some flies and moths occasionally, which, however, I never found touched. Nothing further, however, appeared outside, and I became pretty sure that either the spider had buried itself alive or had escaped. I had wished Captain Hutton to see it, but his absence from town prevented me doing anything further till the 8th of May, when I examined it, first of all by cutting open the nest where it had been repaired. I then found that the nest had been deepened by about an inch, or rather that the materials which had been used in mending the side of the nest had been taken out of the bottom. In the bottom I found four young ones dried and dead, and this made me sure that the old one must still be in the nest. Accordingly I passed a straw down the hole from the top, when I found that about half-way down, it was stopped by something, and after cutting away a little more of the nest I soon found the dried body of the old spider in a hollow in the nest, at a bend about half-way up. It was shrunk and shrivelled up, but quite perfect, showing that it had literally starved itself to death. I found the body of a blue-bottle fly in the nest, dried also, but with the head off it. From this and other instances—which I shall refer to presently—of nests sealed up from the inside, containing sometimes dead and sometimes living spiders, it is perfectly clear to me that the spider deliberately sealed its nest and starved itself and its young to death. It evidently could not bear to leave its home, or it would have done so easily at any time with its young. The partial marring of its handiwork seemed to have so disheartened it that it sealed itself up in its own ruined house—a broken-hearted architect and builder. The nest from the surface of the ground to the bottom is exactly eight and a quarter inches, and has several bends in it.

Sealed-up Nests.

I come now to refer to a fact, in connection with the habits of these spiders, which I may as well say at once is to me totally inexplicable. I have not seen it referred to in any way, by any of the observers who have recorded their experiences, and I should have hesitated to mention it now, were it not that so many instances of it came under my notice, as to preclude the idea altogether of accident as an explanation. I refer to the fact alluded to above, that the spider is sometimes found in her nest with her trap-door sealed-up from the inside, with no means whatever of ingress or egress, and yet with the outside of her door covered over with clay or soil, plastered over and sealed up as it were, implying the absolute necessity of the co-operation and assistance of another spider, probably the male. Many instances of this came under my notice, but as the facts observed are of themselves insufficient to justify the propounding of any theory I will not attempt to arrange them under any classification, but simply copy what I have noted in my field-book, in the hope that attention being now drawn to the matter, a larger number of facts may be recorded on the subject leading ultimately to a clear explanation of the mystery :—" 8th November, 1874. Bobbin Gully. Saw one large heap of clay, but could not find the door anywhere near it, the ground being quite bare. The clay was all hardened and glazed on the top though fresh; so I took my knife, and cut off the surface clay (about an inch thick), intending to carry it home as a good specimen of excavation. When, to my surprise, I found a large hole underneath going down into the ground. On turning over the cake of clay, I found the upper end of the nest which I had cut off, with the trap-door shut and sealed down, the side which had opened, being tied down to the side of the nest by a number of fine threads. Some very minute spiders were moving about inside. This hole had evidently been used for shunting out the excavated clay, and when this had been accomplished, the lid was shut down and sealed from the inside, and yet the inmate has probably another means of egress, as the outside of the trap-door was wholly undistinguishable, being all covered over with clay, the same as its surroundings, and carefully smoothed and glazed with a crust. At any rate the spider does not use that hole now for ingress or egress, but it had been used for tipping out the clay, and then closed. Not having a spade with me, I could not examine it, but will do so again. I secured the clay with the lid and the top of the nest." You have it now before you, No. 23. "9th November, 1874. In the afternoon, I examined the nest, the door of which was sealed up, and found a new fresh lid upon it. I dug the nest out, and found the spider, a large one, alive near the bottom, but no signs of any other means of ingress or egress. This is a perfect mystery to me, but it is just possible I may have mistaken the hole, though I do not think so." You will see I am giving you exactly what I noted in my field-book at the time. This was the first case of the sort I had observed or read of, and naturally I was careful, even to doubting my own accuracy. I have since seen so many instances of the same thing, that now I have no doubt whatever, about its being the same hole. "The nest was ten inches deep and very sinuous, having four distinct bends, north, south, east, and west. Sketch No. 3, is a plan of it, but the clay section is also secured (nest No. 3.) The cephalo-thorax in this spider, No. 3, is peculiarly large and broad. In the bottom of the hole, were lots of *débris* of food, wings, legs, hard cases of beetles, etc., and a brown material, like old moss, but this is found in them all, and the bottom of this, and all the nests examined in this locality were not lined with silk." On the same day, later on, the following entry appears in my note-book :—" Found another nest with the lid sealed up, and on digging found the legs and hard parts of the body only, of the inmate, at the bottom. It either had died, or been killed and eaten." No further remark is made, as I felt very puzzled about it. From that time till the 26th November, repeated instances of sealed up nests came under my notice, but no new fact, nor any further light was thrown on the subject. On that date, however, the following entry appears in my field-book :—" 26th November, 1874. At Awamoko River. Nests very plentiful and of all sizes. One nest with raised lid, I found embedded in clay, and on raising it, found it had been sealed down. The lid is fully more than half-an-inch thick, with a lining of silk near the top, and on the bottom, and a sort of cap of soil on the top. The thickness was mostly made up with earth woven in between the silk. I secured the lid and put it in a match-box, but found, on reaching home, that it had all crumbled down, except the silk linings." It is now before you, No. 22. " I dug this nest out with my knife, and found it not very deep, as it came upon the rock about eight inches down. On removing the lid, I put down a straw to see how deep it was, and on withdrawing it, I felt something resisting, and on pulling it out, I brought up a beautiful white bag of eggs (Cocoon No. 2.) On digging out the nest, I got the spider at the bottom, but unfortunately it had been pierced with my knife; it was alive, but unfit for a specimen. In the bottom of the hole, was a quantity of what is apparently moss, and brown fibre, and remains of insects. I could not detect any other hole for ingress or egress; though either, it must have had some way of getting in after covering the clay up about its trap-door, or this must have been done by some other spider. Query! Do they shut themselves up to hatch their eggs, and if so, do the males close them in? It is possible this may have had another gallery, as in digging down I came on another tube going downwards, though no hole or trap-door could be found on the surface corresponding to it. This second branch or gallery went deeper than the other, and in it I found another spider, much smaller than the other, but unfortunately not expecting it there, I had pierced it with my knife; I regretted this, as it may have been the male. I cannot be sure that there was any connection between the two holes, as I did not see them actually bifurcate, but I almost certain they were connected, as they were so close, and also from the direction they took, and no second hole or trap-door being discoverable above. If they were connected, and I really think so, this is the first (and I may add now, the only) instance in which I have found two spiders in one hole. Could it have been the male and female sealed up together?

Not the result of accident.

These are all the facts I have to offer on the subject. Other sealed nests were found at other times, and some of their trap-doors are in the case before you, but nothing specially different from what is above related was observed. I put forward no explanation or theory, but no doubt I shall be told, that these are all instances of accidental covering up by other spiders, which had placed their excavated dirt heaps on the top of their neighbours' trap-doors, or that they are cases of accidently burying, by the slipping of a bank or something of that sort. I may as well say therefore at once, to prevent such surmises, that they are quite untenable, as would be evident to any one seeing the nests on the ground. Apart altogether from the care which I always took to find out if there were any nest near, from which the excavated matter could have come, there is no getting over the fact, that the trap-doors were always sealed and tied with strings on the inside, and that the spider was always, with one exception, hale and hearty inside, and that the nests had no other outlet. Also these nests were all on level ground, with no bank or place near them from which the soil covering them could have accidentally come. No; whatever is the explanation, these are inadmissible. Noting a number of sealed up nests, and watching them at every month of the year, might supply the key, as I feel strongly impressed with the idea, that it has something to do, either with their hybernating, if they do hybernate, or with their breeding. Unfortunately it is only at long intervals that I get the chance of observing them, but I would commend this matter to some of our Oamaru natualists for investigation.

Breeding-cocoons and young ones.

On this subject M. de Walckenaer, as quoted by Moggridge, says that the Trap-door Spider attains her maturity in August (corresponding to our February); leaves her mother in September (our March), and that she lives with the male before the time of laying eggs, and that M. Dorthes has many times seen, in the same nest, the male and female with about thirty young ones. From the preceding extract from my note-book, it will be seen that the only instance in which two spiders were found by me together was on the 26th November, and that there was a cocoon of eggs in the same nest, and the nest itself was sealed up. But you will remember that I described how I found out the use of the enlargement by seeing a cocoon suspended in it. This was on the 9th November. Between those two dates, I repeatedly found cocoons of eggs in the nests. Some of the nests were sealed up, and some were not, and some had enlargements, and some had not. The eggs, however, were always in cocoons of varying sizes, and always suspended about a third, or half-way down the nest. In this they differ from those described by M. Erber, quoted by Moggridge (pages 115 and 143), which were found "as single eggs at the bottom of the tube, not placed in cocoons, but attached by separate threads." Where there was no enlargement, the cocoons were small, and where the enlargement existed, the cocoons were large, giving another illustration of the capacity of this spider for adapting the construction of its nest to suit special circumstances. One of the cocoons before you, No. 3, is an inch-and-a-quarter long by three-quarters broad, and contains, I have no doubt, from 50 to 100 eggs. It was very much larger before it was put into the spirits, the covering sack is thin and transparent, and when found was fully distended, like a balloon. I was informed by a resident in the neighbourhood that "some weeks before the 9th November there were no cocoons in any of the nests he examined; but no end of young spiders of all sizes in almost every hole." It is not very clear how this could have been the case, unless we are to suppose that these spiders are both viviparous and oviparous, or have no regular breeding time; and on this subject I may note that my manager's wife informed me that, "some months before November, she confined a Trap-door Spider in a corked bottle, alone, and in a few days there were a great many little ones in the bottle, and the old one was dead." But whatever may be the explanation of these two statements—and of their truthfulness I have not the remotest doubt—my own observations show that, on the 8th November, I got some very minute spiders in a sealed-up nest which had an enlargement in it, and that towards the end of February, I got a nest with a number of young ones which I took down to Dunedin with me. One or two of these young ones are in bottle No. 10, with the dried spider, and they are very small. Between these dates, nests with young spiders in them were repeatedly obtained. Besides the occasion mentioned, where they were got crawling outside, I will only refer to two other occasions when I found them, and as both had special circumstances connected with them, I will copy from my note-book:—"13th November, 1874.—My little boys and servant brought me the bottom of a nest, which had been cut through by the plough immediately before they dug it out, the upper part of the nest being in the sod turned over. It was got on the hill above the stable-paddock, in virgin land, and it is now before you, No. 5. The mother spider and a great many of her young ones were secured, and are now in bottle No. 4. Altogether there were thirty-three, besides herself, put into the spirits by me; but a great many were said to have escaped out of the nest, and were not caught. The nest was tough and well-woven, and some of the young, on my attempting to remove them, seemed to adhere to the bottom of the nest. Several of them had a greenish-blue spot on them, and some were brown, as referred to in page 225. The other occasion I wish to refer to is on the 28th November, when, in the evening, I cut out the very beautiful trap-door No. 1. On cutting it out with a knife, I found a smaller hole, close to the hole belonging to the trap-door, and, thinking it might be a double-nest, as I could find no lid corresponding to the small hole, I dug both carefully out. The small tube had no connection with the larger one, I am at a loss to know how ingress or egress from it is managed. At the bottom of the larger tube (the one, of which I have the door), I found the spider herself, and after, with considerable force, pulling her out of her hole with a pair of forceps, I found a lot of young ones packed close and hard on the bottom of the hole, and she had been squatted firmly over them. I secured them all, I think numbering twenty. She and her progeny are in the small-necked phial alone (labelled No. 11). Below the young ones was a mass *débris* of insect (beetles especially), and below that, the brown fibrous matter so often observed before. The hole had a horizontal bend at first into the bank, and then went straight down, and was not more than eight inches deep. It was the same width from top to bottom, and had no wide part for eggs or young ones. So that what I observed at the Bobbin, in this respect, does not hold good at the Stable Gully.

Débris in bottom of Nests.

You will have noticed that, several times in these notes, I have referred to my having found masses of fibrous matter, and the remains of insects, in the bottom of the nests. It is unnecessary that I should more particularly refer to this, as it bears on the question of their food, and on this subject, Moggridge—the best authority on these spiders—says (page 135) :—"More observations of this kind are greatly wanted, as it is most important that we should know what are the principal sources of food upon which these spiders depend for their existence. If we could answer the questions, What do they eat? and, what do they fear? we should have advanced a long way towards solving the larger problem as to the causes which limit particular species to certain districts. For there seems every probability that other new types of nests remain to be detected in warm climates, some of which may perhaps exceed those we have been here studying in beauty of workmanship and adaptation; it is at least certain that an abundant harvest of interesting facts in the life history of Trap-door Spiders remains yet to be gathered in." Now, curiously enough, this very question of food is one in which my experience has been quite different from that of all other observers. Moggridge, at page 135, says:—"I have but seldom detected any refuse in these nests;" and this accords with what M. Erber tells us—"In October, 1872, however, I found a black layer of *débris* at the bottom of five nests of *Nemesia eleanora*, and this was composed principally of the remains of insects, and, among others, of some rather large beetles."

M. Erber, too, says, "I failed to find either the remains of food or excrement." So he had to watch the spiders catching their prey by means of a snare in front of their holes, and then he says: "After sucking out the juices (of beetles) they carried the empty bodies to a distance of several feet from their holes." My experience of the Oamaru species is, that, amongst the scores of nests that I have examined, there was scarcely one but had masses of refuse, food, and animal matter in the bottom of the holes. In some nests this was in the form of a little ball of legs, wings, scales, and plates of insects (beetles especially) all spun together. In others, and by far the greater number, it was in the form of a perfect mass of matter, packed down tight in the bottom of the nest, filling up the tube at the lower end, sometimes as deep as an inch, as in the nest I brought to Dunedin, or as in the specimen of *débris* from the bottom of a nest now before you, No. 25. This mass of matter consisted on the top, of *débris* of food, legs, wings, and elytra of beetles and other insects, such as grasshoppers, and once, the case of a chrysalis. Below this, and partly mixed with it, and with an occasional chitinous wing of a beetle, was always a brown material like moss, which the microscope reveals to be animal matter, as well as the hardened integuments and epidermis of insects, and the coarse matted threads of spiders spun all through it and dried up. In one large nest found at the Bobbin there were the remains of many beetles in the bottom and also bits of green stuff like bundles of chewed grass. I regret now that I did not preserve this; but my idea at the time was that the brown stuff was moss or grass, and was used by the spider as a sort of bed or cushion for its young; but the microscope has since satisfied me that it is not moss, but animal matter, and this makes the exceptional green stuff found in this one hole all the more peculiar. In one nest, found in autumn by a servant of mine, and which had a double branch with a trap-door on the branch as described afterwards, there were caterpillars and grasshoppers, in fact my informant stated that the side gallery, as I may term it, was stored with caterpillars and grasshoppers. John Reid, Esq., of Elderslie, told me that he has often seen beetles lift the trap-doors and run in, and his belief was that the beetles lived with the spiders; at any rate the rule in Oamaru in November is, that there is a large accumulation of refuse food, etc., in the bottom of the nests, and Erber's observations that "the spiders always carry away the empty bodies of beetles to a distance of some feet," do not apply here. On the contrary, there is evidence on the other side to show that the habit of the Oamaru species is to accumulate its *débris* and refuse food for some time, and then, when its midden gets too bulky, it is all cleaned out at once and thrown upon its usual excavation heap. Two distinct instances of this in two different places were observed by myself in which the refuse food remains of insects, and the animal matter so usually found at the bottom of the nest, were all tumbled out over the bank of clay excavation in front of the holes, and in both cases they were great heaps, and also in both cases, when I dug out the nests, the bottoms were found clean, and no refuse in them.

It is, I think, quite likely that the time of year, and the presence, or otherwise, of young ones has something to do with the deposits of refuse food inside the nests. Moggridge's observations seem to have been made in October (corresponding to our April) whereas mine, on this point, were mostly made in November. At that time of the year, in the Oamaru district, I am safe in saying that I found lots of refuse in every nest.

Food and enemies.

As to the mode of capture of their prey employed by the Trap-door Spider, I have no doubt Erber's observations, in this respect, are correct, and that a snare is constructed on the ground in front of the nest, from which the wily spider pounces out upon the unlucky insect, which gets caught in the meshes of its net. I have never actually seen this snare, but in the mornings have seen traces of it remaining, and should not have known what they were, without Erber's interesting description. I do not think that in New Zealand, on the open grass-covered terraces of the Oamaru district, the Trap-door Spider has any very extensive choice in the way of food. If it lives exclusively on animal food, and I suppose it does, the Fauna of such a district do not present very great variety, nor are they very abundant. The insect life is certainly the most abundant, or rather, I should say, almost the only wild life, but at best, it is very meagre, as compared with most other countries, or even with most other parts of New Zealand. Beetles, Moths, Dragon Flies, Grasshoppers, Spiders, Caterpillars, a few Butterflies, and a very few small Ants, comprise about the only insects noticeable to unscientific eyes, and no doubt from this very limited and simple bill of fare, our friend the Trap-door Spider makes his choice, as I have no doubt he is more than master of them all. Of the enemies which he has to fear, I know of none that could touch him, except Wekas, which are very scarce now, however, lizards, and a few small birds, such as Sand Larks. As to monkeys, squirrels, and several kinds of birds, as well as tortoises, frogs, toads, and centipedes, all which, M. de Walckenaer states, prey upon these spiders, there are absolutely none of them.

Exceptional forms, Forked Nests.

I must now briefly refer to one or two exceptional forms of nest, and, as connected with the subject of food, I will refer, first, to the nest, a section of which is shown in Sketch No. 6, Plate VIII., and the inmate of which was Spider No. 6. This nest was found in the Stable Gully, and a small cocoon of eggs was found in it near the top. (Cocoon No. 1.) On digging it out and shaving away the side of the sod, I found running out from it near the bottom, a streak of earth, showing dark in the yellow clay. On examining it further, I found it was surface soil, and hence showed distinct and black. It was mixed with fibres of the brown animal matter already described, wings, legs, and hard cases of insects, beetles, etc. This showed me it was another branch, and so I carefully scraped the sod away, till I found this branch join the main excavation or nest. This side branch was evidently an old part of the nest which had been abandoned, and it was filled up and packed tight with surface soil (black mould), so that these spiders must have the faculty of taking soil down into their holes, as well as throwing it out. The *débris* of the refuse food alluded to, was also mixed with the black soil, in fact this was evidently its old midden, where all the refuse had been thrown, the whole being packed in tight, and sealed up by the usual lining of the nest, so that on looking from the main nest, I could not tell where the branch started from. There may have been a trap-door at the junction of this double branch, but I could not detect any. If there was one formerly, it had been amalgamated with the lining of the nest, the inside of which had been rounded off, smoothed and papered, just the same as others. There is no doubt in my mind, that a very long time must have been necessary for one spider to accumulate all this large mass of animal matter so tightly packed, and if the black mould were really surface soil, it almost suggests the idea, that this spider was acquainted with the antiseptic qualities of dry earth, for what else could this soil have been mixed up with the refuse for, if not to prevent the unwholesome odour from such a mass of decaying animal matter. If the object of the spider were merely to fill up the whole from any cause, it would have done so at once, and it would probably have used only clay from its main, or new, nest, but the packing being surface soil mixed with refuse animal matter, suggests the above idea, and that the spider preferred to get rid of it in this way, rather than empty it out, and thereby draw attention to its nest.

Double-branched Nest.

The other exceptional form of nest I wish to refer to, is a double-branched one, but quite distinct from the one just described, inasmuch as, the double branch proceeded upwards from the upper part of the nest, and not downwards from the lower part, as in the last. A great part of Mr. Moggridge's book is taken up with references to this description of nest, and to it I must refer you for information as to the wonderful way in which this double branch is utilised as a means of retreat from enemies, and also as to the marvellous way in which the second trap-door is hinged at the mouth of the branch, so as to be capable of closing up either the branch or the main nest, the door having a handle or flap attached to it, for more convenient use by the spider. I confess that though I searched anxiously for such, I never found one. A servant of mine, however, on whose veracity I can depend, informed me, that in the month of April, he found such a nest in the cultivation paddock. His statement is, that when he lifted the outer door on the surface of the ground, he saw the spider holding down the trap-door with its feet. (The spider was one of those first sent to the Rev. Pickard Cambridge.) On forcing the door open, the spider retreated down its hole, and on digging down after it, it retreated up a side gallery, which had a door on its entrance. This door had a little flap attached to it. In this branch gallery were stored caterpillars and grasshoppers. The main tube was crooked, but the branch gallery was straight and sloped upwards, as shown in Sketch No. 1, Plate VIII., which is a copy of the original given to me by the man who saw it. In the particular spot where this was got, I was not able to examine many nests, and in those I did examine, the soil around was so loose and friable, that the nests got spoiled in the digging, so that though I did not get them, I think it is highly probable this type of nest may yet be found in abundance. At any rate, I am sure there is an ample field for many observers to occupy their attention upon, as I believe the type of nest, and habits of the individual will vary in different localities.

Do they emit a viscous secretion from the palpi?

As some doubt seems to exist as to the *Territelaræ* emitting from their palpi a viscous secretion, enabling them to traverse the perpendicular surfaces of dry, highly polished bodies, I may as well state, that my experience is the same as Moggridge's, viz.: "That when placed in a glass tumbler they all remained helpless prisoners, though struggling vigorously for their freedom."

Comparison with Jamaica nest.

Through the kindness of Captain Hutton, I am able to exhibit to you, a Trap-door Spider's nest from Jamaica, presented to the Museum by Mr. Murison. You will see at a glance, that it is quite a different type from any of those I have described, or exhibited to you. It is really a nest, or pouch opening directly from the surface of the ground, about an inch in diameter, and about three inches deep. It has nothing at all in common with our species, except the silk-lining and the trap-door, and these are much more tough and thick in the woven material, than are any Oamaru nests. The nest too, tapers in at the bottom to a point, and is closed up, though it is now slit up, and has nothing at all like a long tunnel connected with it, as is invariably the case here. Unfortunately the spider connected with this nest has been destroyed by insects. If the trap-door of this nest is a fair specimen of the West India type referred to by Moggridge (pages 80 and 133), as a "single-door wafer nest," then clearly there is no difference between it and many of the trap-doors of the Oamaru nests now before you except in the strength of the material, which is no doubt due to the effects of the tropical climate. There are great differences between the nests from the two places, but none in the general type of trap-door, and this illustrates what I stated near the beginning of my paper, that the distinctions put forward by Moggridge of "single-door cork nests," and "single-door wafer nests," is not a good one, especially as he says that "the single-door wafer nest is only known, at present, in the West India Islands." If this turns out to be a good distinction it will indeed be remarkable that this type should only be found at two such extreme points on the Globe, as Jamaica and New Zealand. In this nest there is nothing of the short spur-shaped enlargement referred to by Moggridge, as sometimes characterises the West India nests. I may point out too, that the Jamaica nests described by Gosse, and quoted by Moggridge, have evidently not "wafer-like doors," merely "lying on," rather than fitting into the aperture of the tube" for he (Gosse) says: "The mouth of the tube is commonly dilated a little, so as to form a slightly recurved brim or lip; and the lid is sometimes a little convex internally, so as to fall more accurately into the mouth and close it."

Distribution in New Zealand.

On the question of distribution, I may state that, though I have found them only in the Oamaru district, I have been told they have been got as far south as Palmerston, in Shag Valley, and in Auckland. In the latter place I have only heard of their being found in scoria walls. My brother, Mr. Justice Gillies, after seeing these nests and spiders, when on a visit here recently, wrote me that his little boy had found a nest in the scoria walls of his garden at Mount Eden. I do not think they are obtainable round about Dunedin, as I have often looked unsuccessfully for them, and my impression is that they will not be found in any of the heavy cold clay lands south of Dunedin. In Oamaru and Shag Valley the soil is a light sandy clay, or silt, resting on a dry bottom, generally of limestone, and it is in such warm lands only, that, I suspect, this sub-tropical species of spider has survived. If this species is limited to certain districts by the supply of food, and by its enemies only, then, obviously, there can be no reason on this score why they should not be found in greater abundance almost anywhere else in Otago and New Zealand than in the Oamaru district. I rather incline to the opinion that this species will be found to be limited by the character of the soil and by climate, more than by food, especially as the very few places throughout the world where they have been found all coincide, so far as I know, in having a light soil and warm dry climate. Should this prove to be the case, it will open up a wide and interesting field for speculation as to the causes which have led to their distribution to such remote corners of the globe, and to their limitation to such small and confined areas. Have they all spread from one centre of creation, or have different types been originated in separate areas of development? Whichever it is, we are pretty sure of this, either that enormous periods of time must have elapsed since the first parent stock migrated east and west, to such extremes of the world as Jamaica and New Zealand, especially when we consider the very indifferent locomotive powers of the species, and its extreme reluctance to leave its native home, or, on the other hand, that some common power has been at work controlling and directing the development of such marvellously intelligent and skilfully artistic creatures in such remote and opposite parts of the globe.

Art. XXXII.—*Notes on the* Coleoptera *of Auckland, New Zealand.*

By Captain Brown.

[*Read before the Auckland Institute, 17th May, 1875.*]

It has been suggested by C. M. Wakefield, Esq., of Canterbury, that the publication of my observations on the *Coleoptera* of Auckland in the "Transactions of the New Zealand Institute" might be the means of disseminating some desirable information. I confess, however, that I accede to the request with diffidence; but, whilst regretting that no abler entomologist has relieved me of the task, I trust that my desire to do justice to the subject will secure the indulgent consideration of the members of the Institute.

I propose, in this short sketch, to confine my remarks on the beetles of this Province to an enumeration of the different families of the order represented here, the names of such characteristic species as are known, adding some few statements regarding the peculiarities of such as I am best acquainted with.

I adopt this method in the hope that it will induce gentlemen of the other Provinces to publish concise accounts of the endemic *Coleoptera* of each division of the Colony, in order that we may obtain a more accurate knowledge of this interesting order of insects.

I have often had occasion to regret that a properly classified collection of such of the New Zealand *Coleoptera* as are known to science is not available to the entomological student of Auckland. I am now, however, so far as the means at my command will permit, preparing such a collection as will materially aid in providing that desideratum. Some two years ago I forwarded a case of New Zealand *Coleoptera* to Dr. Sharp, the entomologist of Dumfriesshire, and, perhaps, I may be permitted to quote from some of his letters to me on the subject. In one he states :—" I have received your box, which contains about one hundred and sixty species, by far the greater number of which are unknown to science, and therefore undescribed." In another, dated the 18th September last, he informs me :—" I am packing up your lot of *Coleoptera*, named, so far as I have been able to accomplish it. As regards the *Curculionidæ*, I have failed to identify more than a few species. Mr. Wollaston has described the *Cossonides*, and as there were, amongst your lot, two specimens of a very interesting new genus of the group, he has described them under the name of *Mesoxenophasis brouni*." On the arrival of that case of insects I shall deposit in the Museum duplicates of all that have been named. I afterwards forwarded two other cases of beetles to the same gentleman, containing about nine hundred specimens of upwards of one hundred species, and have no doubt the result will be equally satisfactory.

I have also corresponded with Captain Hutton, F.L.S., of the Dunedin Museum, on the subject, and he, having intimated his desire to assist me, I sent him nearly fifteen hundred specimens, on 5th January last, for distribution amongst such entomologists in England as might be willing to undertake the task of naming and describing them, stipulating that one named individual of each species should be returned to me in order that I might place duplicates of these also in the Museum. I am indebted to Mr. Wakefield for much valuable assistance, as also a collection of about a hundred of such species as occur in Canterbury or other of the Middle Island Provinces, which will enable me to institute a comparison with ours.

I may premise the details of my subject by the observation that, in comparison with the *Coleoptera* of India, and particularly Burmah, where I collected, in the year 1857, those of this country must ever appear insignificant as to size, and singularly destitute of the brilliant metallic colours so characteristic of the order ; nevertheless, our beetles are by no means to be despised, as they exhibit a variety of forms that will always prove a source of interest to the studious, and, I may add, of pleasure, even to those who display but little inclination to study the works of the Creator, as exhibited by this beautiful order of insects.

Taking the different classes in rotation, we have, first of all, the

GEODEPHAGA.

The predaceous ground-beetles are divided into two distinct groups or families—*Cicindelidæ* and *Carabidæ*; the former generally accorded the first place, appears to be represented in this Province by only two conspicuous species, one of which, *Cicindela tuberculata*, is abundant on almost every road and pathway. I have taken three others, and although these insects frequent places exposed to bright sunshine, I found one, the smallest of all, in heaps of vegetable rubbish in the Domain, in such numbers as would warrant the belief that such is its usual haunt; it differs in colour from all the other *Cicindela* I have seen in this country.

I have five species from the Middle Island, all bearing a strong family likeness to our own in their general outline and colour.

Carabidæ exhibits seven moderately large species in my collection, the finest, *Feronia antartica*, is about an inch long, of bright dark bronze colour; but another fine *Carabid* is the grandest of the group in these islands. The second in size frequents the roots of potatoe crops, where it is serviceable to the agriculturalist, and may also be found under stones at Mount Eden.

In addition to these, I possess a number of small species, most of them brighter in colour than their more bulky friends; but all, I regret to add, unnamed. One active little *Carabid* of a shining whitish-colour, ornamented by dark marks on the elytra and thorax, is common during summer amongst weeds and rubbish on the sea shore. The sub-family *Scaritides*, distinguished by their elongate form, the junction of the elytra and thorax by a neck, and the palmation of the anterior tibiæ, affords two species at least for observation. I discovered them under sacks of grain and chaff. It is desirable that a collection of our predaceous beetles should be exhibited in the Museum by themselves, coupled with a notice that farmers and gardeners should abstain from injuring or destroying them, when they see them in the land they may be tilling, as they render such people important services. It may safely be assumed that the Middle Island has the advantage of us, both as regards the size and the number of the species of *Carabidæ*.

HYDRADEPHAGA.

Dytiscidæ offers but few species for observation; indeed, I only know of five, whilst *Gyrinidæ* seems to have no representatives whatever. I saw one species of Boat-beetle in a pool near Remuera, but never elsewhere.

The large *Onychohydrus hookeri*, asserted by Dr. Buller as belonging to the North Island, I have searched for in vain.

Perhaps it may not be out of place to assure such Acclimatization Societies as may be engaged with the introduction of European fish into our rivers that no danger need be apprehended from our Water-beetles. I placed several of them in a glass globe containing young fish, and the result of the experiment satisfied me that they will not attack carp. It is, therefore, probable that they will abstain from interference with others under circumstances much more favourable to the fish.

Some specimens from the South Island are much prettier than any we possess; but nearly all the members of this class being nameless as yet, I can give little information respecting them.

Brachelytra.

Staphylinus oculatus, a carrion beetle, may be accepted as the type of this section, as well as of the indigenous carrion-feeders. This class, divided into thirteen families, comprising some seven hundred species in Britain alone, furnishes my cabinet with rather less species than the number of families I have mentioned. I possess six from Canterbury, differing from ours mostly in unimportant details; but two of our species are rather more finely-coloured than those of the South Island. I found numerous individuals of one small, dull species, on the sea beach of the East Coast under *Algæ*, even to a depth of two feet below the surface. Of the *Brachelytra*, it may be confidently asserted that New Zealand will not provide much more than a fiftieth of the number of species found in Britain, and none at all equal to those which adorn the cabinet of the British collector.

Necrophaga.

The Carrion, or Burying Beetles so abundant in most other countries, do not appear to have been equally partial to New Zealand. I possess two species of *Histeridæ*, one of them closely resembling those which occur in the South Island, neither of them have been described as yet, so far as I am aware. I have taken two other Carrion-feeders (besides *Staphylinus oculatus*), which I believe will exhaust the list, so far as really indigenous insects of the class is concerned. The small blue and red insect, found in considerable numbers amongst bones and decaying animal matter, is an importation from abroad named *Necrobia rufipes*.

Lamellicornes.

Of the *Melolonthidæ*, the most familiar to us is the brilliant green *Pyronota festiva*, abundant for the greater portion of the year on *Leptospermum*, and unfortunately on such of our orchard trees as bear stone fruit; being exclusively vegetable feeders, they are exceedingly injurious to the trees we so desire to preserve. This insect varies in colour; I have taken several varieties, though all have a bright metallic hue. I have occasionally captured an insect, resembling *Pyronota festiva*, but four times larger which I imagine to be *Stethaspis suturalis*, most probably the finest specimen of the group we shall find. It is more common at Wellington than Auckland. *Odontria striata*, a rather handsome beetle, as well as two species belonging to *Rhysotrogus*, I have, now and then, found in the morning entangled in spiders' webs, but, not under other circumstances, and am therefore inclined to believe they are of nocturnal habit, but it is just possible that the experience of other collectors may prove my conjecture to be erroneous. A species I possess from Canterbury, belonging to *Rhysotrogus*, I have not succeeded in finding as yet.

Of *Lucanidæ*, I cut one fine specimen out of a partially decayed Kowhai tree, near Stokes' Point, and subsequently two others out of rotten branches of a tree I could not identify, in a clearing on the East Coast. I suspect these are specimens of *Dendroblax earlianus*, but hesitate asserting this with confidence. I also obtained two other species out of Tupakihi, one of which has antennæ of unusual development, *Coriaria sarmentosa* seems to be the habitat of these two species, as I have frequently found them embedded in its decayed wood, in different localities, but never anywhere else, and am inclined to think that both species are new to science. I also possess a couple of specimens of *Lissotes reticulatus*, and of another species (*Ceratognathus helotoides*), which terminates the catalogue of the endemic *Lucanidæ* of New Zealand, so far as I am acquainted with them. *Dynastidæ* furnish my cabinet with three species—*Pericoptus truncatus*, *P. punctatus*, and one smaller insect unnamed—the two former are identical as to species with others from Canterbury, but are somewhat larger; the third which was given to me by Mr. Wakefield, of Christchurch, I have never found in this Province. I saw one specimen of *Pericoptus* on the wing in January last, and was greatly annoyed at being unable to capture it, owing to a severe cut on one of my feet; the larvæ I have occasionally found buried in sand on the beach under kelp and logs. Of the habits of these insects, respecting which so little is known, I can only surmise that they live principally in burrows deep in the sea shore, and only appear above it by night. When overtaken by gales of wind, being bulky, heavy insects, they succumb, and thus are found in numbers strewed along the beach, dead, and generally mutilated.

The fact of their being seen by different observers under precisely similar circumstances, I can account for in no other way, and venture to assert my belief that further investigation will bear out my view of the case; however, I intend to pursue a systematic course, in order to ascertain, if possible, something more definite regarding their peculiar habits.

STERNOXI.

This section exhibits thirty-eight species in my collection, only two of which are identical with others which occur in Canterbury, whilst there are three others from that Province which I have never seen in Auckland.

These insects vary in size from one line to an inch, the largest, *Elater zealandicus*, I cut out of a decayed Kowhai tree. I collected nineteen species in the vicinity of Auckland in the course of some three years, and as I have a penchant for these insects, I searched for them assiduously, and at last came to the conclusion, that very few others would be found. In December last, having removed to another locality, I selected one side of a wooded ravine as the scene of future operations, and with considerable labour having rendered it passable, I spent the greater portion of seventeen days in collecting there, with a result that indicates my having formed an erroneous estimate of the productiveness of this class. Unfortunately a severe cut on the ancle, with a tomahawk, on the 29th December, whilst out collecting, forced me to abandon my researches for the rest of the season. These few days' work, however, furnished me with examples of sixteen species quite new to me, which must seem to be an extraordinary number, when taken in connection with what has been previously stated; and in addition, many individuals of another very handsome species of which I only obtained two specimens at Auckland (one at Cabbage Tree Swamp, and the second in the Domain, nearly two years afterwards, on a Ngaio tree.) I have two other species in the box referred to in connection with Dr. Sharp. Not only were the species more numerous in the locality alluded to, but the insects are far finer examples of the class than I have seen elsewhere. I can hardly form an estimate of the number likely to be produced by the South Island, or even of this Province alone, but it must be obvious, that more careful investigation will add considerably to those already obtained, and we shall find that we possess, at least, one group of insects excelling those of Britain, in beauty, and exceeding them in number.

MALACODERMI.

Owing to a considerable portion of my collection being in England or *en route* from thence, I am unable to give as good an account of the species which occur here, as I might otherwise have done. One, or rather, two species of *Tanychilus*, are very handsome insects. Another species which I captured quite recently, is one of the most beautiful of the New Zealand beetles; it is about four lines in length, of a fine metallic-purple colour, with four bright yellow marks on the elytra. The largest species with which I am acquainted is *Nacerdes lineata*, a very different insect from those I have been describing.

HETEROMERA.

This section comprises a numerous variety of species, some of which are represented by innumerable individuals. As an instance of this, I may mention that, on one occasion I saw on the floor of a cellar, when removing some rubbish, some thousands congregated within the space of a few feet.

The collector is often provoked at finding the most insignificant beetles so numerous, whilst he may often search in vain for more than one or two of the more valuable kinds. This is to be regretted, as, unless several of a kind are placed at the disposal of the more skilled European entomologists, they are unwilling to undertake the task of describing them. I have taken one specimen of a species at Auckland, which I have never met with elsewhere, and another at the Island of Motuihi; the first is a beautiful beetle. Of another species, seven lines long, somewhat cylindrical, and of a dull black colour, I have secured about a dozen specimens. Of *Cilibe* I have two species, generally found under stones and logs, whilst Canterbury affords three at least for observation, one of them being much larger than any which occur here. *Prioscelidæ* may be found in rotten wood throughout the Province; but I only know of two species; the finest is *Prioscelida tenebrionides*, which varies in colour from black to red.

I have lately captured four specimens of an insect belonging to this class, which is the most handsome I have met with; it is of a bright black colour with innumerable silvery lines in irregular patches all over its body.

Of *Mordella* I have taken six species; the most conspicuous being *Mordella antartica*: the smallest, but most abundant, species may be found on the blossoms of Ti-tree scrub in swampy places. These are troublesome beetles to capture, but more so to mount.

I must now notice *Chærodes trachyscelides* (group *Diaperidæ*), which is found in considerable numbers on the sea-beach, amongst kelp, when embedded in the sand. When I first met with this insect, I at once thought I had discovered a new species belonging to *Pericoptus*, and went to some trouble in order to ascertain its habits, which might afford a clue to the discovery of those of *Pericoptus*. *Chærodes* burrows into the sand the moment it is disturbed by the collector. It varies in colour, from pale white to brown but I believe the difference in colour will not affect the number of species. On a subsequent occasion I discovered a nearly allied species, much smaller in size, and far less common than that already adverted to, specimens of which have been transmitted to London. *Chærodes trachyscelides* may also be found on the western shore of the Province; but I am not aware of its occurrence farther South.

Rhyncophora.

The *Curculionidæ*, embracing seventeen families in Britain, affords a large number of indigenous species for observation, many of them being very curious insects. The largest specimen I have taken was found near the summit of Mount Eden, amongst loose scoriæ, where I did not expect to find it. Two individuals of a rather smaller but finer beetle, I cut out of a tree at Stokes' Point; but I have never met with others of the same kinds. Both of these comparatively bulky beetles, however, are vastly inferior to *Rhyncodes ursus* and *R. saunderei*, which belong to the Province of Canterbury; the former may justly claim pre-eminence as the typical specimen of the group. I possess a good many species of *Stephanorhynchus*, which are chiefly remarkable for their thickened thighs.

Of *Scolopterus* I have taken six species of a black or bronze colour, the smallest and most common is named *Scolopterus penicillatus*, and one of a dark red, found only on the native fuschia. *Psepholax* may generally be found in the decayed wood of Ngaio, Manuka, Kowhai.

Our present defective knowledge of this extensive class renders any detailed account impossible. In illustration of its extent I may mention that, besides the number I have sent home to be named, I have still remaining in one small bottle upwards of two thousand specimens, varying in size from the third of an inch to half a line.

The inexperienced collector will often fail to recognize many of the the members of this group, owing to their resemblance to pieces of wood, bark, etc, and their habit of remaining motionless when disturbed.

I have often noticed numbers of Elm and other trees in our neighbourhood presenting a decayed or blighted appearance, generally attributed to atmospheric influences, but were the owners of such sickly-looking plants to remove portions of the wood adjacent to the decaying twigs, they would probably find that the larvæ of insects belonging to this group did the damage.

Mr. Wakefield, in his treatise of 4th September, 1872, which appears in the "Transactions of the New Zealand Institute," refers to a species of *Brentidæ* (*Lasiorhynchus barbicornis*), which I never met with until T. F. Cheeseman, Esq., F.L.S., showed me one which he discovered near a decayed stump at the Thames. That beetle is by far the largest I have yet seen, its rostrum alone is equal to the entire length of *Prionoplus reticulatis*, hitherto considered the largest of our *Coleoptera*.

LONGICORNES.

The most conspicuous members of this class with which I am acquainted are *Prionoplus reticularis*, *Æmona hirta*, *Xuromorpha lineata*, and *Hexathrica pulverulenta*; the three latter being handsome beetles. Another remarkably fine species, dark blue with yellow stripes of about an inch long, occurs in the vicinity of Remuera. A single specimen of another species, which I captured on a fence at Whitiangi, is nearly as long as *Prionoplus*, but more cylindrical in form; its prevailing colours being blue and yellow; and more recently I discovered another new *Longicorn*, which equals, if not excels, those already alluded to in beauty, though rather less bulky. Another *Longicorn* (*Tetrorea cilipes*) is common on Motuihi and along the East Coast. There is a curious *Longicorn*, which I suppose to be *Calliprason sin-*

clari, found at Tairua, of a green colour above, but with silvery pubescence underneath. The smallest insect of the kind I know, occurs amongst vegetable rubbish in the Domain; but, though small, it is a pretty beetle.

The members of the *Rylotolea* abound in most parts of the Province, may be found on almost all the native shrubs, but seem partial to such as are covered with climbers.

This group comprises a great many species, very various as to size and colour, but few exceed seven lines in length, and although they are rarely remarkable for beauty, they exhibit as fine average examples as any other family of indigenous *Coleoptera*. *Rylotoles griseus* may be accepted as a rather inferior specimen; but it is perhaps the one most generally known. I have only seen one or two specimens from the South Island, but must not, therefore, infer that it is deficient in species there; on the contrary, I am inclined to think that this group is well represented throughout the whole of these islands. I have sent home about three hundred to be identified.

Eupoda.

Although I have found the members composing this section exceedingly numerous, I am unable to give much information respecting them, owing to the reprehensible practice which obtains, with me as well as others, of devoting special attention to the finer or more remarkable families, to the almost entire neglect of such as have no claims to beauty.

They are most abundant on Ti-tree blossoms, but may be found on most of our native shrubs. All the species are small, and generally rather sombre, varying in colour from black to red and brown. I have sent about a thousand to England to be named; but none have been returned to me as yet. I suspect the number of genera and species will prove to be small, when compared with the number of individuals. They are difficult to set out, a fact which may have something to do with the neglect we have displayed towards them.

Pseudotrimera.

This is the last class to be noticed. *Coccinella tasmanii* is the most common representative species, and may be readily identified by its colour, which is a bright black, ornamented with sixteen yellow spots. Another species, besides four yellow or rather orange marks on the elytra, has a broad orange band around the margins. The other species are insignificant as to size, but have more claim to beauty. One single specimen, which I found at Whitianga, is of a yellow colour with dark spots, somewhat resembling the British *Coccinella 22-punctata*. I am unable to state whether *Chilomenes lunata*, *C. maculata*, and *Epilachna reticulata* occur in this Province, as I have no descriptions of them. The beetle which must be considered the type of the class is one which I discovered at Tairua. It is one-third of an inch in length, of a reddish colour, relieved by bright narrow stripes. I have sent some home to be named, together with a considerable number of the smaller species, and hope to be permitted on some future occasion to furnish more reliable information respecting them, if not anticipated by other gentlemen more competent to deal with the subject; but, as the principal aim in writing this paper has been to induce gentlemen more conversant with this branch of natural science to contribute to our knowledge, it is most probable that I will not find it necessary to trouble the members of the Institute with further remarks.

I now deposit in the Museum specimens of the undermentioned beetles:—

No. 1,	*Cicindella tuberculata*	No. 19,	*Elater olivascens*
2,	,, *latecincta*	20,	,, *lineicollis*
3,	,, *wakefieldi*	21,	*Nacerdes lineatus*
4,	,, *feredayi*	22,	*Tanychilus metallicus*
5,	*Feronia antartica*	23,	*Stephanorhynchus*, n. sp.
6,	,, n. sp.	24,	*Scolopterus bidens*
7,	*Colymbetes rufimanus*	25,	,, *pencillatus*
8,	*Staphylinus oculatus*	26,	*Navomorpha lineataum*
9,	*Histeridæ* (species ?)	27,	,, *acutipennis*
10,	*Necrobia rufipes*	28,	*Tetroreo cilipes*
11,	*Lissotes reticulatus*	29,	*Calliprason sinclairi*
12,	*Cerathognathus helotoides*	30,	*Hexatricha pulverulenta*
13,	*Lucanidae* (species ?)	31,	*Rylotoles griseus*
14,	*Odontria striata*	32,	*Prioscelida tenebrionides*
15,	*Rhisotrogus zealandicus*	33,	*Cilibe phosphugoides*
16,	*Stethaspis suturalis*	34,	*Chærodes trachyscelides*
17,	*Pyronota festiva*	35,	*Mordella antartica*
18,	*Elater zealandicus*	36,	*Coccinella tasmanii*

ART. XXXIII.—*Remarks on the* Pselaphidæ (Coleoptera) *of New Zealand.* By Captain BROWN.

[Read before the Auckland Institute, 16th August, 1875.]

ON referring to Captain Hutton's Catalogue of the New Zealand Insecta, as published in the "Transactions of the New Zealand Institute," under date the 11th November, 1873, it will be observed that no mention is made of this group of the *Pseudotrimera*, most probably because of its having been unknown to our entomologists at the time.

As the omission of an entire group of Beetles from our only available list, seems to me a matter of importance, I will endeavour to remedy the defect, by giving a brief account of the species at present known to science.

The family *Pselaphidæ* is represented in these islands by fifteen named species, placed in six *genera*, four of which appear to be peculiar to Australia and New Zealand, whilst the others (*Pselaphus* and *Euplectus*) are of wide distribution; and there can be no doubt, that this list will be greatly augmented from time to time as our entomologists make further discoveries which will render, it necessary, to establish several new *genera*.

Those which have been described are named as follows :—

Tyrus mutandus	*Dalma pubescens*
Pselaphus pauper	*Sagola major*
Bryaxis inflata	,, *prisca*
,, *micans*	,, *miscella*
,, *dispar*	,, *parva*
,, *deformis*	*Euplectus convexus*
,, *impar*	,, *opacus.*
,, *grata*	

The Beetles comprising this family are small, but remarkably handsome as compared with the greater portion of our *Coleoptera;* their characteristic colour is red, varying from orange to brown; and they may be readily distinguished from all our other beetles by their abbreviated elytra and cumbersome antennæ, the latter being usually terminated by a distinct club; but inexperienced collectors are apt to confound them with the *Brachelytra*, a mistake, however, which is easily avoided by attending to the joints of the tarsi, as well as the general outline of the body; the abdomen of the *Pselaphidæ*, though comparatively as much exposed as is the case with the insects belonging to *Brachelytra* is much less elongate.

The group is divided into the sub-families *Pselaphini* and *Euplectini*, and as an instance of the importance of a thorough investigation of our *Coleoptera*, I may quote from a paper read by Dr. Sharp, before the Entomological Society of London, in which it is asserted that the discovery of "the new genera *Dalma*, which is intermediate between the two genera *Batrisus* and *Euplectus*, indicates that the division of the *Pselaphidæ* into two main groups can scarcely be maintained."

I have found these insects in various parts of this Province amongst vegetable refuse, under boards and stones, in splintered stumps of trees, and in company with, if not actually joint inhabitants of the nests of, the Red Ant, at all seasons of the year; but although they occur under such varying circumstances, a collector will be a long time in obtaining many species, or even many individuals of any one species, as it is but seldom that more than one or two are met with at one time, and being inconspicuous as to size, they are very likely to be overlooked altogether.

I now deposit in the Museum a typical specimen of this group, for reference by such entomologists as may not be acquainted with them, but as even a complete typical collection of the group in this Museum would not promulgate a knowledge of these interesting insects beyond that narrow sphere, I take the liberty of attaching copies of the descriptions of the fifteen species already enumerated, and of asking the members of this Institute to aid me in pressing on the "Board of Governors of the New Zealand Institute," the advisability of reprinting them in the "Transactions." If some such course is not pursued, what encouragement will be held out to our entomologists to persevere in their researches beyond the mere selfish gratification of enriching their private collections with a number of nameless beetles? And moreover, how are we to avail ourselves of the joint labours of our collectors, and those eminent entomologists who place their valuable services at our disposal in describing and naming our recently discovered insects, unless the course I venture to recommend be adopted? Surely it cannot be expected of our entomologists, that after expending a considerable amount of time and money in bringing to light our indigenous fauna, and inducing the more skilled European entomologists to name and describe those unknown to science, that they should also, if desirous of communicating such acquired knowledge, supplement their labours by personally transcribing the printed descriptions for each of our colonial collectors.

I will now conclude this paper by expressing a hope, that this year's volume of "Transactions" will afford satisfactory replies to these queries in the shape of a re-print of such descriptions, in the form of an appendix or otherwise, as the Board of Governors of the Institute may deem most beneficial to the interests of science.

ADDITIONAL NOTES, DESCRIPTIONS, ETC.

Descriptions of two new genera of Pselaphidæ. By Dr. Sharp, *of Thornhill, Dumfrieshire, Scotland.*

Dalma, nov. gen. Corpus sat elongatum, subdepressum. Palpi maxillares breves, articulo 2° basi gracile, apice abrupte fortiter incrassato, articulo 3° parvo subtriangulare, articulo ultimo crasso, securiforme-ovali, longitudine articuli 2'. Caput mediocre, nullo modo rostrato-deflexum, tuberculis frontalibus evidentis, sat distantibus. Antennæ breviusculæ, apice fortiter clavatæ, 11-articulatæ, basi distantes. Prothorax cordatus. Prosternum magnum; coxæ anteriores robustæ modice exsertæ. Trochanteres intermedii breves, ut femoris apex cum coxa articula est. Coxæ posteriores prominentes basi fere contiguæ. Abdomen sat elongatum, minus deflexum, marginatum, segmentis ventralibus sex, quorum primo vix conspicuo. Pedes robusti modice elongati, tarsis unguiculo unico valido.

Sagola, nov. gen. Labrum, broad and transverse; its front margin forming a gentle curve, the sides being more advanced than the middle. Mandibles without teeth on their inner edge, with the basal portion very thick; the apical portion abruptly curved inwards; elongate, slender, and acuminate. Maxillæ with the lobes distinct, short, but with long pubescence; their palpi short, four-jointed; first joint abruptly curved in the middle, second joint rather longer than the first, rather narrower at the base than at the extremity, twice as long as broad; third joint short, about as long as broad; fourth joint oval, broader than the preceding joints, about twice as long as broad; its extremity a little truncate, and furnished with a very minute appendage. Mentium large, rather broader than long, quadrate, but with the anterior margin forming a slight double curve, being a little produced and acuminate in the middle. Labial palpi short, stout, two-jointed; second joint shorter than and not quite so thick as the first joint. Paraglossæ prominent, extending about as far as the extremity of the labial palpi.

Antennæ, eleven-jointed, elongate, and rather stout, not clubbed; the apical joints being but little thicker than the basal ones, separated at their point of insertion by their broad, flattened, contiguous, frontal tubercles. Head short, not in the least rostrate. Eyes moderately large. Prosternum rather large, front coxæ slender, moderately prominent.

Mesosternum elongate. Middle coxæ large, only partly embedded in their cavities; separated only by a thin lamina of the mesosternum. Femoral portion of hind coxæ prominent and conical, contiguous at their base; their trochanters moderately large; but the apex of the femur almost attains the coxa. Legs elongate, simple; tarsi much shorter than tibiæ, with two well-developed unguiculi. Hind body elongate, strongly margined at sides; the dorsal and ventral plates equal to one another, with five visible segments, both above and below, but with a well-developed additional basal segment visible on dissection, the ventral plate of which is horny, the dorsal plate membranous. Body pubescent, general form elongate, sub-depressed, very staphylinous-like.

This genus appears to be extremely close to *Faronus*; but the species possess a well-marked process of mesosternum, separating the middle coxæ, of which there is no trace in *Faronus lafertei*; the frontal tubercles, also, are more approximate in *Sagola*, so that the distance between the antennæ at their insertion is less than in *Faronus lafertei*.

Copies of descriptions of new species of Pselaphidæ *from New Zealand.*
By Dr. SHARP.

Tyrus mutandus, n. sp. Rufescens, antice angustatus, sat dense setosus, impunctatus; pedibus elongatis; elytrorum stria suturali basi foveolato. Long. 1¼ M.M.

Antennæ, longer than head and thorax, reddish yellow, first and second joints about equally stout; first, longer than second; second, about as long as broad; third, fourth, and fifth, about equal in length, each a little longer than broad; joints six, seven, and eight, slightly shorter than the preceding joints, especially the eighth; ninth joint, stouter and longer than the eighth, about as long as broad; tenth joint, slightly broader and a little shorter than the ninth, not quite so long as broad; eleventh joint, stout, oval, as long as the two preceding ones, but stouter than they are. Head, narrow, not half the width of the elytra, the antennæ approximate at their insertion, the tubercules contiguous, but separated by a well-marked channel, on each side near the eye is a distinct fovea; the vertex is elevated, smooth, and shining. Thorax, longer than broad, only about half as broad as the elytra, much narrowed in front, behind the middle with a very deeply-impressed curved line, which terminates on each side in a deep, but ill-defined impression; it has no punctures, but is clothed with a short upright pubescence. Elytra, bright reddish-yellow, much narrowed at the shoulders, each with a sutural stria which is very deeply impressed at the base, and outside this a short, deep, and broad humeral impression; they have no punctuation, but are clothed, especially about the sides, with a long, fine, upright, pale pubescence. Hind body short and convex, pubescent, the first segment only slightly longer than the second. Legs long and slender, the claws of the tarsi small.

Pselaphus pauper, n. sp. Rufo-castaneus, nitidus; capite medio impressione magnâ; prothorace elongato, impressione basali curvata bene distinctâ; elytris striâ discoidali sat profunde impressâ. Long. corp. 2⅓ mm.

Obs.—*P. lineata*, King, peraffinis; prothoracis impressione magis profundâ, ejusque parte basali nitidâ, elytro-rumque striâ discoidali bene distinctâ, differt.

Antennæ, longer than head and thorax, the ninth joint but little thickened. Head, with the channel between the frontal processes rather broad, and terminating between the eyes in a deep impression, which is continued backwards along the vertex. Thorax, not more than half the width of the elytra, longer than broad, not much dilated in the middle, in front of the base with a deep curved impression, the part behind this shining like the rest of the upper surface. Elytra, longer than the thorax, much narrowed at the shoulders, each with a sutural, and a very distinct curved discoidal stria; they are quite shining and furnished with a few fine curved hairs. Hind body rather densely set with very fine depressed hairs.

Bryaxis inflata, n. sp. Pilosa, nitida, rufescens, capite prothoraceque picescentibus; vertice foveis duabus magnis; prothorace basi trifoveolato, foveis lateralibus magnis, sulco curvato profundo conjunctis; elytris abbreviatis, apice utrinque fortiter sinuatis, estriatis; abdomine balde convexo; Metasterno brevissimo. Long. corp. $2\frac{1}{4}$ mm.

Mas., abdomine segmento 2° ventrali apice medio leviter emarginato, seg. 4° basi tuberculo parvo, 6° leviter impresso.

Antennæ pilose, rather stout, fifth joint distinctly longer than the contiguous ones; ninth joint hardly broader than the eigth; tenth transverse, nearly twice as broad as the ninth; eleventh joint large, a little broader than the tenth, distinctly pointed at the extremity. Apical joints of maxillary palpi stout. The part of the head in front of the antennæ distinctly rostrate; the upper surface of the head with two very large pubescent foveæ between the eyes. Thorax subglobose, in front of the base with a very deep curved impression, terminating on each side in a large fovea, and in its middle impressed with a small and not very distinct fovea. Elytra not longer than the thorax, rounded at the sides, and greatly narrowed at the base; convex, without striæ or humeral impression, but emarginate on each side at the extremity. Hind body very convex, all its dorsal segments about equal in length.

Bryaxis micans, n. sp. Rufescens, nitida, impunctata, setis elongatis, erectis parce vestita; capite fronte depressâ, vertice bifoveolato; prothorace elongato, simplice; elytris striâ suturali minus distinctâ, discoidali nullâ. Long. corp. $1\frac{3}{4}$ mm.

Mas., antennis articulo 5° magno, intus acuminato, articulis 9–11 distortis; metasterno medio impresso; trochanteribus anterioribus spinâ tenui; abdomine segmento 2° ventrali ante apicem tuberculis duobus, apice setiformibus subito recurvis. Fem., incog.

Mas., antennæ rather stout, first joint elongate, quite as long as the three following joints together, these scarcely differing from one another; fifth joint elongate, inwardly projecting and angulate; joints nine, ten, and eleven forming a distorted club; the tenth joint is broader than the ninth; but has its base cut away on one side, and its apical portion projecting; the eleventh joint is large, and it also is irregularly formed; its base being broad and oblique, and the articulation not in the middle, but on one side. Head depressed in front, so that the antennal tubercles are distinct and between the eyes with two distinct foveæ. Thorax narrow and elongate, longer than broad, the sides prominent in the middle, the base margined; on each side, behind the projecting part of the thorax, and obscured by it, there is a not very easily seen fovea. Elytra longer than the thorax, with a fine sutural stria, but otherwise without striæ or depressions. The whole of the upper surface is shining and impunctate, but bears some long, sparing, fine hairs.

Bryaxis dispar, n. sp. Piceo-rufa, nitida, setis elongatis tenuissimis parcius vestita; vertice bifoveolato, fronte depressâ; prothorace simplice, latitudine haud longiore; elytris striâ suturali distincta, discoidali nullâ. Long. Corp. $2\frac{1}{3}$ mm.

Mas., antennis 10–articulatis, articulis duobus ultimus estus, concavis; trochanteribus anterioribus spinâ tenui elongatâ armatis; abdomine segmento 2° ventrali ante apicem processis tenuibus duobus leviter recurvis insigne.

Mas., antennæ longer than head and thorax; first joint scarcely so long as the two following together; fifth joint longer, but scarcely stouter than the contiguous ones; eight joint small, scarcely so large as the seventh; ninth joint large, cut away on one side, so as to leave the apical portion prominent on that side; eleventh joint large, much broader in one direction than in the other, and with one of the two broad faces impressed or concave. Head with the front much depressed in the middle, and the vertex with two large foveæ. Thorax much narrower than the elytra, about as long as broad, the sides dilated a little in front of the middle, and on each side there is an indistinct fovea behind the dilated part. Elytra much longer than the thorax, with a deep and distinct sutural stria; but without other impressions. Legs long and rather slender. The whole of the upper surface is shining and impunctate, and bears some long, fine hairs.

Bryaxis deformis, n. sp. Fem., rufescens, nitida, setis elongatis tenuissimis parcius vestita; capite quadrifoveolato (foveis frontalibus antice minus discretis); prothorace simplice; elytris striâ suturali profunda, discoidali nullâ; predibus quatuor anterioribus deformibus (tibiis extus curvatis). Long. corp. 2 mm.

This species closely resembles the Fem. of *B. dispar*, but has the antennæ shorter and stouter, and has two foveæ in the frontal depression, which appear quite distinct and separate when viewed from above; but less so when looked at from the front. The four front tibiæ are extremely remarkable, as from the middle to the extremity they are much bent outwards.

This form is so remarkable that I at first supposed the legs were deformed; but, after a careful examination, I have concluded that it is more probably natural. Except for the characters mentioned above, the insect closely resembles the Female of *B. dispar*.

Bryaxis impar, n. sp. Rufescens, nitida, glabra, vertice bifoveolato; clypeo antice transversim impresso; elytris striâ suturali minus profundâ. Long. corp. 1½ mm.

Mas., antennis 10-articulatis, art. 9° maximo; metastorno late sed parum profunde impresso; abdomine segmento basali ventrali apice bituberculato.

Fem., antennis 11-articulatis, art. 9°, 10° que transversis; metasterno abdomineque simplicibus.

Antennæ, stout and short (except for the two terminal joints in the male; the basal joint short, its visible part not longer than the second joint; the ninth joint in the male excessively developed, longer than broad, and on the inside it is a little cut away at the extremity, and the tenth joint in the same sex is only about half the bulk of the ninth; in the female, the seventh and eighth joints are extremely small; the ninth joint is also very short, but much broader than the eighth; and the tenth joint, which is also short, and very transverse, is considerably broader than the ninth, the eleventh joint being comparatively large. The head is smooth and shining; it has in the frontal depression two indistinct foveæ, and the vertex has also two very small foveæ. The thorax is about as long as broad, smooth, and shining, without impressions or foveæ. The elytra are very elongate, quite smooth and shining, and show only on each a single fine sutural stria. The hind body is very short and deflexed; the legs are slender.

Bryaxis grata, n. sp. Rufescens, nitida, fere glabra; antennæ in utroque sexu 11-articulatæ, articulis penultimis parvis; clypeo antice æquali haud impresso; prothorace ante basin lineâ curvatâ impressa, medio desinente; elytris striâ suturali distinctâ, plicâque intra-humerali obsoletâ; capite subtus medio lineâ longitudinali elevatâ valde discretâ; pedibus minus elongatis. Long. corp. 1⅔ mm. (vix).

Mas., vertice bifoveolato; metasterno late impresso; abdomine segmento 2°, 6° que transversim foveolatis (segmento 5° medio omnino carente).

Femina, vertice æquali; metasterno abdomineque haud impressis.

Antennæ (only differing in the sexes in that those of the male are slightly longer than those of the female, with the first joint short, its visible part about as long as the second joint; third joint, more slender than, and about as long as the second joint; joints, fourth to tenth, bead-like, the tenth differing but little from the others; eleventh joint abruptly larger, obtusely pointed. Thorax about as long as broad, smooth and shining, without foveæ, but immediately in front of the base transversely depressed, the depression, however, leaving the middle untouched. Elytra elongate, nearly twice as long as the thorax, each with a well-marked sutural stria, and an indistinct intra-humeral impression. Hind body very short.

N. g. *Dalma pubescens*, n. sp. Obscure rufescens, nitidus sed pubescentia (præsertim in abdomine) obtectus; prothorace ante basin transversim impresso trifoveolatoque, medio antice minus profunde, lateribus utrinque profunde canaliculatis; elytris striâ suturali latâ et profunda, basique profunde bi-impressis. Long. corp. 2½ mm.: lat. elytrorum fere 1 mm.

Mas., antennarum articulo nono maximo (undecimo paulo majore) intus apice foveâ magnâ impresso.

Fem., ant. articulo nono præcedente paulo majore.

Antennæ stout in the male, moderate in the female; about as long as head and thorax, basal joint only a little elongate; second joint stout, bead-like, about as long as broad; joints third to sixth short, bead-like; joints seven and eight in the male short and very transverse, in the female scarcely differing from the preceding joints; ninth joint in the female broader, but scarcely longer than the eighth; in the male extremely large, subquadrate and impressed on the inner side at the extremity; tenth joint short and transverse in both sexes; eleventh joint stout, obtusely pointed, moderately long; in the male slightly stouter than in the female. Head rather small (smaller in the female than in the male sex), considerably narrower than the thorax, the frontal tubercles quite distinct, short, flattened, and shining, rather widely separated; the vertex is elevated, and on each side has a fovea confluent in front with a frontal depression. The thorax is narrower than the elytra, not so long as broad, the sides rounded in front, and considerably narrowed behind; in front of the base is a deep transverse impression, which commences on each side in a large fovea, from which there proceeds forwards a longitudinal impression; on the middle of the transverse basal impression is placed a very large fovea or depression, from which a moderately distinct channel proceeds forwards, but does not reach the front of the thorax; the thorax is not punctured. The elytra are longer than the thorax, and are redder than the rest of the surface; they are impunctate, but each has a very distinct sutural stria, and outside this they are rather deeply impressed, the impression between divided into two by a well-marked, raised, longitudinal fold. The whole surface is covered with a fine yellowish pubescence, which is more distinct on the hind body than elsewhere.

Sagola major, n. sp. Rufescens, nitida, elytris rufis; prothorace transversim cordato; capite lato, angulis posterioribus leviter dilitatis. Long. corp. $2\frac{1}{2}$ mm.

Mas., trochanteribus anticis prominulis acutis; abdomine segmento 6° ventrali tuberculis duobus elevatis. Fem., incog.

This species differs from *S. prisca* by its much broader form, by its more slender antennæ, the basal joint in particular of these organs being notably more slender, and by the more deflexed extremity of the hind body, as well as by the different characters of the male. The first visible dorsal segment of the hind body possesses a transverse band of glandular pubescence, which is wanting in the other species here described.

Sagola prisca, n. sp. Obscure rufa, elytris sanguineis, capite thoraceque parce, longius, abdomine dense pubescentibus; antennis crassiusculis, articulis quatuor penultimis leviter transversis; capite angulis posterioribus rotundatis. Long. corp. $2\frac{1}{2}$ mm.

Mas., abdomine segmentis 3°, 4° que apice tuberculis duobus elongatis, 5° transversim depresso, apice emarginato.

Antennæ with the first joint stout and elongate, second joint small, subglobular; third joint similar in shape to second, but still smaller than it; joints fourth to tenth differing little from one another; eleventh joint hardly as broad as the tenth, but a little longer than it, obtusely pointed. Head small and short, with two small foveæ on the vertex, and with a fine channel separating the short, flattened, frontal tubercles; this channel expanding a little behind, so as to appear as if it terminated in a very small fovea. Thorax subcordate, with a large quadrate impression on the disc behind the middle, and, close to each hind angle of this, a very small fovea, and with a larger fovea on each side. Elytra about one and a-half times as long as the thorax, a little narrowed towards the shoulders, each with a sutural stria, which towards the base is very deeply impressed, and between this and the shoulder with a coarse, elongate impression; this impression appears to be nearly divided into two near its base. The hind body is broad, and its exposed portion is slightly longer than the elytra.

Sagola misella, n. sp. Obscure rufa, elytris sanguineis; antennis articulis penultimis vix transversis; elytris abdomine multo brevioribus. Long. corp. $2\frac{1}{4}$ mm.

Mas., a femina notis sexualibus externis vix distinguendus.

This species is very closely allied to *S. prisca*, but is readily distinguished therefrom, by its much shorter elytra and metasternum; its antennæ are also more slender, and their fifth joint is notably thinner; the hind body is broader towards the extremity; and the remarkably conspicuous male characters of *S. prisca* are in *S. misella* entirely wanting.

Sagola parva, n. sp. Corpore antice fortiter angustato. Obscure rufa, elytris sanguineis; antennis sat gracilibus, articulis penultimis vix transversis; prothorace elongato, latitudine fere longiore; elytris abbreviatis, abdomine multo brevioribus, prothorace vix longioribus. Long. corp. $2\frac{1}{3}$ mm.

Very closely allied to *S. misella*, but with the head and thorax narrower, and the elytra a little shorter than in that species; the antennæ also are rather less developed than in *S. misella*, being both a little shorter and more slender.

Euplectus convexus, n. sp. Rufescens, pube brevi depressâ dense vestitus; fronte profunde bisulcatâ; prothorace angustulo, basin versus impressionibus tribus magnis; elytris striâ suturali basi profunde impressâ; impressioneque intra-humerali bene distinctâ; antennis articulo ultimo acuminato. Long. corp. $2\frac{1}{3}$ mm.

Mas., pedibus omnibus incrassatis, tibiis posterioribus intus angulatis.

Antennæ, shorter than head and thorax, second joint not so long as first; joints third to ninth bead-like, differing little from one another, except that the ninth is a little broader than the others; tenth joint, short, rather strongly transverse, about twice as broad as the ninth; eleventh joint, large, broader than the tenth. Head, rather long and narrow, very deeply impressed between the frontal tubercles; from each side of the impression proceeds backwards a deep furrow, which terminates between the eyes as a fovea-like expansion. Thorax much narrower than the elytra, about as long as broad, much narrowed behind, with a very large impression behind the middle, which is connected on each side with a deep large fovea near the hind angles. Elytra distinctly longer than the thorax, with the sutural stria deeply impressed at the base, and with a rather large intra-humeral impression.

Euplectus opacus, n. sp. Rufescens, opacus, pube brevissimâ densius vestitus; antennæ breves; capite parvo, transversim impresso; prothorace basin versus impresso, disco canaliculato; elytris striâ suturali, alteràque subtili, discoidali, abbreviatâ, basi profunde impressis. Long. corp. $1\frac{1}{3}$ mm.

Antennæ, shorter than head and thorax, second joint a little shorter than the first, subglobose; joints, third to eighth very small; ninth joint broader than its predecessors, transverse; tenth joint, broader than the ninth, strongly transverse; eleventh joint, stout. Head very short, a large portion of its upper surface occupied by a curved or angulated transverse impression. Thorax short, not so long as broad; in front of the base it has a deep curved impression, which is indistinctly expanded in the middle and on each side, and in front of this there is a longitudinal impression on the disc. Elytra, longer than the thorax, with a distinct sutural stria and a fine abbreviated discoidal stria, these striæ being deeply impressed or foveolate at their commencement. Legs, rather short.

ART. XXXIV.—*Descriptions of a New Genera and Species of* Heteromera, *New Zealand.* By F. BATES, F.L.S.

[*From the "Annals and Magazine of Natural History," Dec., 1873; Feb., 1874.*]

As there is considerable activity just now displayed in the publication of papers descriptive of the coleopterus fauna of New Zealand, I have thought it might be acceptable to give descriptions of all the species of New Zealand *Heteromera* contained in my collection that appear to be new to science.

I have therewith incorporated a revision, together with descriptions of new species, of my genus *Hypaulax* and another, allied, new genus *(Astathmetus)* from Colombia.

Of the genus *Cilibe* (peculiar to New Zealand) I have established twelve species (ten of which are new, the *phosphugoides*, White, = *elongata*, Brême) and two supposed varieties.

The *Titæna erichsoni*, White, proving upon examination to be generally distinct from *Titæna*, has caused me to notice the species of that genus (which are peculiar to Australia), and to describe some that are new; the New Zealand group of three species forms a new genus *(Artystona)*, the characters of which are fully stated in the body of the paper. I have also thought it interesting to describe the cognate group of species found in New Caledonia which constitute my genus *Callismilax*, some of the species of which have already been described by Montrouzier as belonging to the genus *Strongylium*.

The *Opatrinus convexus*, Fairmaire, described from examples coming from Wallis Island, occurs also in New Zealand; it will form the type of a new genus, totally removed from *Opatrinus*, and must be placed not far from *Scotoderus*, Perroud.*

The *Opatrum tuberculicostatum*, White, evidently does not belong to that genus; as M. Miedel, of Liége, is at present engaged upon a monograph of the *Opatrides*, I leave this in his hands.

I have not as yet been able to consult the work by Blanchard containing the description of his *Bolitophagus angulifer* (from New Zealand); I, however, strongly suspect it to be identical with a species I have in my collection, and which I refer to the genus *Bradymerus*, Perroud: this genus is placed by its author with the *Bolitophagides*: to me it seems more natural to place it with the *true Tenebrionides*.

I have received from Mr. Pascoe examples of the *Selenopalpus cyaneus*, Fab.; these appear to me specifically identical with the type specimens (in my possession) of *S. chalybeus*, White. The characters of this genus lie rather in the form of the hind femora and tibiæ in the male (of which the former are strongly incrassated and somewhat arched, and the latter much thickened and strongly and acutely produced at the apex within) than in the form of the last joint of the maxillary palpi (in the same sex), as we find in some male examples of the *Dryops (Ananca?) strigipennis*, White, a precisely similar form of palpus as in *Selenopalpus cyaneus*—*i.e.* the last joint strongly expanded, flattened, and with a deep semicircular excision at the outer edge.

The *Zolodinus zealandicus*, Blanch., has the very exceptional character of having the hind margins of the third and fourth ventral segments corneous.†

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* The description of *Scotoderus cancellatus*, Perroud, very accurately applies to examples of *Iphthimus cancellatus*, Montrouz., obtained from the collection of Doué. *Dechius*, Pascoe, is but another name for *Scotoderus;* and Perroud's, having priority, must stand. The mesocoxal cavities being widely open externally, revealing the trochantins, at once removes this genus from the position where Perroud has placed it, viz. in the vicinity of *Antimachus* (a genus of *Ulomides*); as I have previously stated ("Trans. Ent. Soc.," 1868, p. 265), its true position appears to me to be near to *Bius*. The *Scotoderus cancellatus* is very near to *aphodioides (Dechius)*, Pascoe, but may at once be separated from the latter by its smaller size, more finely punctured prothorax, the more distinctly crenated striæ of the elytra (especially those by the suture), with the intervals distinctly punctulate. *Scissicollis (Dechius)*, mihi, may instantly be distinguished from both by its sparsely punctured and not at all rugose head, the very strong (and punctured) groove down the middle of its prothorax, the remainder of the surface of this part being almost impunctate.

† It is the same in the genus *Calcar* and in another, allied but undescribed, South American genus; these somewhat militate against the value of this as a great divisional character, as laid down by Drs. Le Comte and Horn.

The *Mimopeus amaroides*, Pascoe, judging from description, will be the same as the *Cilibe elongata*, Brême.

The genus *Rygmodus*, White, has been shown by Mr. C. O. Waterhouse ("Journ. of Entom." v. p. 194) to belong to the *Hydrobiidæ*.

The number of the now described New Zealand *Heteromera* amounts to but forty species, distributed in twenty-two genera; there are doubtless many more to come.

Cilibe opacula, n. sp.

Somewhat broadly oval, but little convex; brownish black, the elytra usually with a tinge of dark chocolate (or purplish) brown; subopaque. Head and prothorax finely and very closely punctured, the interstices (except on the epistoma and disk of prothorax) a little elevated and reticulate; epistoma broadly truncated in front, the angles rounded, the suture strongly marked at each side: prothorax deeply arcuately (sometimes slightly sinuously) emarginate in front; front angles prominent, subacute, slightly convergent; base more or less strongly bisinuate-emarginate; the hind angles more or less produced, acute, directed behind or sometimes a little outwardly, reposing on the shoulders of the elytra; sides gradually narrowing in a slight curve from base to apex, sometimes (Fem.,?) subparallel from the base to a little beyond the middle, thence rapidly curvedly narrowed to the apex; usually they are very slightly sinuous in front of the hind angles; disk very moderately convex, lateral margins rather broadly expanded, a little reflexed or concave, and unequally thickened at the edges; base and apex more or less distinctly margined or thickened at each side, sometimes throughout at the apex; a more or less distinct, transverse, angulate impression at each side of the middle, close to the basal margin; scutellum transversely curvilinearly triangular, closely punctured: elytra more or less sinuate-truncate (and a little wider than base of prothorax) at the base; a space, more or less open, between the base of the elytra and base of prothorax; sides very slightly rounded, more or less gradually narrowed from the middle to the apex; expanded lateral margins wide, reflexed or concave, transversely and somewhat reticulately rugose-punctate, and studded with very small granules; disk closely, finely, and rather uniformly punctured, the interstices (especially at the sides) a little elevated and reticulate and studded with indistinct minute granules; a series of narrow longitudinal costæ more or less indicated, and an irregular row of rugged foveæ, just within the expanded margin, not extending to the apex: underside brownish-black, shining, finely punctured; flanks of prothorax more or less strongly (especially basally) longitudinally rugose, the underside of the expanded lateral margins being transversely rugose: legs dark brown, shining; femora finely and not closely punctured; tibiæ closely submuricately punctured, the anterior obliquely truncated at the outer side at apex; hind tibiæ quite straight; tarsi and antennæ reddish-brown; joint eight of the latter subpyriform, nine and ten a little transverse, subturbinate, eleven large, broadly rounded at apex.

Length $8\frac{1}{2}$–9 lines; width of elytra $4\frac{1}{4}$–$4\frac{3}{4}$ lines.

Hab. New Zealand.

There is a very great amount of individual variation in the species of this genus in the form of the prothorax (especially) and elytra, and in the amount and intensity of the punctuation, etc. of their surface.

In one of the three examples of the present species before me (possibly a female, as similar differences exist in individuals of the other species whereof a series has been obtained), the form is more expanded or more broadly oval, the head and prothorax are broader in proportion to their length, the sides of the latter, instead of gradually narrowing in a slight curve from base to apex, are subparallel to a little beyond the middle, thence rapidly curvedly narrowed to the apex; besides the two ordinary foveæ at each side of the middle, at the basal margin, there is also a broad transverse line or depression, feebly arched, subparallel and near to the basal margin; the elytra are broader and less narrowed behind, and the base is squarely truncated; and the punctuation on the prothorax and elytra (especially on their disks) is more open.

Altogether the largest, most expanded and opaque, and least convex form in the genus.

Cilibe nitidula, n. sp.

Very near to the preceding, and of the same form, but smaller; the the colour black; the entire upper surface much smoother, and shining; the punctuation finer and more open, the interstices less distinctly elevated and reticulate: the elytra do not present the shagreened appearance seen in the preceding; they are more, and very distinctly, convex behind the middle, and consequently more abruptly declivous behind; on the under side the punctuation and the rugosities on the flanks of the prothorax and on the abdomen are similar but stronger; the hind tibiæ are feebly but perceptibly sinuous; antennæ, etc., as in *C. opacula.*

In the single example of this species before me, the head is distinctly impressed on the crown; the prothorax is gradually and slightly curvedly narrowed from base to apex; the apex is strongly arcuately (and feebly sinuously) emarginate, the front angles prominent, subacute, and directed forwards; the base is strongly bisinuate, the hind angles prominent, acute, and slightly outwardly directed; the lateral margins are expanded (but less broadly so than in the preceding) and slightly reflexed or concave, the edges irregularly thickened, and the base and apex margined at each side only.

There is a large, distinct, outwardly curved impression at each side of the disk, extending from near the middle to the basal margin; the scutellum is transversely curvilinearly triangular and closely punctured; the elytra are distinctly convex behind the middle, and are consequently more abruptly declivous behind than in *C. opacula;* the base is feebly sinuately truncated, and between it and the base of the prothorax (and the hind angles of the latter, which repose on the shoulders) there is a decided open space, as in *C. opacula;* the lateral margins are expanded (but less broadly so than in the preceding species) and concave, and there is the row of rugged foveæ just within this margin, as in *C. opacula;* the disks of the elytra also present traces of numerous narrow longitudinal costæ; the under side and legs are of a deep brownish-black, shining; the antennæ, tarsi, and palpi are reddish-brown.

Length $7\frac{1}{4}$ lines; elytra, width $3\frac{5}{6}$ lines.

Hab. New Zealand.

Cilibe otagensis, n. sp.

Very close to *C. opacula*, and difficult intelligibly to define in what it differs from that species; it is, however, distinctly narrower or oblong-oval, usually smaller, paler, more convex, the base of the prothorax more closely applied to the base of the elytra, distinctly more shining, the punctuation etc., on the elytra coarser, more confluent and confused, somewhat ruggedly so at the sides; the sides of the prothorax more rounded, more incurved at the base, the median basal lobe more prominent; the base, consequently, has not that appearance of being bisinuate-emarginate as is the case in *C. opacula*.

Head closely punctured, the punctures coarsest and somewhat confluent on the front, between the eyes, where there are also usually two more or less marked foveate depressions; prothorax more or less strongly transverse; sides more or less regularly rounded, more narrowed in front than behind, always distinctly and more or less sinuously incurved before the hind angles; apex deeply arcuate-emarginate, the angles prominent, subacute, and usually directed forwards; base bisinuate, the angles more or less prominent and acute, reposing on the shoulders of the elytra, and directed backwards; disk moderately convex, very closely (save on the centre) punctured, the interstices a little elevated, and more or less reticulate, at the sides; a transverse depression subparallel and near to the base, and an angulate fovea at each side, close to the basal margin (as in Fem., ? of *C. opacula*); sides moderately expanded, the edges unequally (not uniformly) thickened; scutellum as in *C. opacula*: elytra oblong-oval, base sinuate-truncated; disk moderately convex, closely and more or less confluently punctured; the interstices (especially at the sides) elevated, minutely granulose, reticulately confluent, sometimes assuming the form of irregular nodules, at others of small umbilicated tubercles; the ordinary series of narrow costæ and the row of foveæ within the side-margins more or less apparent; sides rather strongly expanded, concave, transversely reticulately rugose-punctate and granulous: underside, legs, antennæ, etc., as in *C. opacula.*

Length $7\frac{1}{4}$–$8\frac{1}{4}$ lines; width of elytra $3\frac{3}{5}$–4 lines.

Hab. Otago, New Zealand. Four examples.

Var.? *grandis.*

Larger (length 9 lines; width of elytra $4\frac{1}{5}$ lines); the elytra less convex, distinctly more gradually declivous behind; the punctuation, etc. (on the elytra especially) coarser, the punctures larger, the interstices still more elevated and more uniformly reticulate; the apical emargination of the prothorax distinctly sinuous; the tibiæ (especially the anterior) distinctly less closely punctured, and the entire upper surface of a browner colour.

Hab. New Zealand. One example.

Cilibe elongata, Brême, and *C. phosphugoides*, White.

Examples of *C. elongata* obtained from the collections of Reiche and Doué (presumably authentic exponents of the species) do not differ from *C. phosphugoides* except in the form of the prothorax, which in the former has the sides more obliquely narrowed anteriorly, and the elytra, which are more acuminate behind. Experience has shown us that these differences possess no true specific value in this genus: *C. phosphugoides* must consequently be sunk under *C. elongata.*

This species is much smaller than any of those preceding; the form is more or less elongate-oval; prothorax shining black; the expanded lateral margins paler; the elytra are of a more or less deep purplish or chocolate-brown. Head convex between the eyes, trapezoidal in front, with the borders usually dark ferruginous, more or less strongly, closely, and sometimes rugosely punctured; epistoma convex, more or less distinctly arcuate-emarginate in front, the sutural impression more or less distinct: the form and punctuation of the prothorax is variable; it is always of a shining black, convex, a depression on the middle near the base, another smaller at each side at the basal margin; usually very finely and not closely punctured on the disk, the punctures more crowded at the sides and finely rugulose, more or less distinctly granulous on the intervals; lateral margins moderately expanded and concave, the edges finely and uniformly thickened; apex deeply emarginate, front angles more or less acute, and usually a little convergent, sometimes directed forwards; base closely applied to the base of the elytra, bisinuate, hind angles prominent, reposing on the shoulders of the elytra, acute, usually a little outwardly directed; ordinarily the sides are a little sinuously contracted posteriorly, but sometimes they are sub-parallel (in this latter case the base is as wide as the base of the elytra); anteriorly they are always more strongly contracted, sometimes very gradually (obliquely) from behind the middle, at others more abruptly (curvedly) from the middle or even before the middle; scutellum transversely triangular, punctured: elytra oval, more or less acuminate behind, convex, subopaque, of a dark purplish brown; frequently the base (narrowly), the suture, the expanded margins, and the scutellum are of a reddish tinge; base sinuous, and generally a little wider than base of prothorax; expanded lateral margins narrow, concave, not distinctly reaching the apex; disk with numerous more or less distinct longitudinal costæ, irregularly punctured, finely rugose (most strongly at the sides), and studded with very distinct, shining, black granules: underside shining black, finely punctured; flanks of prothorax longitudinally wrinkled, the lateral margins transversely wrinkled; abdomen finely longitudinally rugose; epipleural fold and legs dark reddish-brown, sometimes ferruginous; antennæ, palpi, and labrum (sometimes) ferruginous.

Length 6–6½ lines; width of elytra across the middle 2⅔–3¼ lines.

Hab. New Zealand. Six examples.

It is doubtless in error that De Brême has reported this species as from New Guinea.

Var. *granulipennis.*

A little smaller (5½ lines); head and prothorax (at the sides) less closely punctured, the punctuation nowhere rugosely confluent; prothorax gradually curvedly narrowed from the hind to the front angles, median basal lobe less prominent, the base consequently appears bisinuately emarginate; the interstices (between the punctures) not perceptibly granulose; scutellum a little shorter, less distinctly pointed behind; elytra scarcely sinuous at the base, the punctuation less varied, the punctures distinctly larger and rounder.

Hab. New Zealand. One example.

Cilibe pascoei, n. sp.

Near to *C. elongata;* more broadly oval. Head closely punctured, somewhat reticulately so between the eyes, the interstices being also finely punctulate; epistomial suture well marked throughout: prothorax moderately convex, black, subopaque; sides subangulately rounded, more strongly (and somewhat obliquely) narrowed in front than behind, distinctly and very feebly sinuously narrowed from behind the middle to the hind angles, which are directed backwards; base bisinuate, closely applied to the base of the elytra; apex deeply subangularly emarginate, front angles produced, acute, directed forwards; disk not closely punctured, acute, directed forwards; disk not closely punctured, the interstices not granulose, but sparsely finely punctulate, basal impressions as in *C. elongata*; lateral expanded margins wide, a little concave, and (together with the sides of the disk) rather strongly reticulately rugose-punctate, the edges unequally (not uniformly) thickened; scutellum strongly transversely triangular, punctured: elytra convex, very dark purplish brown, the suture and narrowly at the base inclined to reddish; base subtruncate; disk finely irregularly punctured, the costæ but little evident except at the base, and, together with the suture, smoother than the intervals; indistinctly, except at the apex, minutely granulose; intervals between the costæ irregularly impressed with much larger punctures, and feebly reticulately rugose, most distincsly so at the sides; lateral expanded margins wide, distinctly extending to the apex, concave, faintly punctured: underside shining black; legs and antennæ dard reddish brown.

Length 6½ lines; width of elytra across the middle 3½ lines.

Hab. Pitt Island (the Chathams.) A single example.

Easily separable from *C. elongata* by the relatively broader form, the subangulately rounded sides of prothorax, the peculiar punctuation of the head, etc., the much broader expanded lateral margins, which in the elytra are distinctly broadly continuous to the apex.

Cilibe humeralis, n. sp.

Oblong or oblong-oval; black; elytra sometimes with a slight purplish-brown tinge, slightly shining, moderately convex. Head moderately punctured, the punctures not crowded, the interstices sometimes sparsely minutely punctulate: prothorax distinctly less transverse than in any preceding species, sides more or less strongly and obliquely narrowed from behind the middle, slightly sinuously narrowed behind; hind angles acute, slightly outwardly directed; disk finely punctured, the punctures more crowded at the sides, the interstices not perceptibly granulose, sparsely minutely punctulate; a transverse, slightly bowed, impressed line at each side the middle near the basal margin, and sometimes a rounded fovea at each side the median line near the middle of the thorax; lateral margins moderately expanded, a little concave, rugosely punctured, finely and somewhat uniformly thickened at the edges; apex deeply emarginate, front angles prominent, acute, directed forwards; elytra slightly emarginate at the middle of the base, obliquely and slightly arcuately truncated at each side; humeral angle very prominent, slightly rounded, reflexed, and deeply concave within the angle; disk finely rugulose, studded with small granules, rather closely and finely but irregularly punctured, the punctures largest and most crowded (and frequently, especially at the base, more or less run together, forming indistinct irregular foveæ) between the costæ; these very indistinct; expanded lateral margins rather broad at the base, gradually narrowing behind and scarcely extending to the apex, concave in their basal portion: underside shining, pitchy black; legs and epipleural fold with a reddish tinge; flanks of prothorax and sterna more or less strongly reticulately rugose and granulose; antennæ, palpi, and labrum (sometimes) ferruginous; anterior border of epistoma rufescent.

Length $5\frac{1}{2}$–6 lines; width of elytra across the middle $2\frac{2}{3}$–3 lines.

Hab. New Zealand. Four examples.

In the Fem. ? the form is slightly more expanded, the prothorax slightly more transverse, the sides less strongly narrowed anteriorly, and the punctuation of the elytra a little more open.

The three species last described are very near to each other, but I think there is ample justification, at present at least, in holding them distinct. The species last described is of a more oblong form (especially in the Mas. ?) than the others; the prothorax has not the same glossy blackness as in *elongata*: and the elytra are less opaquely roughened, more closely punctured, and much less distinctly granulose; the humeral angle is much more prominent, the lateral expanded margins broader and strongly concave within the humeral angle. From *pascoei* it may be known by its narrower and more oblong form, finer and closer punctuation, and more narrowly expanded lateral margins.

Cilibe thoracica, n. sp.

In this species the prothorax is still more decidedly elongated (but is yet wider than long) than in the preceding. Form elongate-oval; entirely in a dark brownish black, subopaque. Head and prothorax (save on the middle of the disk) closely punctured, the punctures rounded, a little more crowded at the sides of the latter, the interstices distinctly punctulate; sides of prothorax gradually and but slightly curvedly narrowed from near the hind angles to the apex, distinctly incurved at the hind angles, which are more produced than in *humeralis*, and slightly convergent or directed inwardly; apex deeply emarginate, front angles subacute, slightly convergent; expanded lateral margins moderately wide, scarcely concave, the edges finely and almost uniformly thickened; a rather slight sublunate impression at each side of the middle, close to the basal margin, and another still less distinct, rounded fovea above and in front of them; scuttellum transversely triangular, punctured; base of elytra as in *C. humeralis*, the humeral angle still more produced (but not strongly concave within the angle), sides with a very distinct sinus behind the humeral angle; disk slightly roughened or rugulose, indistinctly (except at apex) granulose, moderately punctured, obscurely foveate-punctured between the costæ (when viewed obliquely); costæ very feeble; expanded lateral margins wide (and concave) at the base, gradually narrowed behind; underside, etc., as in *C. humeralis*.

Length $5\frac{1}{4}$ lines; width of elytra across the middle $2\frac{3}{4}$ lines.

Hab. New Zealand. One example.

The punctuation on the head and on the sides of the prothorax is more crowded, and the insterstices more closely and distinctly punctulate than in *C. humeralis*: the sides of the thorax are distinctly incurved at the hind angles; the punctuation on the elytra is less defined; and the form is elongate-oval.

Cilibe brevipennis n. sp.

Smaller, and of a more briefly oval form, than any other species in the genus. Black, usually most nitid on the prothorax, the elytra frequently of an obscure purplish-brown hue; sometimes the entire upper surface is of a decided reddish-brown colour. Head and prothorax finely and closely punctured, the punctuation very dense (and frequently finely reticulately rugose) on the former and on the sides of the latter; the interstices more or less distinctly minutely punctulate; prothorax transverse, apex deeply emarginate; front angles prominent, more or less acute, usually directed forwards, sometimes slightly convergent; sides anteriorly very gradually narrowed from the middle (sometimes from behind the middle), posteriorly subparallel, or slightly incurved (in one example they are distinctly excurved at the hind angles, which are consequently somewhat outwardly directed), hind angles, more or less produced, acute, directed backwards; lateral margins moderately expanded, more ar less concave; three more or less distinct impressions at the base, and sometimes two indistinct foveate impressions on the middle, at each side of the median line; elytra short, moderately convex, base feebly sinuous; humeral angle not distinctly prominent as in *C. humeralis* and *thoracica*; sides sub-parallel or slightly rounded, not sinuous behind the humeral angle; expanded lateral margins rather broad at the base, narrowed behind, more or less distinctly extending to the apex, strongly concave at the base (especially within the humeral angle) as in *C. humeralis*; punctuation, etc., almost as in *C. thoracica*, but (especially at the sides and apex) the surface is slightly more roughened, more distinctly granulose, and the punctuation a little finer and closer: underside, etc., as in *C. humeralis*.

Length $4\frac{1}{2}$–$5\frac{1}{4}$ lines; width of elytra $2\frac{1}{3}$–$2\frac{3}{4}$ lines.

Hab. New Zealand. Five examples.

Cilibe granulosa, De Brême.

Easily recognizable by its usually squalid aspect, and coarsely sculptured and closely granulose surface. The humeral angle is more or less strongly prominent; the expanded lateral margins of the elytra broad and concave; and there is at the sides a more or less distinct sinus behind the humeral angle; the costæ on the elytra are more conspicuous (especially at the base) than in any of those preceding. In some examples we can perceive on the elytra a very minute pubescence.

Length, $5\frac{1}{4}$–$6\frac{3}{4}$ lines; width of elytra, $2\frac{1}{2}$–$3\frac{1}{5}$ lines.

Hab. New Zealand. Six examples.

Cilibe rugosa, n. sp.

Near *C. granulosa*, but distinctly narrower; the expanded lateral margins of the elytra very narrow, not concave, except slightly at the base; the surface of the elytra distinctly punctured, reticulately rugose, not granulose, or granulose-punctate, and with three distinctly prominent costæ on each; humeral angles not prominent, the sides not sinuous behind them; and the anterior tibiæ have the outer apical angle strongly dentiform.

From the following (*C. tibialis*, the only other species having the outer apical angle of the anterior tibæ dentiform) it may be known by its different form, somewhat squalid, opaque surface, the elytra distinctly rugose, costate, and pubescent; the prothorax more deeply emarginate at apex, the front angles more prominent, the hind angles not acutely produced, etc.

Brown, slightly squalid; head (except the epistoma) and prothorax coarsely punctured, the interstices narrow, appearing a little elevated, and a good deal broken up on the front of the head and the base of the prothorax, allowing the punctures to run confusedly together. Head trapezoidal in front; sides of the epistoma almost completely continuous with the antennary orbits, the angles slightly rounded: prothorax arcuate-emarginate in front, the angles a little produced, subacute, directed forwards; sides regularly but moderately rounded, more narrowed anteriorly than behind, a little sinuous in front of the hind angles, these latter not acutely produced, slightly divergent; the three impressions by the base as ordinary, the two outer strongly marked, and another rounded depression on the middle, at each side of the median line: elytra rather strongly narrowed behind, humeral angles not prominent; sides slightly rounded from the humeral angles, not at all sinuous behind them; the surface somewhat coarsely punctured, very distinctly reticulate-rugose, and very thinly clothed with a short, minute, rigid, pale golden pubescence, on each elytron three very distinct costæ, with a much fainter one between them; these send out irregular, lateral, elevated branches, which cause the reticulate-rugose appearance before mentioned, the interstices being somewhat squalid; the punctuation, costæ, etc., obsolete at the apex; lateral expanded margins very narrow, and concave only at the base; under side brown, closely and somewhat coarsely punctured, much more distinctly pubescent (especially on the abdomen) than on the upper side; flanks of prothorax sparsely, pronotum closely and coarsely, rugose-tuberculate: legs rather long, reddish-brown; hind tibiæ a little sinuous, front tibiæ with the outer apical angle strongly dentiform; tarsi elongate; antennæ and palpi ferruginous.

Length $5\frac{1}{4}$ lines; width of elytra $2\frac{1}{3}$ lines.

Hab. New Zealand. One example.

Cilibe tibialis, n. sp.

Oblong or (rarely) oblong-oval, convex, entirely dark brown, slightly shining, anterior border of the head more or less rufescent; epistoma broadly emarginate in front, the sides distinct from the antennary orbits, the angles broadly rounded; head and prothorax rather coarsely and closely punctured, the interstices on the middle of the former, and on the sides of the latter, appearing a little elevated and somewhat reticulate; prothorax strongly transverse, rather broadly and feebly, and usually a little sinuously, emarginate at apex; front angles not at all prominent, convergent; sides more or less rounded (ordinarily they are well rounded), more or less strongly incurved anteriorly from the middle, less strongly and a little sinuously posteriorly; hind angles acutely produced, divergent; lateral margins not distinctly expanded, the edges very finely and almost uniformly thickened; the three impressions by the basal border always obscure, sometimes obsolete; elytra oblong, or oblong-oval, the punctuation finer than on the prothorax and with a disposition to run together between the costæ; costæ more or less distinct; the intervals, or interstices, more or less distinctly reticulate-rugose at the base, sides, and apex; lateral margins narrowly expanded, usually not distinctly extending to the apex, strongly reflexed at the base, rather coarsely transversely rugose-punctate; flanks (save the lateral margins) of prothorax and sides of abdomen longitudinally wrinkled; flanks of meso- and metasterna coarsely punctured; abdomen finely punctured; under side shining black; epipleural fold and legs reddish-brown, or piceous; antennæ elongate, and, together with the palpi, ferruginous; outer apical angle of the interior tibiæ strongly dentiform.

Length 6–$7\frac{1}{2}$ lines; width of elytra $2\frac{4}{5}$–$3\frac{3}{4}$ lines.

Hab. New Zealand. Seven examples.

The apical emargination of the prothorax is distinctly more feeble in this species than in any of the others, and the front angles least prominent; it is also the most convex, and, ordinarily, the most oblong, form.

Cilibe impressifrons, n. sp.

Oblong or elongate-oval; ordinarily black, the elytra sometimes dark brown, the entire insect sometimes reddish brown; most nitid on the prothorax; rather convex: head rather long, rather finely and closely punctured; a distinct, transverse, slightly bowed impression across the front between the eyes: epistoma broadly truncated in front, the suture rather strongly marked and angulate at the sides; prothorax very finely and, on the middle, remotely punctured; a strong angulate impression at each side close to the basal margin, and sometimes an obscure transverse impression between them; apex moderately emarginate; anterior angles subacute, directed forwards; sides more or less regularly rounded, more contracted anteriorly than posteriorly, occasionally a little sinuous before the front angles; hind angles more or less (sometimes almost imperceptibly) outwardly produced, acute; lateral margins very slightly expanded, a little concave, the edges moderately and almost uniformly thickened: elytra oblong-oval, feebly sinuous at the base; shoulders more or less distinctly rounded; punctuation, etc., almost as in *C. tibialis*, but the interstices, especially at the sides, are more distinctly rugulose; expanded lateral margins narrow, almost obsolete (or strongly narrowed) at the base, scarcely perceptibly continued to the apex, a little concave, the edges sometimes slightly reflexed at the base: markings on the underside similar, but much feebler, to those in *C. tibialis*; legs, antennæ, and epipleural fold reddish piceous; anterior tibiæ acute (but not at all dentiform) at the outer apical angle.

Length $6\frac{1}{2}$-8 lines; width of elytra $2\frac{4}{5}$–$3\frac{3}{5}$ lines.

Hab. New Zealand. Five examples.

The oblong or elongate-oval form, the transverse impression between the eyes, the almost smooth prothorax in contrast with the somewhat coarsely sculptured elytra, the scarcely expanded sides of the prothorax, and the lateral expanded margins of the elytra obsolete at the base, will serve to distinguish this species.

Artystona, n. g.

Differs from *Titæna* in the prosternum less strongly and abruptly elevated between the coxæ, not distinctly concave in front of them, the anterior horizontal portion longer; the head consequently is less deeply imbedded in the prothorax, and does not repose on the front coxæ. Prothorax squarer, less convex, truncated at base and apex, more or less finely punctured. Lateral reflexed margins of the elytra distinctly terminating at the humeral angle; the punctuation of the surface of the elytra is in rows of fine punctures, the intervals being convex, interrupted, and forming, especially at apex, series of oblong tubercles. Legs longer and (especially the tarsi) more slender. Body not pilose.

Artystona erichsoni, White *(Titæna)*.

The *Titæna interrupta*, Redtenb., must be referred to this species, the type specimens of which are in my collection.

The head is remotely punctured; the prothorax more closely punctured, with the interstices quite smooth.

Hab. New Zealand. Three examples in my collection.

Artystona wakefieldi, n. sp.

Readily to be distinguished from *A. erichsoni* by the colour entirely of a dark shining brown; the head and prothorax much more closely and rugosely punctured; and, as a secondary character, the intervals on the elytra (especially at sides and apex) are more strongly interrupted and more distinctly tuberculiform.

Length 5 lines.

Hab. New Zealand. Five examples.

Examples of this species in Doue's collection were labelled "*Strongylium volvulum*, Klug."

Artystona rugiceps, n. sp.

Of the same colour as the preceding, but smaller; form decidedly less parallel; eyes narrower, appearing outwardly conical when viewed from above, a distinct space between their upper margin (which is entire) and the antennary orbits; these latter very convex, subangulately rounded: head much more strongly rugosely punctured; the punctures larger, rounder, and deeper; punctures on prothorax not more numerous than in *A. wakefieldi*, but larger, rounder, and deeper; the interstices not at all rugulose: elytra sculptured as in the preceding, but the form is elongate-oval.

Length $3\frac{3}{4}$–$4\frac{1}{4}$ lines.

Hab. New Zealand. Seven examples.

This is the species dispensed by Dr. Schaufuss under the name of "*Helops? porcatus*."

Adelium zelandicum, n. sp.

Oblong, subparallel, attenuate behind, depressed; bronzed brown, more or less metallic. Head short, immersed up to the eyes in the prothorax, somewhat rounded in front; epistoma very short, convex, distinctly emarginate in front, the suture more or less distinctly marked, arcuate; one or more impressions between the eyes; rather strongly and somewhat irregularly punctured and rugose: labrum prominent, transverse; angles strongly rounded, notched at apex: antenn æmoderate, a little longer in male than in female, perfoliate (distinctly so in male), gradually thicker, and a little compressed outwardly; the joints obconic, all longer than wide, three shorter than four and five united, the last largest of all, obliquely rounded at apex: prothorax subquadrate, wider than long; sides anteriorly moderately incurved, posteriorly subparallel, or very slightly sinuously contracted; apex arcuate-emarginate, and distinctly margined throughout; front angles a little depressed, obtuse; base closely applied to and overlapping the base of the elytra, strongly emarginate at the middle, the hind angles obtuse; more or less finely, and somewhat irregularly, punctured, more or less distinctly wrinkled at the sides and at the hind angles, distinctly (especially at the sides) but very finely pubescent; the whole surface more or less uneven by numerous irregular foveate impressions, the most constant being the rounded fovea at each side of the middle at the basal margin: scutellum rather large, convex, punctured, transversely curvilinearly triangular: elytra but little broader at base than the base of prothorax, narrowed behind, finely pubescent, with numerous striæ, these sometimes a little irregular, more or less finely impressed, but very rarely (in but one out of the ten examples before me) distinctly punctured; the intervals (except at the apex) flat, very finely and closely muricate-punctate, here and there interrupted by irregular transverse impressions, which sometimes assume the form of rounded foveæ: underside bronzed brown, finely pubescent: prosternum slightly compressed in front of the coxæ, its process rather narrow, convex, finely margined at the sides, very obtuse and not produced behind; intercoxal process wide, subtruncate at apex: legs reddish-brown; tarsi and antennæ ferruginous; the four front tarsi distinctly more expanded in male than in female: inner edge of hind tibiæ fringed with longish hairs in the male.

Length $3\frac{1}{4}$–$4\frac{1}{4}$ lines.

Hab. New Zealand. Ten examples.

There are some points of resemblance, especially in the form of the head, between this species and the *Cymbeba dissimilis* of Pascoe; and, did I hold that genus unmistakably distinct from *Adelium*, I might be inclined to place this with it as a second species. It has not, however, the produced and pointed prosternal process, the distinctly marked-off epipleuræ of the elytra, nor the apically rounded intercoxal process, as in *Cymbeba dissimilis*. I possess examples of this latter coming from Cape York, New Hebrides, and New Caledonia.

Amarygmus zealandicus, n. sp.

Form and general aspect of *A. hydrophiloides*, Fairm.; but differs from it, and from all the other species of the genus known to me, in having the four hind tibiæ attenuate at the base, and then expanded, and strongly sinuous (almost broadly dentate in the hind pair) at the inner margin.

Prothorax green, with a slight bluish tinge, brassy at the sides; elytra green, with a brassy tinge, the sutural region a little coppery; head and prothorax finely and, except on the epistoma, not very closely punctured; elytra punctate-striate, the striæ distinctly deeper and the punctures a little larger than in *A. hydrophiloides*; intervals finely and not closely punctulate; under side and legs piceous; tarsi and basal joints of antennæ paler; lower margin of the four posterior femora emarginate; anterior tarsi strongly expanded, the intermediate thickened; antennæ elongate.

Length 3½ lines.

Hab. New Zealand. One example.

The peculiarities observable in the tibiæ and tarsi of the species are either sexual or subgeneric.

Techmessa, g. n. (*Œdemeridæ*).

Mentum transversely quadrangular. Last joint of maxillary palpi cultriform, acute at apex. Mandibles bifid at apex; labrum short, slightly sinuously truncated in front. Head short; epistoma broadly and squarely truncated in front. Eyes large, slightly transverse, entire, more (concolor) or less (telephoroides) strongly prominent. Antennæ inserted on slight prominences in front of, and quite distinct from, the eyes; joint first, swollen, pyriform; second, a little shorter than third, and both obconic; third, not more than half as long as fourth; fourth to tenth, sub-equal, cylindric (concolor) or elongate-obconic (telephoroides); eleventh, a little longer then the tenth, subfusiform. Prothorax scarcely wider than long and convex in concolor; distinctly wider than long, subdepressed, and somewhat unequal in telephoroides; truncated at base and apex; sides rounded, abruptly incurved anteriorly, gradually contracted posteriorly, rather strongly grooved or margined along the base. Elytra elongate, parallel, scarcely convex, somewhat broadly rounded at apex. Femora sublinear; tibiæ armed with two distinct spurs at apex; the two penultimate joints of the tarsi rather short, expanded, and spongy pubescent beneath. Abdomen of five free joints. Body more (telephoroides) or less (concolor) linear, shortly pilose.

Of all the published genera of the Œdemeridæ the present seems to me to approach nearest to *Cycloderus*. It is, however, at once to be distinguished from that genus, and from all the others of the family known to me, by the short third joint of the antennæ.

Techmessa concolor, n. sp.

Black, a little shining; everywhere rather densely clothed with a shortish, semi-erect, brownish pile. Head and prothorax coarsely punctured and rugose; the punctures more crowded on the front of the former and on the sides of the latter; elytra rather strongly and closely punctured, and transversely confluently rugose; under side and legs brownish black, pubescent, punctured; antennæ (save the three basal joints) and palpi dusky-brown.

Length 3 lines.

Hab. New Zealand. One example.

Techmessa telephoroides, n. sp.

Sublinear, depressed, slightly shining; somewhat thinly clothed with a short, subdecumbent, whitish pile; head and prothorax brownish-black; the front and hind margins of the latter reddish-brown, rather coarsely and closely punctured and rugose; the punctures most crowded on the front and epistoma of the former, which are also unisulcate down the centre; prothorax distinctly wider than long, subcordiform, a little depressed and unequal by slight irregular depressions: elytra pale brown, with a yellowish tinge, closely punctured and rugose; underside reddish-brown, pubescent, finely and not closely punctured; legs and palpi pale yellow; antennæ, brown.

Length, 8½ lines.

Hab. New Zealand. One example.

Art. XXXV.—*Critical Notes on the New Zealand* Hydroida.

By Millen Coughtrey, M.B.B.M.; Edin. Univ.; Corr. Mem. Roy. Phys. Soc. Edin.; Hon. Fell. Historic Soc., L. and C., etc.

[*Read before the Otago Institute, October 26, 1875.*]

To the last volume (No. VII.) of the "Transactions," I contributed a paper on the "New Zealand *Hydroida*," in which I gave the results of an examination of the type specimens of Capt. F. W. Hutton's paper on the New Zealand *Sertularians*,"* and of several other specimens I had obtained on the New Zealand coast. Further study of these species and comparison of them with British and other forms have proved to me that in many cases I was in error in my previous paper, and I now hasten to correct these errors. The classification I have now adopted is the commonly accepted one of Mr. Hincks, as proposed in his "British Hydroid Zoophytes," and the order will, therefore, be found different to that used in my former paper. Mr. Hincks divides the *Hydroida* proper into three sub-orders: α *Athecata* (*Hydroida* destitute of true thecæ, or protective cases either for the polypites or gonophores; β. *Thecaphora* (*Hydroida* furnished with thecæ), and γ. *Gymnochroa* (*Hydroida* destitute of polypary). The first of these corresponds with Professor Allman's *Gymno-blastea*, and is represented in New Zealand by the *Eudendrida* and *Tubularidæ* (†) more especially the second agrees with

* Vol. V., 1872.

† I append to these notes a description of a pretty Tubularian species I lately obtained in the Rock-pools off Tomahawk Caves, and in various parts of the Upper Harbour, Dunedin.

Allman's *Calypto-blastea*, and is very abundantly illustrated on our coasts; the third sub-order is identical with the *Eleuthero-blastea* of Allman, some members of this sub-order also existing in New Zealand.‡ §

Sub-order THECAPHORA, Hincks.

Family I.—*Campanularidæ*. Genus *Obelia*.

O. geniculata, Linnæus, Hincks, *loc. cit.*, p. 148.

Laomedea-geniculata, *vide* "Trans. N.Z. Inst.," Vol. VII., p. 290, Fig. 42, Pl. XX.

It differs from the British specimens in the following particulars. It is more robust in habit, its hydrothecæ are larger, and its gonothecæ present some peculiarities; in many specimens these are decidedly urceolate, but occasionally there occurs on the same colony one or two reproductive capsules that have a similar form to the nutritive calycles, only that they are quite as large as the other gonothecæ. For interesting points concerning its distribution in space, I must refer to the "Annals and Magazine of Natural History."

O. pygmæa, sp. nov., mihi. *Vide* "Annals" *loc. cit.*

Genus *Campanularia.*

C. bilabiata, mihi. "Trans. N.Z. Inst.," Vol. VII., p. 291, Figs. 46–49, Pl. XX.

This not like any of the British forms.

C. Integra, Hutton, Vol. VII., "Trans." *loc. cit.*

The species I depicted in Fig. 45, Pl. XX., I now believe to be *Campanularia caliculata*, Hincks.

Family IV.—*Laföeidæ*. Genus *Laföea*, Laniouroux.

Within the past four months I have got several scraps of what I believe to be *Laföea dumosa*, chiefly from Wickliff Bay, Hooper's Inlet, and Sandfly Bay Beach, Tairoa Peninsula.

Family VII.—*Haleciidæ*. Genus *Halecium*, Oken.

H. delicatula, sp. nov., mihi. "Annals," *loc. cit.*

I have since obtained this in the lower harbour Port Chalmers.

Family VIII.—*Sertulariidæ*. Genus *Sertularella*.*

S. johnstonii, Gray, "Dieff. N.Z." Hutton, *loc. cit.* Coughtrey, "Trans," *loc. cit.*

‡ *Vide* Memoir on Tubularian *Hydroids*. Roy. Soc., 1871.

§ I have seen two *Hydræ* in New Zealand; one nearly like *H. viridis*, of Britain, and the other I have not been able to identify with the British members of *Gymnochroa*.

* Genus *Sertularia* is now divided into three:—1. *Sertularella*; 2. *Diphasia*; 3. *Sertularia*.

Though larger in general habit, and the hydrothecæ are more of a subconical form than what we find in *S. tricuspidata*, I agree with Mr. Hincks that the two species are very closely allied to one another.

S. simplex. Hutton, *loc. cit.* Coughtrey, "Trans.," *loc. cit.*, p. 283. Figs 8 to 11, Pl. XX.

In my paper to the New Zealand Institute, I expressed an opinion that *S. simplex* of Hutton was the New Zealand representative of *S. polyzonias* of Linnæus, and I grouped along with Hutton's species, several pigmy varieties in which the hydrothecæ were transversely wrinkled. In this I was wrong, and I would now regard Captain Hutton's species as a distinct one, approaching nearest to *Sertularella fusiformis* of Hincks, while the transversely wrinkled variety is an intermediate form between *S. rugosa* and *S. tenella* (British species), but resembling more closely the latter, and the large form ("Trans.," *loc. cit.*, Fig. 10, Pl. XX.), I have proposed to call *Sertularella robusta*. *Vide* "Annals," *loc. cit.*

Genus *Sertularia*, Linnæus (in part.) Hincks, "Brit. Hyd. Zooph."

S. bispinosa, Gray.

Mr. Busk when reporting on the *Sertularian Zoophytes* and *Polyzoa* of South Africa ("Brit. Assoc. Reports," 1850), remarked upon the resemblance between this species and *S. operculata* (British.) The likeness only holds good between one of the varieties of *S. bispinosa*, of New Zealand, and that is the extremely lax, slender and delicate variety. The other variety both by the peculiarity of its gonothecæ, and its more robust and coarse habit is different from the British form.

S. ramulosa, mihi. Trans., *loc. cit.* There are two varieties, coarse and delicate.

S. trispinosa, mihi. Trans. *loc. cit.*

The intermediate position of this species between *S. bispinosa* and *S. ramulosa*, has been preserved in all recent specimens.

S. abietinoides. Gray.

One variety of this species bears a close resemblance to *S. filicula* (British species) in its general habit, but the characters of the hydrothecæ and of the gonothecæ are quite distinct. Similar differences separate it from the more robust British ally *S. abietina*.

S. fusiformis, Hutton, *loc. cit.* Coughtrey, p. 285 (Trans. *loc. cit.*)

In consequence of there being a likelihood of this species being confused with *Sertularella fusiformis*, of Hincks, I would suggest for this species the name of *Sertularia longicosta* (from the crest along one side of the gonothecæ.) Its ovarian capsules, approach somewhat the form of those described by Mr. Busk, on the South African variety of *Pl. cristata*, again the apex of the capsule has an appearance not unlike the crest of *Camp.*

calceolifera, Hincks. "Annals N.H.," Ser. 4, Vol. X., p. 85. It never attains a greater height than two inches.

Sertularia pumila (sp. nov. to N.Z.), *Synthecium gracilis*, mihi, "Trans." *loc. cit.*, p. 286, Figs 26 to 31, Pl. XX.

I am now perfectly satisfied that I was in error when I placed this species under Allman's genus *Synthecium*. I have carefully compared it with varieties of *S. pumila* from the Mersey (Britain) and elsewhere, and cannot detect sufficient specific characters for a new species. The difference I observed in the New Zealand specimens as shown in Trans. *loc. cit.*, Pl. XX., Figs 26 and 27 (both magnified to same extent) is present in British specimens, and one character has been observed by Dr. M'Intosh, in St. Andrew's specimens (namely, presence or absence of joint in the stem). "Annals N. H.," Ser. 4, Vol. XII., p. 205.

Sertularia elegans. *Synthecium elegans*, Allmans. (Gymnoblastic Hydroids).

Another small specimen has enabled me to confirm my previous identification of this species. It is equally pigmy in size with my first one, and in one of the calycles has the lower three-fourths of the pecular ovarian capsules described by Professor Allman.*

Sertularia monilifera, Hutton. Coughtrey, "Trans.," *loc. cit.*, p. 282.

I am now inclined to place this species under the genus *Diphasia*.

Genus *Hydralmania*, Hincks.

During my two visits to the Bluff Harbour, I obtained a most beautiful Hydroid, which I have provisionally placed under the above genus with the specific name of *bi-calycula*. The description of *H. bi-calycula* is given in the communication to the "Annals" before alluded to.

Genus *Thuiaria*.

T. sub-articulata. I am now quite satisfied that this species is distinct from the British species *T. articulata*. *T. articulata* is by far the finer and more delicate of the two, its pinnæ are longer, the hydrothecæ more evenly tubular and free from dentations, while the absence of transverse wrinkles over the whole of the ovarian capsules contrasts clearly with the New Zealand form. Though some of the British specimens have the proximal three-fourths of the ovarian capsules wrinkled.

Our Southern specimens bear the same relation to the East Coast ones, as Mr. Norman's Shetland variety, bears to the ordinary British form.

Regarding the members of the family *Plumularidæ*, I desire to reserve my notes with one exception, and that is *Plumularia simplex*, mihi. Fresh

* In Annals *loc. cit.*, I describe a specimen from the Bluff Harbour that is very like *S. pumila*.

specimens of this have proved to me it is not a *Plumularian*, but a *Sertularian*, and I intend to place it in its proper position in a future paper.

APPENDIX.

Description of a New Zealand Tubularian *(Family* Tubularidæ.)

"Hydrocaulis developed, invested by a chitinous perisarc. Hydranths flask-shaped, with a proximal and a distal set of verticillate filiform tentacles. Gonophores in the form of fixed sporosac." (Hincks and Allman).

Genus *Tubularia*. Sub-genus *Thamnocnidia*, Agassiz.

Tubularia attennoides, sp. nov.

Trophosome. Hydrocaulis of a cluster of simple stems, semitortuous, of about ½ line in width and from one to two inches in height; perisarc strong and leathery, corrugated transversely in the distal part of stem so as in some places to closely resemble annulations; perisarc for a line in length from base of hydranth is very transparent and delicately annulated just beneath the collar.

Hydranth separated from stem by a distinct but simple (unfluted) collar, which becomes narrow near the base of the hydranth; proximal row of tentacles, about twenty-four in number, and about double the length of inner or distal row, which are about twenty in number.

Gonosome, Gonophores male, on very short erect peduncles, from two to six in one cluster; when two, sub-pedunculate; when six, nearly sessile. Each gonophore has four tentaculi-form processes which are more delicate than those seen in *T. attenuata*, Allman, and relatively much longer. Colour—body of hydranth, a bright orange-vermillion, darkest within the inner circle of tentacles; cænosarc, dusky vermillion; perisarc, straw colour; spadix, true vermillion.

Attached to sides of rock-pools and submerged piles at Anderson's Bay, Vauxhall Jetty, and other places in Dunedin, Upper Harbour, rock-pools in Tomahawk and other bays between Hooper's Inlet and Ocean Beach, Otago Peninsula.

Art. XXXVI.—*Description of a Species of Butterfly belonging to the Family* Satyridæ, *Westwood.* By Richard Wm. Fereday, C.M.E.S.L.

[Read before the Philosophical Institute of Canterbury, 20th November, 1875.]

Plate IX.

Oreina (?) Othello.

Head, sooty-black.

Antennæ, sharp, slender, jet-black annulated with white; club compressed, lamellate and broadly spoon-shaped, concave on the under and

R.W. Fereday, del.

OREINA OTHELLO n.s.

convex on the upper side with the apex curled back; underside of outer margin of club deep yellow, extending partly down the shaft.

Eyes, naked.

Labial palpi, of moderate length, contiguous, slightly diverging towards the apex, obliquely elevated in front of the head, densely clothed with hairy scales, three-jointed, middle joint long, third joint very small.

Body, sooty-black.

Fore-legs, sooty-black, rudimental, very small, rather smaller in the female than in the male; tarsi not jointed, two rudimental claws on the tarsi of the female.

Middle and posterior legs, sooty-black, ungues double.

Wings, sooty, velvety-black, shot with rich bronzy-brown; fringe same colour. Expanse, Mas., 19–21 lines; Fem., 24–25 lines.

Upperside—Primaries, entire; costa and hind margin convex; apex and anal-angle (the latter considerably) rounded; a submarginal patch (slightly paler than the ground colour) from three to four lines broad near the costa, and narrower towards the anal angle. Within the patch are several confluent black ocelli with small silvery-white pupils. There are generally five of these ocelli, three of which are in a line drawn from the costa (near the apex) towards the middle of the inner margin; the pupil of the ocellus nearest the costa being very minute and in some specimens obsolete, and the ocellus farthest from the costa being the largest of all the ocelli. The two other ocelli are respectively situated in the areolets between the third subcostal, externo-medial, and sub-externo-medial nervures, and are in some specimens followed by a third ocellus, detached from the others and situated in the areolet formed by the sub-externo-medial and interno-medial nervures; these latter ocelli form a sub-marginal row.

Secondaries, orbiculate-triangulate; hind margin slightly denticulated, but denticulation hardly perceptible; discoidal cell closed; color same as the primaries, but without any markings.

Under side, colour and markings of the upper side repeated, but rather paler and more richly bronzed.

The accompanying figure will help to illustrate the above description.

Habitat, Western range of mountains, Province of Canterbury, New Zealand; also, mountains at Lake Guyon, Province of Nelson, New Zealand.

This interesting butterfly is found at a great altitude, frequenting the slopes formed by the *débris* from the disintegration of the mountain peaks. No vegetation is seen on these slopes, the *débris* being composed of small angulated stones continually slipping down the incline. The butterfly is generally seen flying in the hot sunshine, close to the surface of the stones, and probably attracted by the radiated heat; and the extremely ragged state of the wings of so many specimens may possibly be accounted for by the sharp edges of the stones cutting them as the butterflies are driven along by the strong winds.

I am indebted to my friend, Mr. J. D. Enys, of Castle Hill Station, for the first specimens that came into my possession.

I have already recorded the discovery of this species ("Trans. N.Z. Inst.," Vol. IV., p. 217), and named it "Pluto," at the same time placing it in the genus *Erebia*, but having since ascertained that such name had been previously appropriated to another butterfly, I have substituted the specific name of "Othello," and finding that Professor Westwood distinguishes the genus *Oreina* from *Erebia*, and other genera of the family by the former having *none* of the nervures of the wings dilated, I have now placed this species under that genus.

Art. XXXVII.—*On the* Mollusca *of Auckland Harbour.*

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 14th June, 1875.*]

The publication of Captain Hutton's excellent catalogue of the Marine Mollusca of New Zealand has afforded me an opportunity of naming the shells which, for some years past, I have collected in and about Auckland Harbour. While engaged in this work, it occurred to me that a list of the species noticed, together with a few cursory remarks, might be of some value as a contribution towards the question of the geographical range of our shells; a point on which very little appears to be known. With this view I have prepared the following sketch, which I have now the pleasure to submit to the notice of the Institute.

For the purposes of this paper, I shall consider Auckland Harbour to extend in a northerly and easterly direction as far as Rangitoto and Brown's Island, and to be bounded on the west by a line drawn from Kauri Point to the mouth of the Whau River. From the great irregularity in the coast line—large bays and inlets stretching back for considerable distances—it is difficult to estimate the area with any approach to exactness, but it is probably not less than eighteen square miles. The depth is nowhere very great: an irregularly shaped depression between the North Head and the Bean Rock Lighthouse exceeds fifteen fathoms, and off Stokes' Point a narrow channel, with a depth of from twelve to thirteen fathoms extends for a considerable distance. No part of Rangitoto Channel, however, exceeds eight fathoms, and the broadest part of the harbour—that between the Tamaki Heads and Rangitoto—has only an average depth of four or five. Many of the bays are very shallow, and extensive mud-banks, often covered with *Zostera*, are daily exposed at low-water.

The distribution of the Mollusca is well known to be considerably influenced by depth, and the sea-bed has, in consequence, been divided by the late Professor Edward Forbes and others into four "Zones" or areas, as follows:—First, the littoral zone, or the space between the tide-marks; second, the laminarian zone, extending from low-water mark to ten or fifteen fathoms; third, the coralline zone, from fifteen to fifty fathoms; and lastly, the deep sea zone. It is, of course, only the first two of these regions that we are concerned with in Auckland Harbour.

Commencing, then, with the littoral zone, we shall find that no part of it is without molluscan inhabitants. When the coast is at all rocky, large areas are covered with the common oyster (*Ostrea mordax*), often associated with the mussel (*Mytilus smaragdinus.*) A peculiar assemblage of species is found near high-water mark. *Littorina diemenensis* is usually in large numbers, filling little chinks and crevices, but often also scattered as it were broadcast over the surface of the rocks. Another little shell, *Adeorbis varius*, generally accompanies it, but is easily overlooked from its small size. A curious minute shell, apparently allied to *Leuconia*, a sub-genus of *Melampus*, is often found gregarious under stones. *Mytilus ater* and *Nerita atrata* are also frequently seen near the upward limits of the tide. Further down the strand, projecting rocks and overhanging ledges are sprinkled over with a variety of small whelks, of which *Purpura quoyi*, *Buccinum testudineum* and *B. lævigatum* are prominent forms. The larger *Purpura textiliosa* is also tolerably common, but *P. haustrum* appears to be rare. The phytophagous species are now well represented, especially where the rocks are covered with *Hormosira* or other sea-weeds. *Turbo smaragdus*, *Labio zealandicus*, *L. subrostrata*, and *Cerithium bicarinata*, are all abundant. Two or three species of Limpets and a *Siphonaria* are not uncommon in suitable localities. The smaller rock-pools, that are generally fringed with *Corallina*, *Jania*, and the finer sea-weeds, usually harbour a few species of *Rissoa* and other minute shells; the larger ones, with coarse weeds, are in a great measure occupied by *Turbo* and *Cerithium*. In all, numerous Chitons can be found; of these *C. pellis-serpentis* and *C. quoyi* principally affect the higher pools, while *C. longicymbus* and *C. sulcatus* are more common near low-water mark. *Katharina violacea* and *Tonicia undulata*, both occur under stones in the large and deep basins, but are not abundant. The finest of all our Chitons, *Acanthopleura nobilis*, has been found on exposed rocks at Rangitoto, but appears to be rare.

A few species are seen only on the verge of low-water mark, but are for the most part stragglers from the next zone. *Fusus zealandicus* and *F. dilatatus* can now and then be picked underneath ledges, sometimes accompanied by *Triton spengleri*. Under stones *Tugali elegans* and *Fusus linea* are often to be observed, together with a number of minute shells, of which *Eulima chathamensis* and two undescribed species of *Columbella* deserve mention. *Parmophorus australis*, one of the most singular of our molluscs, can also be occasionally collected. The inky black colour of the animal, and its large size compared with the shell—which indeed it almost entirely conceals—will cause it to be easily recognized when once seen. *Crenella discors*, a rather handsome bivalve, should also be mentioned here, from its curious habit of spinning a nest for itself under the roots of sea-weeds or among Sponges and Tunicata.

Boring molluscs are well represented in the space between the tide marks; the sandstone rocks being everywhere preforated by two species of the *Pholadidæ (Pholas similis* and *Pholadidea tridens)* and by *Lithodomus truncatus*. The intensely hard basaltic lava around Rangitoto alone appears to successfully resist their attacks. *Venerupis reflexa* often shelters in the deserted burrows of the Pholas, but is capable of excavating for itself in the softer rocks. The ravages of the *Teredo* in the timber of our wharves and jetties is too well known to need more than simple mention here.

Where mud or sand takes the place of rocks, we find a somewhat different assemblage of species. *Amphibola avellana* can everywhere be seen crawling among the mangroves that line the sides of the more sheltered bays. The affinity of this curious species is with the tropical genus *Ampullaria*, which includes a large number of forms, all inhabitants of fresh water, and many of which are well-known in India and other countries under the name of Pond-snails. Hidden among the roots of the sedges and rushes that often fringe the line of high-water mark *Melampus costellaris* may be observed, sometimes in great abundance. A few fluviatile shells—principally species of *Hydrobia* or of allied genera—are often found in pools that are only entered by the sea at spring-tides, or during storms. The extensive mud-flats and sand-banks that are laid bare by the recess of the tide are the favourite habitat of many species of bivalves. The Cockle *(Chione stutchburyi)* prefers sheltered and rather muddy localities; the Pipi *(Mesodesma chemnitzii)* inclines to a more sandy and exposed situation. *Hemimactra ovata* is plentiful, buried in the muddy banks of the tide streams. Other common forms are *Mesodesma cuneata*, *Tapes intermedia*, *Tellina deltoidalis*, etc. Accompanying these, and to a great extent preying upon them, are some of the Zoophagous Gasteropods, the most abundant of which are *Buccinum maculatum*, *B. costatum*, and (near low-water mark) *Ancillaria* *australis*. On Zostera beds, *Haminea obesa* can always be found, and in some localities in countless thousands. A very different shell—*Gibbula nitida*—is also of constant occurrence. The largest of all our shells, *Pinna zealandica*, is also not uncommon, generally buried to nearly the top of its valves in the mud. At certain seasons of the year a species of Aplysia, apparently yet undescribed, can be picked up in some numbers, as also can a member of the curious genus *Pleurobranchæa*, and a few small Nudibranchs. *Pecten laticostatus* is occasionally seen, as are *Mysia zealandica* and *Solemya australis*, but these are more common in the next zone.

We have now to consider the inhabitants of the Laminarian zone; an acquaintance with which we can only make by means of dredging, or by examining the refuse thrown up after heavy gales. The first of these methods is the most satisfactory, but is only applicable where the bottom is tolerably even, or composed of sand and mud. From the few dredgings I have been able to make, it appears that *Venus mesodesma*, *Tapes intermedia*, and *Corbula zealandica* are by far the most common species; the first named often forming extensive banks. Other forms of frequent occurrence are *Zenatia acinaces*, *Anatina tasmanica*, *Nucula consobrina*, and *N. margaritacea*. In sandy places a species of *Philine* often comes up in the dredge, usually accompanied with the pretty little *Monilea zealandica* and a fine *Pleurotoma*, as yet undescribed. *Fusus stangeri*, *Marginella albescens*, and *Venericardia zealandica*, are also commonly met with. *Terebratella rubicunda* is often seen attached to stones, and is also abundant about low-water mark at Rangitoto; but in no locality in the harbour have I observed it at all approaching the size that it attains on more exposed coasts. In the deeper portions of the harbour *Trichotropis inornata*, *Cerithium terebelloides*, and a new species of Natica are tolerably plentiful. *Murex octogonus* is sometimes dredged; but the commonest whelk is *Buccinum lividum*, which occurs everywhere, and seems to take the place below low-water mark that its near ally, *B. costatum* occupies above. Of the Chitons, *Cryptoconchus monticularis* is common on the reefs, and is occasionally exposed at low spring-tides; a few smaller species also occur, of which a pretty little *Acanthochætes*, not yet identified, deserves mention. Of the shells that inhabit rocky ground, and are consequently only seen after storms, *Haliotis iris* and *Imperator cookii*, must not be passed over without notice: although both are common on many portions of our coasts, they are decidedly rare in Auckland Harbour.

It remains for me to mention the occasional occurrence of a Cephalopod (*Sepioteuthis major*) which seems to be a summer visitant only. I once observed a smaller species apparently allied to *Octopus*, but neglected to preserve the specimen and so cannot now speak confidently as to its genus. Dead shells of *Spirula lævis*, and also of the well-known "sea snails," *Ianthina exigua* and *I. communis*, are frequently cast up after north-east gales; but as these species live in tke open sea only, we have no right to claim them as inhabitants.

The subjoined catalogue contains the names of 175 species, arranged as follows:—*Cephalopoda*, 2; *Heteropoda*, 2; *Gasteropoda*, 120; *Lamellibranchiata*, 50; *Brachiopoda*, 1. Several of these are not mentioned in our catalogues, and are probably new to the New Zealand Fauna. I must here mention my obligations to Captain F. W. Hutton, of the Otago Museum, who has most kindly assisted me in determining several of the species, and who will probably soon describe some of the new forms.

Before concluding this sketch, I may perhaps be allowed to draw the attention of such of our members who have a taste for Natural History to the wide field still remaining for research in the invertebrata of our seas. In no other branch of the New Zealand Fauna does so much remain to be be done. Of the lower classes, as for instance: the Sponges, Zoophytes, and Annelids, hardly anything is known; in fact only a few conspicuous species appear to have been collected. It is probable that not one-half the Crustacea have been obtained. We are better acquainted with the Echinoderms, thanks to the excellent little catalogue issued by the Geological Survey; but in this class it is obvious that many additions will be made. The Mollusca have undoubtedly received the most attention, but even here large families have been almost entirely neglected. In confirmation of this I need only point to the Nudibranchs, which in Britain alone, number about 112 species, whilst here only three have as yet been described. There is no reason, so far as I am aware, for supposing that this order is less abundant here than at home; and certainly at least a dozen forms can be observed in Auckland Harbour, a locality which cannot be said to be productive in species as compared with other portions of the coast. It must also be remembered that no attempt at dredging worthy of the name has as yet been made; and yet it would be difficult to estimate the number of entirely new species, of all orders, and the valuable information as to the habits and distribution of those already known which will be obtained by the systematic use of the dredge at even moderate depths. Deep sea dredging, say at a greater depth than 100 fathoms, is too laborious and expensive an undertaking for private individuals, but in the comparatively shallow water near the shore a great deal might be done.

There are other questions, too, that require attention besides that of "species hunting," and perhaps of more importance. The geographical distribution and relative abundance of the species is one that has hardly been touched, and yet it will yield most valuable results. There are also the phenomena connected with the growth and development of each individual form—perhaps the most interesting portion of the subject. Every species has a history of its own—always suggestive and full of interest—but in too many cases the historian is yet to be found. There is its birth; its first transient wandering existence; later, its adult life—whether buried in the sand of the sea bottom or anchored by cables capable of resisting the heaviest surf—whether boring deep in submerged timber or excavating chambers in the hardest stone—now, as the Oyster, immovably bound to the exposed rock, or, as the *Fusus*, crawling slowly over it—now darting rapidly through the water, or floating on its surface, the sport of every wind and tide; there is its food—its means of obtaining it—its special habitat—its relations to the species immediately surrounding it—its economic value to man. All these are chapters in the life-history of every species, and chapters which in many instances are yet to be written. The table of contents is indeed prepared; but the contents themselves—the material which is to give the work its real value—still remains to be filled in.

List of species observed in Auckland Harbour :—

I. CEPHALOPODA.

Sepioteuthis major, Gray.
Spirula lævis, Gray.

II. HETEROPODA.

Ianthina exigua, Lamark.
,, *communis*, Lamark.

III. GASTEROPODA.

Murex octogonus, Gray.
Fusus zealandicus, Quoy.
,, *dilatatus*, Quoy.
,, *stangeri*, Gray.
,, *plebeius*, Hutton.
,, *lineatus*, Gray.
,, *linea*, Martyn.
,, n. sp.
,, *duodecimus*, Gray.
,, *nodosus*, Martyn.
Pleurotoma buchanani, Hutton.
,, n. sp.
,, n. sp.
,, n. sp.
,, n. sp.
Daphnelia letourneuxiana, Crosse.
Triton australe.
,, *spengleri.*
Buccinum maculatum, Martyn.
,, *costatum*, Quoy.
,, *luridum*, Hutton.
,, *lævigatum.*
,, *testudineum*, Quoy.
,, n. sp. (?)
Purpura haustrum, Martyn.
,, *textiliosa*, Lamark.
,, *scobina*, Quoy.
,, *quoyi*, Reeve.
Ancillaria australis, Quoy.
Voluta pacifica, Lamark.
,, sp.
Marginella albescens, Hutton.

Columbella, n. sp.
,, n. sp.
Natica, n. sp.
Scalaria zelebori, Dunker.
,, *lineolata*, Kiener.
,, sp. (?)
Chemnitzia zealandica, Hutton.
Odostomia lactea, Angas.
,, sp.
Eulima chathamensis, Hutton.
Struthiolaria nodulosa, Lamark.
,, *vermis*, Martyn.
Trichotropis inornata, Hutton.
Cerithium bicarinata, Gray.
,, *subcarina*, Sowerby.
,, *kirki*, Hutton.
,, *terebelloides*, Von Martens.
,, n. sp.
Littorina diemenensis, Gray.
Rissoa, sp.
,, sp.
,, sp.
,, sp.
Turritella rosea, Quoy.
,, *fulminata*, Hutton.
Calyptræa maculata, Quoy.
Trochita tenuis, Gray.
Crypta costata, Deshayes.
,, *contorta*, Quoy.
,, *unguiformis*, Lamark.
Nerita atrata, Lamark.
Turbo smaragdus, Lamark.
,, *granosus*, Lamark,
Imperator cookii, Lamark.
Adeorbis varius, Hutton.
Rotella zealandica, Chenu.
Chrysostoma, sp.
Polydonta tuberculata, Gray.
,, *tiarata*, Quoy.
Labio zealandicus, Quoy.
,, *cingulatus*, Quoy.
,, *subrostrata*, Gray.
Euchelus bellus, Hutton.
Diloma nigerrima, Linn.
Ziziphinus tigris, Martyn.
,, *selectus*, Chemintz.
Cantharidus elegans, Gmelin.
Monilea zealandica, Hutton.
Gibbula sanguinea, Gray.
,, *nitida*, Adams.
,, n. sp.
Haliotis iris, Lamark.
Tugali elegans, Gray.
Parmophorus australis, Lamark.
Tectura pileopsis, Quoy.
Patella, sp.
Nacella radians, Gmelin.
,, sp.
Chiton pellis-serpentis, Quoy.
,, *quoyi*, Deshayes.
,, *sulcatus*, Quoy.
,, *longicymbus*, De Blainville.
Tonicia undulata, Quoy.
Acanthopleura nobilis, Gray.
Acanthochætes porphyreticus, Reeve.
,, *hookeri*, Gray.
Katharina violacea, Quoy.
Cryptoconchus monticularis, Quoy.
Buccinulus albus, Hutton.
,, n. g. (?)
Cylichna striata, Hutton.
Bulla quoyi, Gray.
Haminea obesa, Sowerby.
Philine angasi, Crosse.
Aplysia, sp.
Pleurobranchæa, sp.
Doris, sp.
,, sp.
,, sp.
,, (?) sp.
Onchidoris tuberculatus, Hutton.
Æolis, sp.
,, (?) sp.
Onchidella nigricans, Quoy.
Siphonaria zealandica, Quoy.
Melampus costellaris, Adams.
Leucoma (?) sp.
Amphibola avellana, Gmelin.

IV. Lamellibranchiata.

Barnea similis, Gray.
Pholadidea tridens, Gray.
Teredo antarctica, Hutton.
Corbula zealandica, Quoy.
Anatina tasmanica, Reeve.
Myodora striata, Quoy.
Chamostrea albida, Lamark.
Hemimactra ovata, Gray.
Tenatia acinaces, Quoy.
Psammobia stangeri, Gray.
,, *lineolata*, Gray.
Hiatula nitidula, Gray.
,, sp.
Tellina deltoidalis, Lamark.
,, *lintea*, Hutton.
Mesodesma chemnitzii, Deshayes.

Mesodesma zealandica, Potier and
,, *cuneata*.
Chione lamellata, Lamark.
,, *yatei*, Gray.
,, *costata*, Gray.
,, *stutchburyi*, Gray.
,, *dieffenbackii*, Gray.
,, *mesodesma*, Quoy.
Dosinia anus, Phillipi.
,, *subrosea*, Quoy.
Tapes intermedia, Quoy.
Venerupis reflexa, Gray.
Cardium striatulum, Sowerby.
Venericardia australis, Quoy. Michaud.
Lucina divaricata, Lamark.
Mysia zealandica, Gray.
,, *globularis*, Lamark.
Pythina stowei, Hutton.
Solemya australis, Lamark.
Mytilus smaragdinus, Chemnitz.
,, *ater*, Zelebor.
Crenella discors, Lamark.
Modiola albicostata, Lamark.
Lithodomus truncatus, Gray.
Pinna zealandica, Gray.
Pectunculus laticostatus, Quoy.
,, *striatularis*, Lamark.
Nucula margaritacea, Lamark.
,, *consobrina*, Adams and Angas.
Pecten zelandiæ, Gray.
Vola laticostatus, Gray.
Anomia, sp.
Ostrea, sp.
,, *mordax*, Gould.

V. BRACHIOPODA.

Terebratella rubicunda, Solander.

BOTANY.

ART. XXXVIII.—*Description of a New Species of* Fabronia.

By Dr. KNIGHT, F.R.C.S., F.L.S.

[*Read before the Wellington Philosophical Society, 29th January*, 1876.]

Pl. XI.

Fabronia octoblepharis, n. s.

PLANTÆ minimæ, ramis plumose foliosis. Folia conferta undique patentia lanceolata longe tenuiter acuminata ciliato-serrata obsoletinervia basi cellulis amplis superne angustis, perichætialia erecta, appressa ovata apice serrata subito in pilum hyalinum producta. Capsula e cellulis laxis rete undulato-quadratum efformantibus composita. Peristomium simplex, dentes 8 geminati, plani, humidi introrsum flexi.

Habitatio ad saxa humidiuscula.

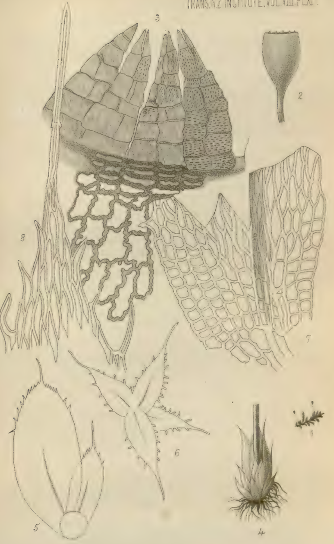
Plant small, plumose leafy. Leaves crowded, spreading lanceolate with fine long tapering points, ciliato-toothed, obsoletely nerved, cells enlarged at the base, narrow above; perichætial erect, appressed, ovate, serrated at the apex, suddenly ending in a hyaline hair-like point. Capsule with lax cells, forming an undulate quadrate web. Peristome simple, teeth in 8 pairs, flat, bent inwards when moistened.

On humid rocks.

DESCRIPTION OF PLATE XI.

Fabronia octoblepharis.

1. Natural size.
2. Theca magnified 17 diameters.
3. Peristome magnified 300 diameters.
4. Perichætium.
5. Perichætial leaves magnified 50 diameters.
6. Cauline " " 35 "
7. Base of cauline leaves " 300 "
8. Point of " " " 300 "



FABRONIA OCTOBLEPHARIS, n.s.

C. Knight, del.

ART. XXXIX.—*Further contributions to the Lichen Flora of New Zealand.**

By CHARLES KNIGHT, F.R.C.S., F.L.S.

[*Read before the Wellington Philosophical Society, 29th January, 1876.*]

Plate XI.

Urceolaria Novæ-zealandiæ, Knight.

Thallus cinerascens indeterminatus leproso-areolatus v. quasi detritus. Apothecia parva immersa, disco subdepresso fusco farinaceo (margine thallode nullo) nucleo, a excipulo dimidrato-fusco cincto, paraphysibus distinctis rectis tenuis. Sporæ in ascis cylindraceis fuscæ ovatæ muralidivisæ horizontaliter 5–6-septatæ, longit. ·027 mm., crassit. ·018 mm.

Ad saxa.

Thallus ashy-grey, indeterminate, leproso-areolate, or as if worn out. Apothecia small, immersed, disc somewhat sunk in, brown, mealy (no thallodal margin), nucleus bound by a dimidiate brown excipulum; paraphyses distinct, straight, fine. Spores in cylindrical asci, brown, ovate, murali-divided, horizontally 5–6-septate.

On rocks.

Fig. 1. Section of apothecium magnified 14 diameters.
1. *a*, Ascus and spores, markings omitted, 300 diameters.
1. *b*, Spores, shewing cellular structure, 300 „

Pertusaria graphica, Knight.

Thallus late effusus cartilagineus albicans v. cinereo-albicans rimuloso-areolatus, verrucis subgloboso-difformibus crebris v. confertissimis (deinde deplanatis) obsitus, e gonidia per totam partem instructus. Apothecia plura in singulis verrucis thalli inclusa (excipulo proprio prorsus nullo) primitus a thallo tecta, tandem aperta, discis irregularibus sæpe in pseudo-discum confluentibus, epithecio fusco, paraphysibus tenerrimis tortilis. Sporæ 4-næ simplices ellipsoideæ grumo-granulosæ dilute luteæ, episporio crasso, longit. ·082 mm., crassit. ·04 mm.

Ad saxa.

* In continuation of Art. LIII., Vol. VII. Trans. N.Z. Inst., page 356.

Thallus widely spread, cartilagineous, whitish or greyish-white, rimuloso-areolate, with numerous or very crowded (then flattened) subglobose deformed verrucæ, furnished with gonidia in every part. Apothecia several included in each verruca (proper excipulum none), at first covered by the thallus, at length open, the irregular discs often flowing into a pseudo-disc; epithecium brown, paraphyses very slender, twisted. Spores four in each ascus, simple, ellipsoid, grumose-granulose, pale yellow; epispore thick, length ·082 mm., breadth ·04 mm.

On rocks.

Fig. 2. Discs of apothecia on verruca magnified 14 diameters.
2. *a*, Section of verruca magnified 14 diameters.
2. *b*, Four spores, with paraphyses, magnified 300 diameters.

Lecidea littoralis, Knight.

Thallus cinereo-albidus v. cinerasceus crassus continuus v. areolatus late expansus lævis. Apothecia adnata majuscula (latit. 2·65 mm.) sparsa atra pruinosa tenuiter marginata deinde tumidula et difformia, margine atro flexuoso v. lobato v. lobato inciso. Sporæ simplices ellipsoideæ, longit. ·013 ad ·018 mm., crassit. ·006 mm. Hypothecium fuscum v. linea atra hypothecii latera et basim circumscribens.

Ad saxa.

Thallus ashy-white or grey, thick, continued or areolate, widely spread out, smooth. Apothecia adnate, rather large (2·65 mm. across), scattered, black, pruinose; margin thin, black, at length raised, deformed, flexuose or lobed or labato-incised. Spores simple, colourless, ellipsoid, length ·013 ad ·018 mm., breadth ·006 mm. Hypothecium brown, or circumscribed at the sides and base by a black line.

On rocks.

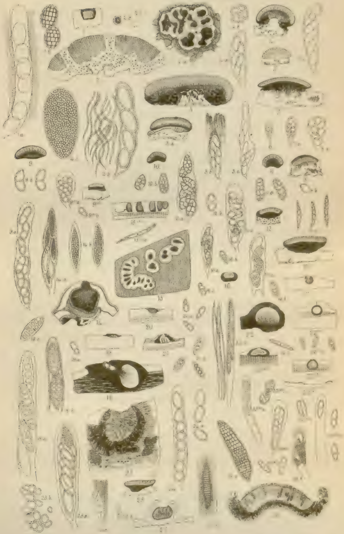
Closely allied to *Lecidea albo-cærulescens*, Wulff, and *L. contigua*, Hoffm.

Fig. 3 and 3 *a*, Apothecia magnified 14 diameters.
3 *b* and 3 *c*, Ascus, spores, and paraphyses, magnified 300 diameters.

Lecidea subglobulata, Knight.

Thallus cinerascens minute furfuraceo-diffractus v. squamuloso-areolatus, granulis gonimis viridibus. Apothecia immarginata interdum confluentia, disco atro convexo tandem hæmispherico v. subglobuloso. Sporæ in ascis ventricosiusculis simplices ellipsoideæ subhyalinæ tandem dilute luteæ, longit. ·013 ad ·022 mm., crassit. ·007 mm. Hypothecium atrum v. fuscum.

Ad saxa.



Thallus greyish, minutely furfuraceus, cracked or squamuloso-areolate, granula gonimia green. Apothecia immarginate, sometimes confluent, disc black convex, at length hemispherical or subglobose. Spores in subventricose asci, simple, ellipsoid, somewhat hyaline, at length yellowish. length ·013 ad ·022 mm., breadth ·007 mm. Hypothecium black or brown,

On rocks.

Fig. 4. Section of apothecium (subhymeneal stratum), much too dark, magnified 14 diameters.

4. *a*, Ascus and spores magnified 300 diameters.

4. *b*, Gonimia magnified 300 diameters.

Lecidea subargillacea, Knight.

Thallus luteo-albus continuus. Apothecia subaggregata innata v. adnata concava fusca immarginata interdum difformia sæpe furfuracea. Sporæ in ascis cylindraceis grumoso-luteæ v. hyalinæ, longit. ·016 mm., crassit. ·008 mm. Hypothecium album.

Ad terram argillaceam.

Thallus yellowish-white, continued. Apothecia somewhat crowded, innate or adnate, concave, brown, immarginate, often furfuraceous. Spores in cylindrical ascus, grumose, yellowish or hyaline, length ·016 mm., breadth ·008 mm. Hypothecium white.

On clay soil.

Syn. *Lecidea meiospora*, Nyl. (?) printed by mistake *Lecanora meiospora*, Nyl. ("Trans. N. Z. Inst.," Vol. VII.) Page 359, No. X.

Fig. 5. Section of apothecium magnified 14 diameters.

5. *a*, Ascus and spores „ 300 „

Lecidea atro-morio, Knight.

Thallus nigro-cinerascens tenuis squamulosus, squamulis minutis rotundis planis rufescentibus nitidis ad ambitu plerumque minute furfuraceis. Apothecia atra parva plana ex hypothallo nigricante inter squamulas denudato oriunda, squamulas haud superantia, interdum margine thallino spurio e granulis minutissimis cincta. Sporæ minutæ ovoideæ v. globulae, longit. ·0065 mm., crassit. ·005 mm. Gonidia magna. Hypothecium fuscum.

Ad saxa.

Thallus dark grey, thin, scaly; scales minute, round, flat, reddish, shining, margin minutely furfuraceous. Apothecia black, small, flat, arising between the scales from the exposed hypothallus, not raised above the thallus, sometimes bound by a spurious thalline minutely granular margin. Spores minute, ovoid or globular, length ·0065 mm., breadth ·005 mm. Gonidia large. Hypothecium brown.

On rocks.

Fig. 6. Ascus and spores magnified 300 diameters.

Lecidea sublapicida, Knight.

Thallus granulosus indeterminatus cinereo-albus. Apothecia in thalli lacunis sæpissimè confluentia adpressa aterrima nuda planiuscula v. concaviuscula, margine tenuissimo atro undulato, paraphysibus tenuis conglutinatis. Sporæ in ascis ventricoso-clavatis parvulæ ovoideæ simplices hyalinæ, longit. ·005 mm., crassit. ·004 mm. Stratum hypothecii subhymeniale atrum.

Ad saxa.

Thallus granular, indeterminate, greyish-white. Apothecia most frequently confluent in lacuna of the thallus, adpressed, very black, naked, flat, or a little concave; margin very thin, black, undulate; paraphyses slender, conglutinate. Spores in ventricose clavate asci, small, ovoid, simple, hyaline; length ·005 mm., breadth ·004 mm. Hymenial stratum of hypothecium black.

On rocks.

Fig. 7. Section of apothecium magnified 14 diameters.
7. *a*, Ascus and spores „ 300 „

Differs from *L. lapicida* in its smaller ovoid spores, much finer paraphyses, and black hypothecium. In *L. lapicida* the subhymenial stratum is slightly colored, and the inferior stratum forms a thin black line continued from the margin.

Lecidea subcoarctata, Knight.

Thallus cinereo-albus areolatus v. areolato-granulosus v. continuus. Apothecia conferta fusca v. atro-fusca adnata sat parva convexa, margine integerrimo pallido v. dilute fusco nudo demum evanido. Sporæ in ascis ventricoso-clavatis simplices ovoideæ incolores, longit. ·011 mm., crassit. ·007 mm. Hypothecium album.

Ad saxa.

Thallus greyish-white areolate or areolato-granulose or continuous. Apothecia crowded, brown or dark brown adnate, rather small, convex, margin quite entire, pallid or pale brown, naked, at length vanishing.

Spores in ventricose club-shaped asci, ovoid, colourless, length ·011 mm., breadth ·007 mm. Hypothecium white.

On rocks.

Fig. 8. Section of apothecium magnified 14 diameters.
8. *a*, Ascus and spores " 300 "

Differs from *L. coarctata* in the much smaller ovoid spores, the ventricose ascus and white hypothecium.

Lecidea subbadio-atra, Knight.

Thallus fusco-cinereus rimulosus æqualis. Apothecia nigro-fusca parva convexa marginata, margine dilute concolore in statu juvenili prominenti demum obscurato. Sporæ fuscæ oblongæ curvatulæ 1-septatæ, longit. ·025 mm., crassit. ·01 mm. Lamina proligera hypothecio nigro duplici (strato intermedio fusco) enata.

Ad saxa.

Thallus brownish-grey, cracked, equal. Apothecia blackish-brown, convex, margined, margin faintly coloured, in the young state prominent, at length obscure. Spores brown, oblong, somewhat curved, 1-septate, length ·025 mm., breadth ·01 mm. The lamina proligera sprung from a black double hypothecium, the intermediate stratum brown.

On rocks.

Fig. 9. Section of apothecium magnified 14 diameters.
9. *a* and *b*, Ascus and spores " 300 "

Lecidea whakatipæ, Knight.

Thallus albus parum visibilis v. obsolete indicatus. Apothecia parva atra juniora plana et tenuiter marginata deinde convexa v. suborbiculata immarginata. Sporæ fuscæ ellipticæ 1-septatæ, longit. ·013 mm., crassit. ·006 mm. Hypothecium atrum.

Ad saxa.

Thallus white or obsolete or scarcely visible. Apothecia small, black, the younger flat and slightly margined, then convex or suborbiculate, immarginate. Spores brown elliptic 1-septate, length ·013 mm., breadth ·006 mm. Hypothecium black.

On rocks.

Fig. 9. (1), Section of apothecium magnified 14 diameters.
9. (1), *a* and *b*, Ascus and spores " 300 "

Lecidea stellulata, Tayl. (descrip. amend.)

Thallus albus v. cinereus tenuissimus minutissime areolatus v. granulosus hypothallo atro limitatus, sæpius in agellos a hypothallo denudato metatus. Apothecia parva subinnata confluentia atra plana tenuiter marginata, margine sæpe e granulis effuso. Sporæ in ascis ventricoso-clavatis, ovatæ fuscæ 1-septatae, longit. ·012 mm., crassit. ·006 mm. Hypothecium atro-fuscum.

Ad saxa.

Thallus white or greyish, very thin, minutely areolate or granular, bound by a black hypothallus, often marked off into small areas by the exposed hypothallus. Apothecia small, subinnate, confluent, black, flat, margin thin, often sprinkled with granules. Spores in ventricose club shaped ascus, ovate, brown, 1-septate, length ·012 mm., breadth ·006 mm. Hypothecium dark brown.

On rocks.

Lecidea petræa, Flow., v. *Neo-zealandica*, Knight.

Thallus cinereo-plumbeus minute granulosus, hypothallo nigricante inter granula denudato enatus. Apothecia sat parva plana crebra, disco aterrimo nudo elevato-marginato, margine primum e granulis minutis suffusis—tandem fusco-atro. Sporæ in ascis ventricosis 3–5-septatae, et septa transversa septulis longitudinalibus v. obliquis juncta, subhyalinae tandem dilute fuscae, longit. ·023 mm., crassit. ·009 mm. Hypothecium fusco-nigrum.

Ad muros.

Thallus greyish-lead colour, minutely granulose sprung from a black hypothallus denuded between the granules. Apothecia somewhat small, flat, numerous, disk very black, naked, margin raised, at first suffused with minute granules, at length brownish-black. Spores in a ventricose ascus, 3–5 septate, the septa joined longitudinally or obliquely by short septa, length ·023 mm., breadth ·009 mm. Hypothecium brownish-black.

On walls.

Fig. 10. Section of apothecium magnified 14 diameters.
10. *a* and *b*, Ascus and spores „ 300 „

Lecidea petræa, Flot., v. *violacea*.

Thallus minute tuberculosus, tubercula violacea, hypothallo nigricante. Apothecia parva creberrima nigra innata v. adnata concaviuscula immarginata. Sporæ fuscae 5-septatae, septa transversa septulis longitudinalibus v.

obliquis juncta, longit. ·027 mm., crassit. ·01 mm. Hypothecium atrum.

Ad saxa.

Thallus minutely tubercular, the tubercles violet; hypothallus blackish. Apothecia small, very numerous, black, innate or adnate, somewhat concave, immarginate. Spores brown, 5-septate, the transverse septa joined longitudinally or obliquely by short septa, length ·027 mm., breadth ·01 mm.

On rocks.

Fig. 11. Section of apothecium magnified 14 diameters.
11. *a*, Two spores " 300 "

Lecidea tubulata, Knight.

Thallus granuloso-diffractus albo-cinerascens indeterminatus. Apothecia nigra marginata, disco plano pruinoso, margine atro elevato. Sporæ in ascis clavatis fuscæ biloculares, loculis tubulo brevi junctis, longit. ·018 mm., crassit. ·011 mm. Hypothecium atrum. Hypothallus albus.

Ad saxa.

Thallus granulose, cracked, whitish-grey, indeterminate. Apothecia black, margined; disc flat, pruinose, margin black, elevated. Spores in club-shaped asci, brown, bilocular, the cells joined by a short tube, length ·018 mm., breadth ·011 mm. Hypothecium black. Hypothallus white.

On rocks.

Fig. 12. Section of apothecium magnified 14 diameters.
12. *a* and *b*, Ascus and spores " 300 "

Lecidea subfarinosa, Knight.

Thallus albus effusus rugulosus. Apothecia (latit. ·8 mm. v. minora) albo-pruinosa rotundato-difformia elevato-sessilia tenuiter marginata, margine sæpe flexuoso, paraphysibus superne fusceacentibus concretis, disco concavo v. plano v. convexo. Sporæ 4–6-septatæ aciculari-fusiformes incolores v. tandem dilute lutescentes, longit. ·034 mm., crassit. ·005 mm.

Ad cortices arborum.

Thallus white, effuse, rugulose. Apothecia (·8 mm. or less in diam.) white-pruinose, rotundato-difformed, elevato-sessile; margin thin, often flexuose; paraphyses brown above, concrete; disc concave, flat, or convex. Spores 4–6-septate, aciculari-fusiform, colourless or dilute yellow, length ·034 mm., breadth ·005 mm.

On bark of trees.

L. farinosa, Ach., *L. Dilleniana*, Ach., *L. abietina*, Ach., *L. premnea*, Ach., and the above Lichen are very closely allied. The New Zealand Lichen approaches closely *L. abietina*, Ach., from which it differs principally in the greater number of septæ in the spores and the smaller apothecia.

Fig. 13. Section of apothecium magnified 14 diameters.
13. *a*, Three spores „ 300 „

Lecidea schistacea, Knight.

Thallus schistaceus determinatus tenuis squamulosus, squamulis rotundis adpressis minutissimis pruinis, hypothallo nigro. Apothecia nigra mediocria v. parva squamulas superantia marginata, disco plano, margine prominenti interdum undulato. Sporæ minutæ ellipsoideæ incolores, longit. ·008 mm., crassit. ·004 mm. Hypothecium nigrum.

Ad saxa.

Thallus slate-grey, determinate, thin, scaly; scales round, adpressed, very minute, pruinose; hypothallus black. Apothecia black, mediocre or small, elevated above the scales, margined, disc flat, margin prominent, sometimes undulate. Spores minute, colourless, ellipsoid, length ·008 mm., breadth, ·004 mm. Hypothecium black.

On rocks.

Fig. 25. Section of apothecium, magnified 14 diameters.
25. *a* and *b*, Ascus and spores „ 300 „

Lecanora parella v. *implicata*, Stirton.

Dr. Stirton, in his additions to the Lichen Flora of New Zealand, published in the "Journal of the Linnean Society," has transferred *Lecanora implicata* to the genus *Lecidea*. The Lichen, however, is a true *Lecanora*, and a variety only of *Lecanora parella*, as I pointed out in a paper published in the "Trans. N. Z. Inst.," Vol. VII., p. 357.

Porina endochrysa, Mont.

Thallus late effusus tenuis fragilis colliculosus glauco-cinereus subtus bullatus. Apothecia immersa, perithecio flavescente integro normaliter globoso, ostiolo fusco depresso primum occluso demum aperto, nucleo, fusco, paraphysibus filiformibus. Sporæ 8-næ incolores cymbiformes murali-divisæ, longit. ·09 ad ·15 mm., crassit. ·025 ad ·04 mm., episporio crasso.

Ad cortices arborum.

Thallus widely spread, thin, brittle, raised in mounds, glaucous-grey, beneath bullate. Apothecia immersed, perithecium yellowish, entire, normally globose; ostiole brown, depressed, at first closed, then open; nucleus brown; paraphyses filiform. Spores 8, colourless, boat-shaped, murali-divided, length ·09 ad. ·15 mm., breadth ·025 ad. ·01 mm., epispore thick.

On bark of trees.

Syn. Thelenella Wellingtonii, Stirton ("Jour. Linn. Soc.," Vol. XIV., p. 473.)

Fig. 14. Section of apothecium (too dark, nucleus diaphonores, but becoming light brown from age.)

14. *a* and *b*, Ascus and spores magnified 300 diameters.

Chiodecton (Platygrapha) inconspicua, Knight and Mitten.

Thallus crustaceus cinereo-violaceus verrucæformis, verrucis dilute concoloribus. Apothecia minuta normaliter globosa, in verrucis thallinis rotundatis v. flexuoso-elongatis supra planiusculis immersa—(passim confluentia)—plura in quavis verruca unumquidque atro-fusco toro oriens, disco rotundo v. oblongo v. attenuato-oblongo nigro. Sporae oblongo-fusiformes curvatulae 3-septatae incolores, longit. ·05 mm., crassit. ·004 mm.

Ad cortices arborum.

Syn. Chiodecton conchyliatum, Stirton, *C. moniliatum*, Stirt., et *C. sinuosum*, Stirt.

Thallus crustaceous, ashy-violet, verrucoid; verrucae lighter colour. Apothecia minute, normally globose, immersed in roundish or flexuose elongated thalline verrucae—(here and there confluent)—several in each verruca, each arising from a blackish-brown torus, disc black, round or oblong or tapering. Spores oblongo-fusiform somewhat curved, 3-septate, colourless, length ·05 mm., breadth ·004 mm.

On bark of trees.

The genera *Platygrapha* and *Chiodecton* are very closely allied. The apothecia arise from a brown torus, and are surrounded by a spurious thallodal margin, which, in *Chiodecton*, assumes a verrucoid appearance from the confluence of a number of apothecia.

Fig. 15. (1), Section of apothecium magnified 14 diameters.

15. (1) *a*, Spore „ 300 „

Opegrapha saxicola, Ach.

Thallus obliteratus. Apothecia atra lirellæformia sacpe flexuosa rarius rotundo-difformia, epithecio pliciformi v. rimiformi, marginibus parallelis v.

medis paullulim distentis. Sporae lineari-oblongae v. lineari-clavatae 3-septatae dilute luteae, longit. ·017 mm., crassit. ·006 mm.

Ad saxa

Thallus obliterated, lirellaeform, often flexuose (rarely round, deformed), margins parallel or a little distended in the middle; epithecium pliciform or rimiform. Spores linear-oblong or linear-clavate, 3-septate, light yellow, length ·017 mm., breadth ·006 mm.

On rocks.

Fig. 16. Section of apothecium magnified 14 diameters.
16. *a*, Ascus and spores „ 300 „
16. *b*, *c*, Spores „ 300 „

Fissurina novæ-zealandiæ, Knight.

Thallus crustaceus laevigatus ochraceus tenuiter areolatus. Apothecia immersa flexuosa lineari-elongata, fissuris a thallo marginatis conniventibus tumidulis, excipulo atro-fusco crasso a thallo insuper tecto infra subito evanescente. Sporae in ascis clavatis 5-septatae ellipsoideae incolores, longit. ·02 mm., crassit. ·01 mm.

Ad saxa.

Thallus crustaceous, smooth, ochraceus, finely areolate. Apothecia immersed, flexuose, linear-elongate; fissures margined by the thallus, connivent, swollen; excipule blackish-brown, above thick, covered by the thallus, below suddenly evanescent. Spores in a club-shaped ascus, ellipsoid, colourless, 5-septate, length ·02 mm., breadth ·01 mm.

On rocks.

Fig. 17. Section of apothecium magnified 14 diameters.
17. *a* and *b*, Ascus and spores „ 300 „

Astrothelium pyrenastroides, Knight.

Thallus effusus glauco-albescens v. cinereo-olivaceus v. ochraceus rimulosus. Apothecia convexa a thallo plus minus velata demum denudata carbonacea, loculis 2–5, ostiolis convergentibus in os commune sæpissime desinentibus, ore ochraceo, paraphysibus tenerrimis rectis v. subtortilis. Sporæ in ascis elongato-cylindraceis incolores demum dilute fuscæ fusiformes 5–8-septatæ—(vix unquam 3–4-septatæ)—v. sæpius murali-divisæ v. interdum locellis medianis a septulis longitudinalibus divisis, longit. ·038 mm., crassit. ·012 mm.

Ad cortices arborum.

Syn. Trypethelium pyrenuloides, Mont. (?)

„ *Cumingii*, Fee. (?)

„ *astroidea*, Fee. (?) "Haud non differt a *T. pyrenuloide*." (Mont.)

Verrucaria pyrenastroides, Kn. ("Trans. Linn. Soc.," Vol. XXIII., Tab. 11, p. 100.)

Astrothelium prostratum, Stirt. ("Journ. Linn. Soc.," Vol. XIV., p. 473.)

Astrothelium ochrocleistum, Nyl., in litt.

Thallus effuse, glaucous, white, or greyish-olive, or ochraceus, rimulose. Apothecia convex, more or less veiled by thallus, at length uncovered, carbonaceous, cells 2–5, ostioles most frequently converging into a common opening; paraphyses very slender, straight or somewhat twisted. Spores in elongated ascus, colourless, at length pale brown, fusiform, 5–8-septate —(rarely 3-4-septate)—more frequently murali-divided, or sometimes median cells divided by short longitudinal septæ, length ·038 mm., breadth ·012 mm.

On bark of trees.

Fig. 18. Section of apothecium, showing the ostioles of adjoining apothecio opening into common canal, magnified 14 diameters.

18. *a*, *b*, and *c*, Ascus and spores, magnified 300 diameters.

Verrucaria gemellipara, Knight.

Thallus cerino-umbrinus tenuissimus glaber linea nigra limitatus. Apothecia parva parum prominula, ambitu applanato, dimidiatim nigra, basi amplificata, poro pertuso instructa, paraphysibus distinctis. Sporæ uniseptatæ in medio subconstrictæ incolores, longit. ·017 mm., crassit. ·006 mm.

Ad cortices arborum.

Syn. V. circumpressa, Nyl., in litt.

V. epidermidis v. *gemellipara*, Knight.

Thallus yellowish-brown, very thin, smooth, limited by a dark line. Apothecia small, slightly prominent, flattened round the border, dimidiate, black, base enlarged, opening by a pore, paraphyses distinct. Spores uniseptate, somewhat constricted in the middle, colourless, length ·017 mm., crassit. ·006 mm.

On bark of trees.

Fig. 19. Section of apothecium magnified 14 diameters.

19. *a*, Spores „ 300

Verrucaria minutissima, Knight.

Thallus atro-cinerascens tenuissimus. Apothecia contigua minutissima prominula dimidiatim nigra, poro pertuso instructa, paraphysibus distinctis. Sporæ dilute fuscæ, uniseptatæ (an interdum 3-septatæ?) in medio subconstrictæ, cellula superiore majore, longit. ·018 mm., crassit. ·005 mm.

Ad cortices arborum.

Thallus dark grey, very thin. Apothecia contiguous, very minute, somewhat prominent, dimidiate, black, with an open pore, paraphyses distinct. Spores light brown, 1-septate, (sometimes 3-septate?) constricted in the middle, the upper cell larger, length ·018 mm., breadth ·005 mm.

On bark of trees.

The spores have much the appearance of a sphæria. Except the bright colour, not unlike those of *Verrucaria conferta*, Tayl. (Leight. Angios. Lich.)

Fig. 20. Section of apothecium magnified 14 diameters.
20. *a*, Spores " 300 "

Verrucaria dealbata, Knight.

Thallus albescens tenuis effusus glaber. Apothecia nigra hæmispherico-conoidea parva dimidiata, paraphysibus distinctis. Sporæ in ascis cylindraceis dilute fuscæ ellipsoideæ 3–5-septatae, longit. ·023 mm., crassit. ·008 mm.

Ad cortices arborum.

Thallus whitish, thin, effuse, smooth. Apothecia black, haemispherico-conoid, small, dimidiate; paraphysis distinct. Spores in cylindrical ascus, faint brown, ellipsoid, 3–5-septate, length ·023 mm., breadth ·008 mm.

On bark of trees.

Fig. 21. Section of apothecium magnified 14 diameters.
21. *a*, Spores " 300 "

Verrucaria saxicola, Knight.

Thallus luteo-olivaceus tenuissimus v. nullus. Apothecia parvula haemispherica, peritheeio carbonaceo integro, ostiolo inconspicuo, nucleo subgloboso hyalino, paraphysibus capillaribus farcto. Sporae in ascis elongato-cylindraceis incolores fusiformes, 7–8-septatae, longit. ·032 mm., crassit. ·005 mm.

Ad saxa.

Thallus yellowish-olive, very thin or none. Apothecia rather small, haemispherical; perithecium carbonaceous, entire; ostiole inconspicuous; nucleus subglobose, hyaline, filled with capillary paraphyses. Spores in elongate cylindrical ascus, colourless, fusiform, 7–8-septate, length ·032 mm., breadth ·005 mm.

On rocks.

Fig. 22. Section of apothecium magnified 38 diameters.

22. *a* and *b*, Ascus, spores, and paraphyses magnified 300 diameters.

Verrucaria micromma, Mont.

Thallus ochraceo-albus granuloso-colliculosus irregulariter plicato-rugulosus plus minus rimosus effusus. Apothecia nigra integra globosa in verrucis thalli confluentibus penitus abdita, canaliculis ad sporas mittendas in verrucas thalli productis, ostiolis nigris minutissimis instructa, paraphysibus distinctis capillaribus. Sporae in ascis elongato-cylindraceis ellipsoideae 3-septatae dilute fuscae, longit. ·016 mm., crassit. ·006 mm.

Ad cortices arborum.

Thallus yellowish-white, granuloso-colliculose, irregularly plicato-rugulose, more or less rimose, effuse. Apothecia black, entire, globose, completely hidden in the confluent thalline verrucae, the channels for emission of spores extending through the thalline verrucae, apertures very minute, black, paraphyses distinct, capillary. Spores in elongated cylindrical asci, ellipsoid, 3-septate, dilute brown, length ·016 mm., crassit. ·006 mm.

On bark of trees.

Fig. 22. (1), Section of apothecium magnified 14 diameters.

22. (1), *a*, Spores „ 300 „

Verrucaria astata, Knight.

Thallus tenuis fulvo-fuscus v. cinereo-fuscus opacus continuus indeterminatus.

Apothecia nigra prominula—madefacta sæpe innata—hæmisphcrica, integra, paraphysibus capillaribus tenerrimis distinctis. Sporæ in ascis elongato-cylindraceis ovoideæ fuscæ 3-septatæ, longit. ·014 mm.; crassit. ·009 mm.

Ad cortices arborum.

Thallus thin, yellowish-brown or greyish-brown, dull, continuous indeterminate. Apothecia black, somewhat prominent, often innate when moistened—hemispherical, entire, paraphyses capillary, very slender, distinct. Spores in elongated cylindrical asci, ovoid, brown, 3-septate; length, ·014 mm.; breadth, ·009 mm.

On bark of trees.

Dr. Nylander (in litt.) has determined this lichen as *V. aspitea*, Ach. There is some confusion about Acharuis's plant. Nylander has remarked, "Esse videtur modo *V. nitida* minor, sporis minoribus." Montaigne describes *V. aspitea*, Ach., with "sporis magnis ellipticis 16-annulates, annulis pauci-cellulosis." He adds that *V. aspitea*, of Eschw. is incorrectly named. He has, therefore, named Eschweilei's plant *V. eschweileri*, with "spora binucleolata." Acharius describes his plant as having polished yellowish thallus, limited by a black line. In these and other characters it differs from the New Zealand lichen.

Fig. 22. (2), Section of apothecium magnified 14 diameters.
22. (2), *a* and *b*, Ascus and spores „ 300 „

Verrucaria sub-biformis, Knight.

Thallus albus effusus inæqualis rimosus. Apothecia subminuta prominentia (madefacta innata) nigra subglobosa integra, paraphysibus capullaribus confertis. Sporæ in ascis cylindraceis oblongæ, 1-septatae incolores, longit. ·02 mm.; crassit. ·007 mm.

Ad cortices arborum.

Thallus white, effuse, unequal, rimose. Apothecia subminute, prominent (innate when moistened) black, subglobose, entire; paraphyses capillary, closely-packed. Spores in cylindrical asci, oblong, 1-septate, colourless; length, ·02 mm.; breadth, ·007 mm.

On bark of trees.

Fig. 22. (3), Section of apothecium magnified 14 diameters.
22. (3), *a*, Ascus and spores „ 300 „

Verrucaria pruino-gricea, Knight.

Thallus effusus tenuis plus minus pseudo-farinaceus griceus. Apothecia minutissima dimidiata patentia. Sporæ in ascis clavatis incoloratae tandem fuscæ lineari-oblongæ, 1-septatæ v. sæpissime interrupte-quadrinucleolatae, longit. ·02 mm. crassit. ·006 mm.

Ad cortices arborum.

Thallus effuse, thin, more or less pseudo-farinaceous, grey. Apothecia very minute, dimidiate, spreading. Spores in club-shaped asci, colourless, at length brown, linear oblong, 1-septate, very often interruptedly quadri-nucleolate; length, ·02 mm.; breadth, ·006 mm.

Fig. 22. (4), Section of apothecium magnified 14 diameters.
22. (4), *a*, *b*, *c*, Ascus and spores „ 300 „

Thelotrema saxatilis, Knight.

Thallus albidus v. cinereo-albidus continuus granulosus indeterminatus, tenuis. Apothecia normaliter globosa in verrucis thallinis rotundatis supra planis immersa, aperturis rotundatis depressis excipulo proprio instructa, paraphysibus capillaribus. Ascus monosporus. Sporae dilute fuscae tandem fusco-nigricantes fusiformes murali-divisae longit. ·16 mm.; crassit. ·038 mm.

Ad saxa.

Thallus whitish, or grey-white, continuous, granulose, indeterminate, thin. Apothecia normally globose, immersed in thalline verrucae, round, flat above; opening round, depressed; furnished with a proper excipulum; paraphyses capillary. Ascus with one spore. Spores dilute brown, at length brownish-black, fusiform, murali-divided, length, ·16 mm.; breadth, ·038 mm.

On rocks.

Fig. 27. Section of apothecium magnified 14 diameters.
27. *a*, Spores and paraphyses „ 300 „

Thelotrema monosporum, Nyl. v. *patulum*, Knight.

Thallus luteo-albus diffractus crassus. Apothecia verrucaeformia excipulo duplici instructa, interiore membranaceo tandem lacero-dehiscente, nucleo madefacto expanso-discoideo, ascus monosporus interdum disporus (ex ea re sporæ minores). Sporæ fuscae fusiformes murali-divisae, longit. ·05 ad ·10 mm,; crassit. ·015 ad ·03 mm.

Ad cortices arborum.

Syn. Thelotrema monosporum v. *patulum*, Nyl. in litt.

Thallus cream colour, broken, thick. Apothecia verrucaeform, with a double excipulum—the interior membranaceous, at length torn, gaping—nucleus moistened expands with a broader disc. Ascus one-spored, sometimes two-spored (then spores smaller). Spores brown fusiform, murali-divided, length, ·05 ad ·1 mm.; breadth, ·015 ad ·03 mm.

On bark of trees.

Fig. 26. Section of apothecium magnified 26 diameters.
26. *a* and *b*, Spores „ 240 „

Bagliettoa map (?) ocellata, Knight.

Thallus fusco-cinereus continuus tenuis subglaber, gonidia magna. Apothecia in verrucis prominulis immersa interdum, 2–4 confluentia, excipulo proprio carbonaceo instructa, primo punctiformia dein aperta, margine thallino albo sculpto-angulari v. sculpto-subrotundo v. irregulariter dehiscente. Nucleus globosus verrucoideus, amphithecio grumoso oriundus, paraphysibus crassis mucoso-diffluxis farctus. Sporae in ascis curvatulis fusiformis ellipsoideae incolores v. luteo-grumosae, longit. ·028 mm.; crassit. ·012 mm.

Ad saxa.

Thallus brownish-grey, continuous, thin, somewhat smooth, gonidia large. Apothecia immersed in somewhat prominent warts, sometimes 2–4 confluent, furnished with proper carbonaceus excipulum, at first punctiform, then open, margin white, cut sharply angular or roundish, or gaping irregularly. Nucleus globose, verrucoid, arising from a grumose amphithecium, filled with thick entangled mucous-like paraphyses. Spores in curved spindle-shaped asci, ellipsoid, colourless, or yellowish grumose; length, ·028 mm.; breadth, ·012 mm.

On rocks.

Fig. 23. Section of apothecium magnified 60 diameters.
23. *a*, Ascus and spores „ 300 „
23. *b*, Gonidea „ 300 „

Platysma novæ-zealandiæ.

Thallus glaucescens v. glauco-pallescens membranosus (latit. 2–3 pollicaris) substipitatus lobato-laciniatus subcaniculatus, lobis expansis laevibus, subtus pallide albus nudus. Apothecia rufa (latit. 2· mm.) conferta marginalia, margine thallino pallido tenui undulato subtiliter granuloso. Sporae hyalinæ ellipsoideæ v. fere sphæroideæ, longit. ·015 ad ·0175 mm., crassit. (v. diam.) ·009 ad ·012.

Ad cortices arborum.

Thallus glaucous or pale glaucous, membranaceous, (2–3 inches broad) substipitate, laciniate, somewhat channeled, spread out, smooth, beneath pale, white, naked. Apothecia red, (2· mm. wide) crowded, margined; thalline margin pale, thin, undulate, finely granular. Spores hyaline, ellipsoid, or almost spherical, length ·015 ad ·0175 mm., breadth (or diameter) ·009 ad ·012 mm.

On bark of trees.

Fig. 24 and 24 *a*, Ascus and spores magnified 300 diameters.

* ERRATUM.—Page 359, No. X., "Trans. N. Z. Inst.," Vol. VII., delete "Lecanora," and insert "Lecidea."

ART. XL.—*On a Remarkable Instance of Double Parasitism in* Loranthaceæ.
By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 12th February, 1876.*]

ONE of the most striking points of contrast between the Floras of New Zealand and the British Islands is afforded by the large proportion of shrubby parasites to be found in the former compared with the latter. New Zealand possess three genera of *Loranthaceæ*, comprising nine or possibly ten species, half of which have showy flowers. The British Islands, with a large Flora, exhibit only a single species, the well-known Mistletoe (*Viscum album*, L.) with unattractive flowers. Central Europe possesses only three or four species. Five genera, comprising about 28 species, are found in Australia, but even in this case, the proportion of *Loranths* to other flowering plants does not exceed that which is found in this Colony.

Instances of double parasitism in this order have been recorded, but they are of very rare occurrence. *Viscum album* has been found growing on *Loranthus europæus*, and one of the Australian species of *Viscum* exhibits a similar preference for various forms of *Loranthus*. In the "Hand-book of the New Zealand Flora," *Tupeia antarctica* is said to be parasitic on *Loranthus micranthus*, but I believe that only a single instance has been observed.

When recently botanizing with my friend, Mr. J. D. Enys, on the mountain above the Broken River, at an altitude of 3000 feet, we had the pleasure of discovering a noble specimen of *Fagus solandri* whose wide spreading arms supported a most abundant and luxuriant growth of *Loranthus decussatus*, some of the branches being from eight to nine feet in length, in many cases bearing specimens of *Tupeia antarctica*, several feet in circumference.

In some cases two or more specimens were growing on the same branch, but these were invariably small, and, in the larger specimens, the portion of the supporting branch beyond the point of attachment of the *Tupeia* was usually dead or dying, showing that the *Tupeia* had absorbed a large portion of the nutritive juices necessary for the full supply of the foster parasite. From 20 to 30 plants of *Tupeia* were parasitic on the *Loranthus* on this single *Fagus*, but although *L. decussatus* and *L. flavidus* were plentiful in the vicinity, no other specimens of *Tupeia* were observed and no other instance of double parasitism during explorations extending over many miles.

The remarkable mode of attachment (see "Trans. N. Z. Inst.," Vol. III., p. 161) of *Loranthus decussatus* was strikingly shown, numerous stems being given off at the point of attachment. and adhering to the foster plant for several feet, often inosculating.

Tupeia antarctica, on the other hand, gives off no stems, and is *simply attached at its base.*

It is worthy of remark that *Tupeia antarctica* is found parasitic on a greater variety of trees and shrubs than any other New Zealand *Loranth.* *Loranthus flavidus*, on the other hand, appears to be restricted to *Fagus solandri.*

Art. XLI.—*Description of a new species of* Hymenophyllum.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 11th October, 1875.*]

In my account of the Botany of the Titirangi District, published in the fifth volume of the "Transactions," I have briefly alluded to a *Hymenophyllum*, as being distinct from any previously described form. Since then I have gathered the same plant in several widely separated localities, in some of which it is by no means uncommon; and there can be little doubt that it will ultimately be found to be generally distributed throughout the colony. My view of its specific distinctness has been confirmed by Mr. Baker, and a full description is given by him in the new edition of the "Synopsis Filicum;" but as this work is not generally accessible here, I have drawn up the following brief diagnosis, including a few points of difference not mentioned in the "Synopsis."

Hymenophyllum cheesemani, Baker.

Minute, forming tufts or cushions on the branches of trees, or creeping among Mosses and Hepaticæ. Rhizome branched, wide-creeping, smooth and wiry. Stipes, 2–3 lines long, filiform. Fronds one-sixth to three-fourths of an inch long, simple, forked, or irregularly digitately divided; quite glabrous; texture, firm; segments, about one line broad, linear oblong or ligulate, obtuse, with only a single central costa in each; margins not thickened, strongly ciliate-toothed. Sori, one to three to a frond, terminal on the segments; involucre nearly free, orbicular, of a much thicker and more compact substance than the frond, divided almost to the base; valves convex, quite entire; receptacle generally included.

Habitat.—Thames Goldfields, Whangarei, Hunua and Titirangi, Great Barrier Island. Not seen below 500 feet. I am indebted to Mr. Kirk for my knowledge of the Great Barrier locality.

Apparently a very distinct species. Its nearest ally in New Zealand is undoubtedly *H. minimum*, which I am glad to find Mr. Baker now considers to be distinct from *H. tunbridgense*. From both these plants it can readily be distinguished by its peculiar habit, less divided, often quite simple fronds, and by the position and form of the involucre. The Australian *H. pumilum*, and *H. moorei*, from Lord Howe's Island, are closely related species. *Trichomanes armstrongii*, from the Canterbury Alps, has precisely the same habit, and but for the thickened margins of the frond, could hardly be distinguished in the barren state. It has, however, the true sori of a *Trichomanes*, and when seen in fructification, it is impossible to confound the two plants.

IV.—CHEMISTRY.

Art. XLII.—*On the Oxidation of Silver and Platinum by Oxygen in presence of Water.* By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th January*, 1876.]

I shall confine myself in this paper to a statement of results, and the considerations which led me to seek them, as I intend leaving the discussion of these in their various relations to certain debateable subjects for another opportunity, my investigations upon this matter being as yet incomplete.

A knowledge of the fact that gold and platinum readily combine with sulphur at a common temperature, and that the compounds thus formed cannot be detected by mere physical tests, suggested to me that oxygen may also combine with these metals under conditions somewhat similar, and in this manifesting none of the more distinguishing signs of chemical action, has consequently to this time been overlooked.

Acting at once upon this suggestion, I fortunately made a series of experiments to test the correctness or otherwise of my suspicion, and the results of these experiments, showing them in the main, I believe, to be correct, I submit to your notice.

I should premise my statement of these results by informing you, in anticipation of what will in due course appear, that one of my principal tests for the oxidation of these metals is that known as the "mercury test," by which it will perhaps be remembered I had the honour of demonstrating before you experimentally the sulphurization of gold by sulphuretted hydrogen; and that this test is based upon the fact that mercury readily amalgamates with silver or platinum when in contact with them, but that if the minutest film of any substance intervenes between the two metals, amalgamation is either retarded or altogether prevented; thus, by the aid of this test, minute quantities of a substance enfilming either of these metals may readily be detected.

Commencing with silver, I ascertained the following facts regarding it:

1. That pure silver immersed for a few hours in distilled water or in the purest water I could obtain, has its surface so modified that it will not amalgamate immediately afterwards.
2. That such an effect is not produced when either rain or spring water is used.

3. That silver thus modified by distilled water is brought back to the amalgamable state by contact for a short time with rain or spring water, also with acetic acid or ferrous sulphate, also by raising its temperature to about 500° F.
4. That electric currents are generated by this metal in saline water free from chlorides, iodides, or bromides, also in water charged with any of these salts.
5. That in dry air silver does not pass into this non-amalgamable state.
6. That spongy silver immersed in an aqueous solution of sodic chloride (in an agate vessel) soon renders it very alkaline.

These results, taken conjointly, signify, I think, undoubtedly that silver is a metal which oxidizes in a superficial way with far greater facility than we have heretofore considered possible.

Thus, in experiment 1, I hold this metal is oxidized by atmospheric oxygen contained in the distilled water used, and the oxides of silver not being reducible or at least readily reducible by mercury, amalgamation is prevented or greatly retarded with water containing chlorides. In experiment 2, we must suppose the silver has also oxidized, but the oxide thus formed has been decomposed by the alkaline chlorides present, argentiferous chloride thus resulting as a secondary product, and this compound, being, as we know, readily decomposable by mercury, amalgamation proceeds with rapidity. However, in regard to silver thus acted upon by chlorides, I always noticed that amalgamation did not appear to proceed instantly when it was placed in contact with the mercury as clean silver does; there was, as it were, a momentary hesitation manifested by the mercury before amalgamation proceeded.

The effect of acetic acid and of ferrous sulphate in experiment 3 is perhaps referable to a solution of argentiferous oxide in the one case, and to its reduction in the other. At the same time, however, we must consider that basic and insoluble silver salts may form here, and these, being readily decomposable by mercury, amalgamation is not retarded. The facts, Nos. 4, 5, 6, I think will be seen corroborative of the correctness of the conclusions I have above drawn.

I may state in further support of this conclusion that I have observed silver, as precipitated from its nitrate, darken near the surface of the solution, and it is only colourless and lustrous where distant therefrom, or when overhung by masses of silver. This darkening I attribute to a superficial oxidation of the silver by the atmospheric oxygen which has permeated the solution used. This metal also, contrary to general belief in regard to it, decomposes mercuric chloride. All these results were in the first place obtained from the metal electro-plated from its pure cyanide upon silver wire; but afterwards, for greater certainty in the matter, I employed silver most carefully prepared, and by approved processes for pure silver. As electro-plated upon lengths of surgical wire, it is most easily worked, and, being thus in a spongy form, its behaviour with the mercury test can be minutely and readily observed. It is necessary, of course, to well wash this silver from alkaline cyanide by distilled water before using it in these experiments. I should inform you I could not observe that sun-light exerted an effect in any of these reactions, whether accelerating or retarding.

In regard now to the metal platinum, I ascertained that it is also passed to a condition in which it will not amalgamate, by giving it contact for a short time with distilled or ammoniated water, also with aqueous solutions of the alkalies, their carbonates or chlorides, while acids generally put it quickly back into an amalgamable condition; an elevation of its temperature to about 400° F. will also accomplish this.

Platinum also generates electric currents when paired with graphite in saline or alkaline solutions.

These facts, I think, show undeniably that platinum not only absorbs oxygen, as is already known, but that this absorption is, in the cases cited, a chemical one, an oxide or a suboxide of this metal being formed. That in the so-termed mechanical absorption of certain gases by platinum, platinic compounds are produced, is an idea which I have long since entertained.*

In conclusion, I would beg to inform you that, from a partial investigation of the behaviour of gold in certain liquids, I believe this metal is also oxidizable under conditions somewhat similar to those under which I have stated silver to be, but the results of this investigation I will endeavour to communicate at our next meeting.

ART. XLIII.—*On the electro-motive order of certain Metals in* Cyanide of Potassium, *with reference to the use of this salt in Milling Gold.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th January, 1876.*]

WHILE on an official visit at the Thames Goldfield I had many opportunities for observing the marked effect of Cyanide of Potassium, in preventing the flouring of mercury used in working off the blanketings. These blanketings I found have as a rule, a decidedly acid reaction, due in a greater part to the presence of ferric and ferrous salts soluble in water, and it is to the former of these salts, that what is commonly known as

* "Trans. N. Z. Inst.," Vol. III., Art. XXXVIII.

"flouring," is mainly due, in the process cited above; such ferric salts being able to either oxidize or chlorodize the surface of any mercury they may be in contact with, thus enfilming it with a compound, which being practically insoluble in water, or in water charged solely with the salts occuring in mineral workings, prevents that metallic contact taking place between detached mercurial globules, which is necessary to amalgamation.

In remedying or preventing flowing so occasioned, this salt, (Cyanide of Potassium) acts by decomposing these mercurial compounds and dissolving in part or wholly their constituent portions, while the surface of the mercury not thus floured, it keeps metallic, by preventing ferric salts acting in the manner stated; these salts being decomposed by this cyanide as they would by any other salt, having as it has, an alkaline reaction.*

In effecting these useful results it is thus seen that cyanide of potassium dissolves a portion of the mercury used; besides this there may be another portion of mercury, though a much smaller one dissolved away from the metal itself by the direct action of the cyanide upon it, aided by the free oxygen always present; this happens if no metal is dissolved in the mercury used, or is in contact with it, having a greater affinity for cyanogen than mercury has. Moreover, in thus contemplating the contingencies entailed or risked by the use of any alkaline cyanide in such milling operations, it must be remembered that both gold and silver are not absolutely insoluble in these cyanides.

Now, the loss of mercury in this way may not be serious, but if *gold* or even *silver* be thus lost (that is by its solution) even in much less quantity than mercury well could be, the loss then may be serious.

Now whether the loss of metal certain to be entailed by the use of cyanide of potassium, falls upon the mercury or upon the gold or silver of these blankettings, conjointly or separately, depends entirely upon this relative affinity of these metals for this salt, or in other words, it depends upon their electro-motive order therein.

According to our present knowledge in regard to this subject, mercury is positive both to gold and silver, under these circumstances, the loss of metal would therefore fall upon the mercury, which is of course desirable: thus we have it distinctly affirmed that "neither gold, silver, or platinum, directly percipitate mercury from its solutions." But feeling the importance of this subject, and moreover having for various reasons grave doubts as to the correctness of these opinions, I investigated this matter for myself, and soon found that in reality mercury is not positive to either gold or

* I will reiterate here, the opinion of mine already published, that before putting in the cyanide to the blankettings, they should be made alkaline by the addition of common soda; less cyanide would then be requisite, and thus working expenses be reduced.

silver in Cyanide of Potassium, as supposed, but very decidedly negative; thus metallic gold in contact with a solution of mercuric cyanides would rapidly dissolve and mercury be reduced.

A knowledge of this fact prompted me to determine the electro-motive order in Cyanide of Potassum, of the various metals which occur in our gold fields, or are employed in any way for milling gold. In the following list most of these will be found, it runs from negative downwards to positive :—

Electro-motive order of metals in Potassic Cyanide.

Carbon.	Lead.
Platinum.	Gold.
Iron.	Silver.
Arsenic.	Tin.
Antimony.	Copper.
Mercury.	Zinc.

Most, if not all the sulphides or other ores occurring in nature, are negative to the whole series. Any of these metals will generally precipitate the ores named below it from its cyanide solution. As already stated, gold and silver thus precipitate mercury, taking its place in the liquid,* which as is already known, silver precipitates gold. In relation to this, however, I find these two metals (gold and silver) are so nearly alike in their affinities for cyanogen, that this precipitation is a very slow process; cyanide of potassium even in contact with an alloy of silver and gold dissolves both, the silver however to the greater extent.

Thus it appears, a loss of gold by solution of it, must frequently happen whenever cyanide of potassium is employed to assist in the amalgamation of blankettings, or other auriferous stuff. In fact all that loss of metal occasioned by its solution, and most of which is, as we have seen a necessity involved in the working of the process itself, falls upon the gold and silver present, the mercury being positively protected from the action of this salt by these more valuable metals.

Further, as the rapidity of action of any exciting solution upon the positive element of a voltaic pair is (other things being equal) the greater the more electro negative to this solution the negative element is, it will happen that the solution and consequent loss of gold and silver in such operations will be the greater when they are carried on in *berdans*, as the

* The precipitation of mercury upon gold from a solution of mercuric cyanide is a very delicate and easy test for gold *in stone*, even when in the form of specks so minute as to be only visible by aid of a microscope; the yellow colour persistent at a red heat of the speck to be tested, and the instantaneous whitening of it occasioned by this cyanide may be taken conjointly as proving that it is gold.

iron of which their receiving part is made, as also the ball, is very negative to gold under the circumstances stated.

The loss of gold in this way will be also greater the more free cyanide of potassium there is present, proportional to the stuff; when the quantity is small the loss is perhaps not serious.

Whatever it is, however, I think it may be avoided, at least in a greater part by allowing the waste liquor from the blankettings to run in a thin stream over copper plates.

ART. XLIV.—*On the Absorption of Antimony and Arsenic from a Solution of their Oxides in Hydrochloric Acid by Charcoal.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, January 29, 1876.*]

SOME time back I showed* that charcoal, when freshly made or ignited, absorbs, from their aqueous or acid solutions, several substances not before known as being affected in this manner, and I proposed to apply this reaction to the purification of certain of our chemical re-agents from substances difficult or tedious to remove by the processes now in use for this purpose.

Since then I have made further investigations in this direction, and find that antimony and arsenic can be so largely removed from solutions of their oxides or chlorides in moderately strong hydrochloric acid (with a little tartaric acid in the case of antimony) by fresh charcoal, that neither of them can be detected therein by Reinsch's test, although before such process was applied both were abundantly evidenced to the test named.

Thus commercial sulphuric and hydrochloric acids diluted with a little water can be purified from either of these substances by agitating them intermittingly for a short time with fresh charcoal, and then filtering off; application of heat to the mixture expedites this result.

The charcoal used does not appear to give up any portion of either the antimony or arsenic when digested with an aqueous solution of potash, hence I consider it very probable that it would absorb either of these metals from alkaline solutions also. Such charcoal, however, when placed in voltaic contact with pure zinc in hydrochloric acid, evolves antimoniuretted or arseniuretted hydrogen (as the case may be) very perceptibly, and it can be wholly divested of either of these substance, when treated in this manner.

In connection with this evolution of such hydrides from charcoal under the circumstances just stated, I will observe here that sulphur, when

* "Chemical News," March 27, 1868.

absorbed by charcoal, is as I have already shown,* also given off, and as a hydride, when the charcoal containing it is connected voltaically with zinc in suitable acids, whereas hot aqueous solutions of potash do not seem to dissolve this sulphur. It appears, therefore, that the character of the absorption of sulphur by charcoal is the same as that of the absorption of antimony and arsenic by this substance.

In examining for minute quantities of either antimony or arsenic by Reinsch's or Marshe's test, I would recommend that the acids used for this (even though purporting to be free from these metals) be filtered through fresh charcoal just before using them, as they frequently extract small quantities of these impurities from the bottles in which they are stored.

Art. XLV.—*On the Solubility of the Alkalies in Ether.* By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th January, 1876.*]

It has hitherto been supposed by chemists that the alkalies are insoluble in ether, but, having been led to doubt the truth of this supposition, from observing certain facts which lately came under my notice, I at once set to work to investigate the matter, and, as it is one of some importance in connection with toxicological examinations, I think it proper to submit the results to you.

My experiments for this purpose were performed both with hydrous and anhydrous ether.

Taking first the hydrous ether, that is the commercial article and that which we really have to deal with in the kind of examinations above alluded to, I agitated separate portions of it with an aqueous solution of caustic potash and carbonate of soda (common soda), then decanted the ether off into clean test tubes, and again from these tubes into platina vessels. I then allowed the liquids to evaporate, when I found the residues resulting from this had a very alkaline reaction, and which was persistent when they were gently ignited, and dissolved in water, clearly showing that a fixed alkali was present in both cases in a free state, or at least as a carbonate. Both magnesia and lime also dissolve in this kind of ether to a notable extent. Bi-carbonate of soda, however, hardly appears to do, or, if so, only in minute quantities.

In regard now to the solvent power of ether itself, that is the anhydrous substance, I find that, when this is mixed with dry potassic hydrate, allowed to clear and then decanted off, a marked alkaline reaction is also

* "London Chemical News," Vol. XXVII., p. 116.

obtained by dipping reddened litmus paper into it, and which is more intense than can be occasioned by any minute trace of alkaline acetate possibly present in the ether, resulting from an inter-reaction of the potash upon it.

The alkalies and their inferior carbonates, therefore, not being insoluble in ether, and alkaloidal carbonates being, as I find, freely soluble therein, I would recommend in special cases, for isolating and obtaining pure alkaloids by Stras's process the use of bi-carbonate of soda, or, better still, an earthy carbonate, in place of caustic alkali, as now employed in aid of this.

I may perhaps be permitted to state further in reference to the solvent property of anhydrous ether, that I find many salts are soluble to a notable extent in it, which are insoluble or nearly so in that which is hydrous; for instance, the chlorides of calcium, nickel, zinc, cadmium, and platinum, also the sulpho-cyanides of nickel, copper, and zinc. The addition of a small quantity of water to any of these etherial solutions generally renders them very turbid, as the salt they contain is thereby precipitated as a hydrate. By the use of anhydrous ether, and by conducting the necessary evaporations in dried air, it is in fact possible to form many saline compounds hardly, if at all, producible otherwise. In this way I have prepared double sulpho-cyanides of nickel and even of copper with certain alkaloids, using chloride of calcium to dehydrate the saline solutions requisite for this.

ART. XLVI.—*On the Oxidation of Gold, and supposed Oxidation of Mercury by Oxygen in presence of Water.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 12th February, 1876.*]

THIS paper states the results of the investigation I promised at our last meeting relative to the oxidation or otherwise of gold, under circumstances which have not been hitherto supposed favourable for such oxidation. They show, and I think pretty clearly, that this metal *is* oxidized superficially under them, as seems demonstrated by the following facts which I give as expressing the general results of the very numerous and often repeated experiments which I have made :—

1. That gold immersed for a few hours in spring water, or in water charged with any neutral salt, refuses for a long time to amalgamate when next immersed in mercury.
2. That it is also passed to this condition by contact for about eighteen hours with distilled water, from which ammonia and other nitrogen compounds have been removed.

3. That it is also thus affected by being placed in contact for a very short time with an aqueous solution of caustic or carbonated alkali or ammonia, at their boiling points respectively, or for a somewhat longer time when the solution used is at a common temperature.
4. That gold is also passed to this condition when ignited with a weak solution of sodic carbonate.
5. That when put into this condition as to its surface, it becomes readily amalgamable by a short contact with either weak acetic or hydrochloric acid; also by ignition, except in the case where ignition has been resorted to, to produce this particular condition of such surfaces.

These facts prove, I think, that gold is chemically acted upon when in contact with water or neutral saline solutions charged with oxygen and nitrogen gases, and that this action is facilitated by the presence of alkaline substances and especially when these are used hot in place of being used cold. It seems to me there can be little doubt entertained, but that gold thus acted upon has been oxidized, and this either to a sub-oxide, or to the purple oxide of gold.

The gold used in these experiments was prepared as pure as possible. Some I twice precipitated by oxalic acid, from very dilute solutions of its chloride.

Other gold I electro-deposited on platinum from its cyanide. Both samples gave similar results, but that obtained by deposition, yielded them quicker, owing perhaps, to the fact of its being coupled with platinum.

There are two circumstances connected with this subject I should relate, which puzzled me a great deal, as they hardly seem to tally with certain reactions of this metal as now known. They are—first, that proto-sulphate of iron in contact with gold which has been acted upon by alkaline solutions or both does not render it amalgamable; secondly, that sunlight, even direct, does not appear to exercise any influence in the reaction I have described. Possibly, though, the purple oxide of gold may prove on examination to be invulnerable in these respects.

I may further relate that gold in either argentic-nitrate or mercuric-chloride rapidly becomes non-amalgamable, but it is recovered to its former condition by acetic acid, I question whether either of these salts are decomposed here. I further find that pure gold, fused with borax and bi-sulphate of potash, though very bright, will not amalgamate; the solution of flux was acid. In weak sulphuric acid also, gold passes to this non-amalgamable condition.

These results, however, and the question they raise demand investigation and I hope soon to be able to accomplish this to an extent which will enable me to throw a clear light upon the subject under consideration. Whatever may be the precise nature, however, of the film thus induced upon gold, and of the reactions which result in the removal or alteration of this film as here described, it is certain that films of this kind must cover the surfaces of a portion of our native gold, and thus retard to a more or less extent, its complete amalgamation when milled.

Thus what with the tendency of this metal to enfilm in presence of common water or alkaline solutions in the manner described, and its tendency to become sulphuretted when in contact with soluble sulphides, there can be but little doubt entertained that most of the natural surfaces of native gold are varnished as it were, with auriferous compounds, and these have to be decomposed by mercury ere amalgamation can proceed, except we use in conjunction with this metal a substance capable of decomposing such films, or else remove them mechanically, as is at present largely accomplished in the stamper boxes.

With reference to mercury, the results I have as yet been able to get, do not point so distinctly to its oxidation by oxygen in presence of water, as those described above do to that of gold. Its mobility at the temperature I have to operate under, stands in the way of my observing indications of any superficial change I may have induced upon it in my experiments. Theoretically it would on first thought appear, that if gold or silver does oxidize, as I affirm, under the above circumstances, mercury should also oxidize under them, as it is certainly positive to both these metals in acid generally. It must be considered, however, in connection with this matter, that gold and silver at their fusing points are in a condition unfavourable to their oxidation, and so mercury (a metal which naturally classes with these), being used in my experiments at a temperature far above its fusing point, may for this reason be less readily oxidizable under the circumstances stated than either of the above metals in their solid state. It appears to me that we should take into consideration here, not only the temperature we are operating under, but the different physical conditions of mercury as compared with that of the above metals at this temperature.

The only results I have yet obtained as to the oxidation of mercury, or otherwise under these circumstances seems to show that it is so oxidized. Thus I find that electric currents of some strength are generated by it in water containing a little sodic chloride; also in aqueous solution of caustic or carbonated alkali; as the only conceivable effect of the salts named is to conduct the electricity thus generated and so render it detectable, I conclude that the action upon mercury which these currents indicate is not originated by such salts, but by the oxidation of this metal.

Supposing, however, oxidation does occur under the circumstances related above, this may have been induced in part by the oxygen condensed upon the platinum, a carbon which I used in conjunction with the mercury in these experiments, as the negative pole.

If this should on further investigation prove to be so, the question as to the oxidation or otherwise of mercury in presence of oxygen and water alone, practically remains unsettled. So far indeed as these experiments and our general knowledge of the behaviour of this metal show, it appears, that in alkaline solution or in water severally, mercury is probably less readily affected than either gold, silver, or platinum.

The result, however, stated in this paper and in Article XLII, Page 332, show, I think, very clearly that the metals, silver, platinum, and gold, readily oxidize under ordinary circumstances, though only to a small extent, thus the film of oxide, or rust as I may properly term it, which is thus formed, never acquires any notable thickness, and so does not manifest its presence readily to mere physical tests. But this limitation in thickness of such films is not due to want of, or weakness of affinity between the underlying metal and oxygen, but rather to the great solidity of these films, and their adherence to the metal, together with their insolubility in the liquid surrounding them, whereby these affinities very soon have their action permanently restrained; contact of the metal with oxygen being thus cut off. Practically there is neither scaling off nor yet any dissolving away of the oxide, or its saline representative, as we have with iron or copper, thus the underlying metal is soon completely protected.

Possibly the knowledge that these metals are chemically acted upon by oxygen, may help us to explain the origin of those electric currents which Professor Becquerel obtained by immersing certain "non-oxidizable metals" in pure water; why should not these currents be in many cases due to the kind of oxidation I have just described, that is to chemical action, rather than as Professor Becquerel attributes to "capillary affinity?" Not only this indeed, but so far as the results I have here given can be taken as correct, it seems certain that a number of cases of so termed *mechanical* absorption are resolved thereby into cases of *chemical* absorption—chemical affinities being the operant power. This aspect of my subject, however, and certain other matters of interest in connection therewith, I forbear to treat for the present, as I hope to be able soon to take up this subject again.

ART. XLVII.—*Notes on the alleged "Replacement of Electro-positive by Electro-negative Metals in a Voltaic Cell."* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

IN a paper by Professor Gladstone, Ph.D., F.R.S., and Mr. Alfred Tribe, which was read before the Royal Society, November 25th, 1875, it is asserted that when zinc and platinum are connected voltaically in a solution of chloride of potassium, "Potassium is set free in some form against the platinum, manifesting itself by the presence of free alkali and hydrogen gas;" and the authors of this paper, upon the supposition above stated and others based in a similar way, argue for the replacement of electro-positive by electro-negative metals, under conditions quite contrary to those we have hitherto held to be necessary for them, and they explain this "reversion" by assuming that some force superior to that of chemical affinity operates in the production of the phenomena they describe, and which is "called into existence by contact."

I will not here discuss the propriety or otherwise of going back to the *contact theory*, which I had thought Professor Faraday long since proved to be untenable, but I would like to make a few observations upon two statements appearing in this paper.

In the first place, as far as I can understand from the abstract of it given in "Nature," it is by no means clear that potassium *is* set free in the experiment described. The alkaline reaction upon which this theory of metallic reduction is based, may in reality be due to a cause quite different from that of such a reduction.

For instance, an alkaline reaction can be readily obtained under circumstances which are similar to those related there, except that contact of dissimilar metals in a voltaic arrangement is avoided, and under which it appears impossible that any metallic reduction takes place. Thus, an aqueous solution of potassic-chloride placed for a short time with amalgamated zinc, or for a longer time with zinc itself, becomes very alkaline. Even pure silver in a solution of this salt soon passes into this condition.* The containing vessels in my experiments for this were agate.

This change in the character of these solutions is hardly wrought by metallic reduction, but rather in the first case by decomposition of water and the formation of ammonia (by the inter-action of nascent hydrogen thus liberated upon the nitrogen present) assisted perhaps by the formation of oxide of zinc by atmospheric oxidation, resulting finally in the formation of an oxy-chloride of this metal through substitution.

* See "Trans. N. Z. Inst.," Vol. VIII., "On the Oxidation of Silver at Common Temperature by Oxygen in presence of Water."

In the second case, that of silver, we have its direct oxidation by the free oxygen present, and the reaction of these oxides thus formed upon the salt in its vicinity, argentic chloride and caustic potash resulting, to which last compound, of course, that alkalinity is induced which we observe.

In the case of zinc it may be that the reactions which result in this alkalinity of the saline liquid surrounding it may not be so simple as I here suppose, further investigations seem indeed requisite ere we can fully explain them; but still the results I have described, and several others I could cite of an analagous nature to these, certainly tend to show that the conception of metallic "replacement," as given in this paper of Professor Gladstone, is as yet scarcely a tenable one, or at least that it requires for adequate support considerably more evidence than has yet been tendered in its behalf.

With regard now to the next statement I have to remark upon, viz., that "Mercury and gold in conjunction would decompose mercuric chloride with deposition not only of lower chloride, but also of metallic mercury," I think it very possible that floating dust or other impurities, or even light had in some way interfered with what should be the legitimate result of the experiment described. In support of this view I found that mercury, which, for greatest purity, I electro-deposited from its potassic-cyanide upon platinum, when not in presence of mercuric-chloride, and kept in the dark away from dust, gave a deposit upon gold of mercurous-chloride only. I may state that the detection of either mercurous-chloride or mercury here appears to me much facilitated if platinum be used in place of gold for the receiving plate, as this metal has its lustre greatly dimmed by even traces of adherent chloride, and any mercury present is easily rubbed off upon an angle of gold, and thus readily identified. Using this modification of Professor Gladstone's apparatus, I was only able to get, even in sixteen hours, a deposit of mercurous-chloride of sufficient thickness to perceptibly impair the lustre of the platinum upon which it formed; its presence, in fact, could not be certainly detected except by the slight darkening of this platinum in caustic potash. By the addition of pure hydrochloric acid, however, to the mercuric-chloride, thicker deposits of this kind were obtained, but none of mercury.

The deposit of this mercurous salt, however, even alone, under the circumstances as found and described by these investigators, appears to me a very suggestive phenomenon, because, upon first sight, it appears inexplicable. I can only attribute the formation of this deposit to the action of a *free acid* or *acids* upon the mercury; a minute quantity of nitric or nitrous compounds dissolved in the saline solution used (taken from the air, etc.) would be competent to thus act upon mercury to the extent required to produce mercurous films such as I have obtained.

But in regard to the question how these deposits are induced upon mercury, I find that hydrochloric acid even readily attacks mercury when paired voltaically with platinum, and, as platinum must act thus because of the oxygen condensed (chemically) upon its surface; and further, as gold will certainly possess a similar though a feebler power of condensation for this gas, we must consider the possibility of a part of the mercurous deposits produced in all these experiments being indirectly due to the metals used in them for the negative element. In these reactions we may safely suppose a portion of the hydrochloric acid present is decomposed; the oxygen condensed upon the negative element oxidizing its hydrogen, while its chlorine attacks the mercury. It is, in fact, a case where both poles conspire to give an effect not producible by either separately, and, as now known, it may throw a light upon the mode in which chemical action is so frequently facilitated, or even at times initiated by touching the positive metal with a metal negative to it in the liquid we may be operating with. It appears to me that this matter is well worth investigating.

ART. XLVIII.—*Notes on the Electric and Chemical Deportment of Argentic Sulphide.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

IN a paper I have given* on the Conducting Power of Sulphides, it is stated that Argentic Sulphide is a good conductor of electricity for a sulphide. I find, however, since this table was compiled that the deportment of this substance into electric currents is a subject which has given rise to some controversy, and that the results as published leave a uniform impression upon chemists that Argentic Sulphide is not an electric conductor in the sense this is usually and properly taken—*i.e.*, not a conductor as a metal is without decomposition.

Thus Professor Faraday supposed it "conducts electricity like a metal, without decomposition; its conducting power, however, increasing with rise of temperature;" while Hittorf is said to show "that, when this compound is free from metallic silver, it conducts only in proportion as it is decomposed."

A knowledge of these conflicting opinions, and of the fact that their tendency is, as the matter now rests, one of antagonism to that of my own opinion on the subject just quoted, induced me to repeat the experiments

* "Trans. N.Z. Inst.," Vol. IV., Art. LI.

upon which my opinion was founded, and with such modification as I thought might best conduce to results informing us correctly on this subject. Taking three plates of pure silver, which had been thickly enfilmed with this sulphide, by twenty-four hours immersion in a strong solution of sodic sulphide, I well washed and thoroughly dried them, but without disturbing these films; then placed them gently on each other, and connected the outside ones with a feeble battery of one cell, which was attached to a galvanometer, when I found an electric current was still indicated, and which was not notably less in quantity than that which was indicated when these plates were out of the circuit.

The same result followed when the silver plates were heated to 300° F. and even used in this experiment while at a temperature approximating to this.

I, therefore, conclude that Argentic Sulphide can be, as I have maintained, a conductor of electricity, and, for a sulphide, a very good one.

Regarding the chemical deportment of this substance (Argentic Sulphide), I find, contrary to what is alleged respecting it, that it is soluble in cyanide of potassium, and at common temperature, and I may state in this connection that auric sulphide is also soluble in this salt; platinic sulphide appears scarcely so, even in a hot solution of it, though sulphur is detectable in this solution afterwards by the nitro-prussic test.

I further find that Argentic Sulphide is not, as heretofore supposed, unattacked by mercury, but is decomposed, though very slowly, by it, mercuric sulphide resulting, attended by amalgamation of the silver thus liberated. Auric sulphide is also very slowly decomposed in the same way; plumbic sulphide, however (as galena), is not.

It will be seen, therefore, that these sulphides in their deportment with mercury behave exactly as we should expect from the electrolytic results I have given in respect to them in my paper on the Electro-motive Power of Gold and Platina in Sulphides,* both silver and gold being there stated to be negative to mercury in sulphide of sodium, and lead positive thereto. Indeed I may state that it was the knowledge of the elytrolytic behaviour of the metals above named which induced me to try for the decomposition of argentic and auric sulphide by mercury.

In this connection I would further inform you that this sulphide (argentic) appears decomposed by chloride of copper alone, although it is stated not to be affected by this salt, except in the presence of an alkaline chloride. Theoretically, indeed, it should be decomposed by this auric salt unaided, as sulphur has a greater affinity for copper† than it has for silver, and

* "Trans. N.Z. Inst.," Vol. IV., Art. LII. † Ibid.

chlorine has a greater affinity for silver than for copper. There is no doubt, however, that the forming of this chloride of silver stops the action at a point at which we cannot readily distinguish that any action has taken place.

ART. XLIX.—*On certain Chemical Effects of Oxygenized Graphite and Platinum.* By WILLIAM SKEY, Analyist to the Geological Survey of New Zealand.

IN the experimental results I am about shortly to describe, I do not for the present distinguish between graphite, etc., as combined with a compound of oxygen such as nitric acid, which easily gives up oxygen, or graphite, etc., as combined with oxygen alone, either as oxygen or ozone.

In some of them it is most probable that this acid or a product of it, as absorbed by the graphite, operates for their production, while in others it really appears that it is oxygen which is the sole operant.

But, as all these experiments were carried on in the presence of nitrogen, a gas which is, as we know, susceptible of being acted upon in certain cases by oxygen in such a manner that nitric or nitrous acids result; and, further, nitric acid is, as I have long since shown, absorbed by charcoal, and also, as will presently appear, by graphite and platinum too, I cannot, therefore, as yet unreservedly attribute any of these results to the action of absorbed oxygen alone, although, as previously stated, I incline to this view.

Having thus defined the position I would hold for the present in regard to the bearing of these results, I will at once state them. They are as follows:—

1st. That any surface of graphite, native or artificial, which has been for some time exposed to the air, liberates iodine from a solution of potassic iodide in weak sulphuric acid.

2nd. That graphite, which can thus liberate iodine, loses this property when washed in ammoniacal or other alkaline solutions; also by ignition.

3rd. That this property of liberating iodine is restored to such graphite by a short exposure of it to the air; or by evolving nascent hydrogen against it; also by digesting it for a little while with hydrochloric or weak sulphuric acid, either at a common temperature, or at the boiling point of these acids respectively.

4th. That graphite, which thus liberates iodine, also rapidly determines a chemical effect upon mercury, when voltaically paired with it in pure hydrochloric acid, mercurous chloride forming.

5. That platinum can be substituted for graphite in the above experiments, with the same general results.

I further find that charcoal does not, even when freshly prepared, notably liberate iodine; but it can be made to do so by digesting it with an acid, the effect of which is perhaps due to its removing all alkaline matters therefrom, and thus enabling the charcoal to retain the oxidizing agent necessary for effecting the liberation in view.

Silver, also, liberates iodine from the solution of it I have named here, and gold even appears to do this, but to a much less extent.

Nitric acid has the same effect upon either graphite or platinum (in relation to iodine) as exposure to air has, and prolonged washing of these metals afterwards does not in any way interfere with this effect, showing, no doubt, that this acid has been absorbed by these metals and is retained very obstinately.

The graphite I used was of course purified both from iron and manganese before being worked with.

In reference to the chemical action of substances upon which oxygen has been in some way condensed, I may perhaps be allowed to state further that when graphite, which has been exposed to the air, is voltaically connected in sea water with graphite just recently ignited, electric currents are generated; graphite, which has been desulphurised, also generates electric currents when connected in this manner with any negative conducting sulphide in a solution of an alkaline sulphuret. By the use of currents generated in this manner I have even electrolyted copper from its sulphate.

I forbear making any specific deductions from the results above related until I can supplement them in such a way as will enable me to discriminate with greater surety than I at present can, the exact nature of the absorptive process by which graphite and platinum become chemically active in the way these results indicate.

Art. L.—*Analyses of a few of the Fire-clays of the Province of Auckland.*

By J. A. Pond.

[Read before the Auckland Institute, 11th October, 1875.]

In introducing the subject of my paper this evening I am painfully aware how imperfectly I have treated it in reference to clays from different districts which have not even been mentioned. Many excellent samples, I have no doubt, have yet to be discovered, while some which have been spoken of as excellent refractory clays, I have been unable to obtain for comparative examination. For instance, Raglan, Coromandel, Wangarei, the Manukau, and many other parts of the country have sent clays competing for the foremost place for the purpose of fire-brick making, one notably from Taranaki, which was supposed to be very valuable for this purpose, proved on examination to be a silicate of magnesia, and formed a most delightful glazed surface at a high red heat, while at a white heat it was in a perfect state of fusion. But undoubtedly the Province possesses some excellent deposits of refractory clays; and some of these I now place before you.

As the diagram will show, I have, for comparison, placed the celebrated Stourbridge clay first, as this has a world-wide reputation. Of the New Zealand, or at all events Auckland clays, I think the Waikato fire-clay has been the most noticed, and it has certainly deserved to be held in high estimation, for it is an excellent clay, but it must, I think, give place to the sample from the Miranda or Wharekawa coal seam. This latter, as will be seen, contains much less iron than the Waikato, and an entire absence of lime, which, in the other analyses, amounts to only a small per centage. The clay next in value is the Bay of Islands, but this, with a higher per centage of lime and iron, would not permit of so white a biscuit being made from it. One thing noticeable in the Waikato and Bay of Islands clays is the large amount of bituminous veins running through them, though entirely absent in the Miranda sample. I do not consider this prejudicial, as it would require less fire to burn the brick, though on the other hand the contraction would be greater and the brick more porous. I may say respecting the Miranda clay that I am indebted to Mr. Tunny for this analysis, but that a sample analysed some time since for the Wharekawa Coal Co. contained 11 per cent. of bituminous matter, which was distributed finely throughout, as if permeated by it. The Waikato and Bay of Islands clays have been most used in Auckland for manufacturing purposes, the former being largely used by the gas works, foundaries, and glass works of this city, and I believe the furnaces for the smelting of iron sand at Taranaki and the Manukau Heads have been made of the same material. With reference to its use for melting-pots at the glass works, the manager complained bitterly of the manner in which it had been collected at the mines and mixed with worthless material, by which it was greatly deteriorated, and it was found necessary in consequence to mix some imported Sydney clay with it. One peculiarity of the Waikato clay is its extreme friability after exposure, which is taken advantage of by the manufacturers before alluded to, and though at first a large sum was paid for the grinding of it, now it is simply left to the action of the weather for a few weeks, and is then in a state of fine division. The great drawback to the increased use of fire-bricks is the distance of the known deposits from the centre of population and the consequent high rate of carriage, and this induced me to turn my attention to samples of clay nearer Auckland. Several of these I received from Mahurangi, but only one was a refractory clay. Some time since I thought the peculiar deposits at Fort Britomart might be worth a trial, and having obtained several samples, and finding them very refractory, I carefully examined them, and was surprised to find how excellent a clay had been overlooked. Any observer, at the time of the cutting through Fort Britomart being made, would have seen some peculiarly marked bands of earth under the superficial soil, the uppermost being a bright red band about two feet in thickness, composed of sandy particles with a large per centage of iron oxide, and immediately beneath it a dark brown band of earth for a depth of about three or four feet, and superimposed upon a layer of white clay, having a depth in some places of five or six feet. These two distinct bands consist of very fair samples of refractory clays, the latter being by far the best, and very little, if at all, inferior for the purpose of fire-brick making, to the Waikato and Bay of Islands clays. The difference in the constituents of these bands is remarkable, seeing how they are situated. The insoluble matter in all the samples analysed is a very large per centage—in no instance less than 90 per cent. The Britomart samples contain a small quantity of pyrites; this has, however, been included in the oxides of iron, and the total is not a large per centage. It may be worthy of remark that during the removal of the earth from the corner of Albert and Custom-house Streets by the Harbour Board, I found the bands identical with those at Britomart, and feel confident that they were a continuation of the same layers which dip slightly to the westward. At the time of this removal several hundred tons of this valuable clay must have been thrown into the Harbour. I think the admixture of the two clays might be judiciously carried out if any practical use was going to be made of them, but in what quantities, would be better seen by experimental use. The last clay to be mentioned is from Mahutangi, and is a fair sample, entirely free from lime and magnesia, the alkalies being larger in proportion than any of the others. This sample is the only one which contains chlorine, and this may be accounted for from its being a portion of the cliff facing the sea. I may remark that I had purposely allowed the samples to become very dry before examination, and had chosen the Waikato and Bay samples as free from bituminous veins as possible.

In bringing this paper before the Institute, I have not the mere feasibility of fire-brick making in view; but when we consider the valuable beds of clay we possess, and in many instances the easy access by water, it will be seen what facilities we have for the manufacture of porcelain, earthenware, and stoneware. The enhanced value in labour would be met by the risk, freight, and high rate of duty in importing, and in many places water power could be utilized, while at the Waikato, Bay of Islands, and Wharekawa mines, the proximity of coal would be of the greatest value. During the year 1873 there was imported into this colony fire-bricks, pipes, earthenware, and stoneware to the value of £48,900, while in 1874 the same class of goods imported were valued at £65,860.

In conclusion, I hope that greater attention will be given to this subject than has hitherto been accorded to it.

ANALYSES OF FIRECLAYS REFERRED TO.

	STOURBRIDGE	MIRANDA.	WAIKATO.	BAY OF ISLANDS.	DARK BAND.	WHITE BAND.	MAHURANGI.
Silica	64·10	59·13	73·00	73·20	85·00	69.80	85·90
Alumina	23·10	30·30	21·80	23·90	9·97	25·89	8·50
Lime	—	—	·16	·23	·20	·26	—
Magnes. Carb.	·90	·76	—	—	·24	—	—
Oxides of Iron	1·80	·81	·16	·71	1·16	2·00	1·50
Alkalies	—	—	·46	·40	·21	·45	·80
Water and organic matter	10·10	9·00	4·42	1·56	3.22	1·60	2·30
	100·	100·	100·	100·	100·	100·	100·

V.—GEOLOGY.

Art. LI.—*Volcanic Action regarded as due to the Retardation of the Earth's Rotation.* By John Carruthers, M. Inst. C.E., Engineer in Chief to the New Zealand Government.

[*Read before the Wellington Philosophical Society, 21st August, 1875.*]

Volcanic Action is so impressive in all its manifestations that it is difficult to realise (what, nevertheless, is true) that the mechanical energy required to produce it is much less than that displayed by the more uniformly acting powers of nature. If, for instance, the whole energy of the tides were converted into volcanic action, it would, in a short time, cover the face of the globe with mountains higher than the Alps or Andes, and render the earth as mountainous as the moon, where, if the hypothesis I now bring forward is correct, much actual motion has been converted into volcanic action, which with us, has not yet been so converted, but still remains in the form of actual motion of rotation.

The power which has raised and still maintains our hills and continents above the sea is, I believe, derived from the retardation of the earth's rotation.

It is quite certain that the earth does revolve less quickly than it used to do, owing to the friction of the tides against the bottom of the ocean, and it has been calculated that on this account the day is longer by one second than it was about a hundred and seventy thousand years ago. Motion cannot be destroyed, and, therefore, that which the earth has lost has taken some other form. The greater part of it has passed insensibly away as heat, having, after first slightly warming the earth, been radiated into space. Even the small part, which by my hypothesis, becomes volcanic action, would also pass insensibly away if it were not accumulated, as a weak stream of electricity is accumulated in a Leyden jar until sufficient intensity had been obtained to make its effects sensible. The strength and rigidity of the earth's crust act the part of this volcanic Leyden jar.

There is, we know, a tide in the ocean due to the attraction of the sun and moon on the parts of the earth nearest to them, being greater than on the parts more remote. There is also a tide in the solid crust of the earth from the same cause, although the rigidity of the latter makes it one of strains rather than of movements. Still, it is contrary to all our knowledge of matter to suppose that there is absolutely no movement, for matter when subjected to strain, more or less, and there must, therefore, be an actual daily tide in the land as well as in the ocean. If the earth had no more rigidity than water, there would be no rise and fall of the sea on the shore, for the land would rise as fast as the water. Our tides are the difference between the land and water tides; they prove and measure the rigidity of the crust. We know from them that the earth is rigid, and that it does not yield to strains, tending to change its form in the way a molten or viscid mass would do.

We will now examine the effect of this land tide in order to ascertain the kind and relative amounts of the strains to which it exposes the crust.

The tide due to the sun alone is about two feet; that due to the moon alone is about five feet, or seven feet altogether. The major axis of the equatorial tidal ellipse is, therefore, at spring tides, fourteen feet longer than the minor axis, or at least it tends to become so. The distance measured on the surface through the pole is twenty-one (21) feet longer from one end to the other of the major axis of the tidal ellipse, than from one end to the other of the minor axis.

By the earth's rotation the end of the major axis passes away from under the sun and moon, and the end of the minor axis takes its place. The major then becomes the minor axis, and must tend to shorten fourteen feet, while the minor tends to lengthen the same amount. Part of the crust tends to stretch and part to compress twenty-one feet.

The polar axis of the earth undergoes no alteration in length from these changes, but if the Sun and Moon in their motion in the heavens separate and come into quadratures, the tide instead of being seven feet is reduced to three feet. No change would take place in the strains above described, but the polar semi axis would be lengthened two feet, thus introducing new and very important tensile strains.

We thus see that the crust of the earth is subjected to a racking movement which exposes every part of it to a tensile and compressive strain alternately, and that the polar axis is continually lengthening or shortening or at least tending to do so.

The crust does not break under these strains, but if another action were added, which increased indefinitely the tensile strains caused by the tides, it will readily be perceived that fracture must take place sooner or later. Such an action does exist in the retardation of the earth's rotation, by which the strains due to the elongation of the polar axis are indefinitely increased.

The earth owes its spheroidal form to its rotary motion; the compression of the poles depends on the velocity of rotation and varies as its square. If, therefore, anything reduces this velocity, the polar axis must tend to lengthen. As before stated, the tides have this effect, the velocity is lessening, the polar axis is therefore lengthening, thus subjecting the crust to a continually increasing tensile strain under which it eventually yields.

That it does yield is proved by the known fact that the earth has now the form due to its present rate of rotation. This cannot be a mere coincidence, but must indicate that the crust has yielded to the strains which tend to lengthen the polar axis, and we may take for granted that it will continue to do so. These are tensile strains and the fracture must therefore be sudden and complete. If they had been compressive, no actual fracture would take place, for the molecules would simply arrange themselves closer together and change of form would follow without fracture. With tensile strains this is impossible for, with them, the molecules are forced further and and further apart becoming every day less able than before to resist the strain, until at last the distance between them becomes greater than that over which the attraction of cohesion can act, when sudden fracture takes place.

As soon as the crust yielded, the fluid interior to the earth, no longer held back by it, would at once take the form of equilibrium; that is, it would rush towards the poles, leaving the equatorial part of the crust unsupported; the latter would be unable to bear for a moment its own weight, or even a ten thousandth part of it; it would break at once at the weakest parts. The primary lines of fracture would tend to be north and south, but as a curved surface like the earth's crust cannot fit itself to a different curve, fractures transverse to the first would be necessary to allow even such an approximation as would enable the strength of the material to bridge over the minor inequalities. There will, therefore, be east and west as well as north and south fractures.

Each line of fracture would become a line of volcanic action.

FIG.1

Let Fig. 1 represent a section of the earth at the equator after fracture. The central part is of less diameter than it was before, part of it having gone towards the poles. The crust is therefore too large to fit on to it, and cannot fall in so as to be supported by the central part without shortening by compression. We will assume that all the crust except the two masses at A has compressed and fallen in. It is apparent that before they can do so also, they must crush together lengthwise, as they have to occupy a smaller space than before.

Wherever matter is compressed heat is evolved, and this will happen at A. It is to the heat thus evolved that I attribute the elevation of a mountain range at A; we must therefore try and find out its amount.

If we knew how much the earth masses had to compress before they could fall in, and the resistance offered to the compression by the elasticity of the material, we could calculate accurately the amount of heat generated; these we will now endeavour to ascertain.

The change which takes place in the shape of the earth in about a hundred and fifty thousand years is equal to lessening its equatorial diameter one foot, and at the same time lengthening its polar diameter two feet; a reduction of one foot in the diameter at the equator would reduce the circumference three feet. The whole compression of the crust in Fig. 2 would therefore be three feet, for this amount of change of shape. If we assume the masses at A to be each one thousand miles long, or 1-24 of the whole circumference, each of them would have to compress $\frac{1}{8}$ of a foot, which is therefore the *amount* of the compression at A.

In order to ascertain the resistance offered to this compression we must find what resistance is offered to the compression of ordinary stone under different conditions, and for this purpose we will take for our standard a pillar one mile long, and for our unit of heat that quantity which would raise the temperature of the pillar one degree Fahrenheit. The area of the pillar is of no moment, as we want to know the length which would be warmed one degree by a given compression of the whole area.

Stone expands about ·000005 of its length when heated one degree; our pillar would therefore expand 1-40th of a foot when heated to the same extent. If instead of being heated the pillar were compressed 1-40th of a foot, an amount of heat would be generated exactly equal to that which would have expanded it 1-40th of a foot. Our unit of heat therefore represents also a unit of energy sufficient to compress stone 1-40th of a foot under ordinary conditions.

The conditions may be, however, so altered that the same compression would require any given number of times more energy to effect it. For instance, if we placed the pillar in a great screw press and lowered the upper plate until it just touched the top of the pillar; if then we applied one degree of heat the pillar would not expand, being prevented by the upper plate; the same would follow at the second and the hundredth application of heat. If at last the screw were turned, and the pillar compressed one unit, the heat developed would be, not one degree but a hundred degrees; the elasticity of the stone had been increased a hundred-fold by the hundred units of heat applied to it, it therefore required a hundred times more force to effect the compression, and this is measured by a hundred times more heat.

If instead of warming the pillar we compressed it by applying equal amounts of mechanical energy the result would be the same, The first compression would warm the pillar one degree, it would then have double the elasticity, and the second amount of energy would effect only half the amount of compression, which would, however, be made against double the resistance and would therefore develope the same quantity of heat as the first, the pillar would therefore be warmed another degree, or two degrees in all, and so on with each application of energy. This assumes that all the heat generated is retained within the pillar. In experiments with short pillars this can never be the case, for the molecular motion is carried through the supports to the earth, but when the pillar is the earth itself, the heat can only be carried away by the slow process of radiation.

The earth is, in fact, exactly in the position of our supposed pillar. Force causing compression has been applied to it by gravity, and is still being applied, heat must therefore be generated. When part of this heat is radiated into space and lost to the earth, the material loses part of its elasticity; gravity, which before was unable to compress it further, is then able to do so, heat is again evolved by the compression, and the elasticity of the material nearly maintained, the loss being measured by the radiation, less the heat generated by the further compression.

If our pillar were compressed until it were only half a mile long instead of a mile, and at the same time the temperature were maintained at 100,000 degrees (to which it would have been raised by the compression); as soon as the constraint was removed the pillar would expand to its full length of one mile, as every degree would expand it 1–40th of a foot, and 1–40 × 100,000 is equal to 2500 feet, or half a mile nearly. In the same way, if a portion of the interior of the earth which had been compressed until its specific gravity was doubled, were brought to the surface, it would expand until it had its original bulk, if it brought with it 100,000 degrees of heat; if, however, its heat were less, that is, if any part of it had been lost by radiation, it would not expand to the full bulk, and it would, therefore, have less elasticity than would be due to the compression it had undergone.

In the case of the earth, some of its heat has certainly been lost by radiation. We cannot tell how much, but, for the sake of illustration, and to show that on any supposition which can reasonably be made there is sufficient left to account for volcanic action, we will assume that it has lost by radiation not more than 49 parts out of every 50 of its elasticity.

On this supposition, the elasticity would be that corresponding to 2000 instead of 100,000 degrees of heat at that depth where the density is double that on the surface, say, at a depth of about 800 miles, and it may be taken, for the purpose of illustration, to decrease uniformly towards the surface. If we assume the thickness of the crust to be 400 miles, its average elasticity would be that due to its average depth of 200 miles, or 500 degrees.

Adopting this elasticity we can calculate by a simple proportion the heat which will be generated when the earth masses at A, Fig. 1, fall in. If a compression of 1–40th of a foot generates one unit of heat, how much will be generated with a compression of one-eighth of a foot when the resistance is increased 500 times? It would be 2500 of our units, each of which would warm a mile of stone one degree Fahrenheit.

As the earth masses have only a quarter of a foot to fall, the whole action would occupy about a seventh of a second. The molecules require a sensible time to transmit motion from one to another, the rate of travel being probably not more than a mile a second; the whole of the molecular motion would therefore be confined to a thin vein extending for only one-seventh of a mile on each side of the line of fracture, but reaching from the surface to the inner side of the solid crust.

From this line of action the energy would spread along the crust, not by the slow process of the conduction of heat, but it would be transmitted at the rate of a mile a second.

The difference between the conduction and transmission of heat may be illustrated by a modification of a time-honoured experiment. If the first of a row of suspended balls be warmer than the last, it will be a long time before any of the excess of heat reaches the latter by conduction, but if the first be lifted and allowed to fall, heat is generated, transmitted through the other balls, becomes potential energy, and may be converted into heat by allowing the last ball to fall again.

It is by this rapid means that the energy collected along the line of fracture is spread; it will find the readiest means of getting into equilibrium, which would be by expanding the matter forming the crust. If we assume that four-fifths of it take this form within 500 miles of the line of fracture, we should then have 2,000 units of heat (being four-fifths of the 2,500 above mentioned) spread over five hundred miles. This would raise the average temperature of the whole by four degrees; the second earth mass at A, would also have its temperature raised in the same manner, giving together a mass 1,000 miles long and 500 miles thick. The expansion of such a mass when warmed four degrees would give a range of parabolic-shaped hills 1,000 miles wide at the base and 360 feet high.

As the earth masses were assumed to be 2000 miles long by one mile wide, or 1–10,000th part of the earth's area, the whole volcanic energy represented by a decrease of three feet in the earth's compression, or in

150,000 years, would be 10,000 miles of such hills, which is much more than denudation would be able to wash down to the sea level in the same time.

As soon as the expansion had taken place a great part of it would be lost at once, for the heat was only just sufficient to cause the expansion, and having done its work it ceases to exist.

Molecular attracton and gravity would at once begin to pull down the elevation again, heat would be again generated, and would prevent further compression until the heat was lost by radiation. The first movement of depression would be almost instantaneous, indeed, the hill would not, unless the material were perfectly elastic, reach the full height above given; it would rise, however, to a height greater than that it could maintain, the excess of elevation being a function of the elasticity of the stone; it would then sink, rapidly at first, and afterwards very slowly.

The normal condition of the earth is thus one of subsidence, and if it were not for volcanic action the solid land would soon sink beneath the sea level.

FIG. 2

Let the figure represent a section through the poles of the earth, the dark line being the form before and the fine line that after fracture. The equatorial belt having fallen in on to its supports, as above described, it would seem at first sight that there would be no compression in the polar sections, as the line E p E is shorter than E P E, and extension rather than compression would be looked for. When, however, the crust yielded to the tensile strain, the point p would be transferred bodily to P, and the curve E p E having a longer radius of curvature than E P E, there would be, in proportion to the area, quite as much compression before it could fit to its new place as there was in the equatorial belt.

We have hitherto regarded the sun and moon as being in the plane of the equator. Their declination would not have much influence on the amount of the strains to which the crust is subjected, but it would largely alter their direction, the pole of the tidal ellipsoid would travel nearly 30 degrees from the pole of the earth, instead of being coincident with it. This would greatly lessen the tendency of volcanic fractures to run in the cardinal points of the compass.

When the earth changes its form the parallels of latitude passing through E E do not change their diameter, and there should be less volcanic action due to north and south lines of fracture at least, at these parallels, than elsewhere, the sun and moon's declination, however, by making these points travel 20 to 30 degrees north and south, would quite obliterate this distinction.

Lines of volcanic action would tend to be of long continuance, as the same causes which had at first decided the position of the line of fracture would be apt to make the next fracture occur in the same place; it is more than likely, however, with the enormous pressures which obtain in these movements of the earth, accompanied as they are by great heat, that rock when fractured would be welded together again, and it would not follow that a line of former fracture was weaker than other parts of the crust, because it had been once fractured.

We will now return to the earth masses at A, Fig. 1. They have just fallen in on to the support below, and the crust on each side of the fracture is in a state of violent molecular agitation.

The heat generated by the compression of the film nearest the surface, at once expands the matter of the crust, and is, by the expansion, imprisoned; it can afterwards escape only by conduction or radiation. From each point of the fracture, heat is rushing in every direction, some of it along the earth horizontally, but some vertically towards the surface. By the time equilibrium had been established the surface near the line of fracture would be raised by continual additions of heat from below to a high temperature, but not sufficient, except in rare cases, to cause volcanic eruptions. Where, as in the Andes, the elevation is very rapid, we may expect volcanoes on the summit of a range, but generally they are due to quite a local cause, and occur, not on the summit, but somewhat to one side of the main line of elevation.

Where a bend occurs in the line of fracture, and still more, where two lines of elevation intersect each other, a cause of volcanic eruption arises, to which I believe is due by far the greater part of the active volcanoes in the world.

If, for instance, the line of fracture be semi-circular, the points along the circumference would be elevated more than the points near the centre. The surface crust of rigid and inelastic rock would be left unsupported in the middle, and as it is far too weak to bear its own weight, it would at once crush together and fall in.

If the bend be on a scale of considerable magnitude, the sheet of rock may have to crush together several feet before it can fall in. Every foot of compression, at the surface, developes enough heat to raise the temperature of one mile of rock by 40 degrees, as a compression of 1–40th of a foot would raise the temperature one degree; at a depth of 33 miles, owing to the increased elasticity, each foot of compression would raise the temperature of the same mass of rock by 3,300 degrees.

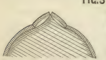
It is not an improbable supposition that, where the rocks had been warped to a convex form by previous elevations, a compression of three feet may often occur in this manner in a sheet of rock 33 miles thick. We should have then a vein extending right across the bend, and one mile wide, of which the temperature was increased by 120 degrees at the surface, and by 10,000 degrees at a depth of 33 miles. At one-quarter of the latter temperature the most refractory rocks would be fused ; at the former, water would boil if the original temperature were 92 degrees.

If once activity were established by an explosion of steam at the surface, the pressure on the heated rock below would be removed, and the eruption would extend to the very bottom. There is always water mixed mechanically with rock, and this would be raised to a temperature of 10,000 degrees. The tension of steam at a twentieth part of this temperature is immense, and if the pressure which retained it were suddenly removed an explosion would follow as violent as has ever been observed.

The temperature of the lower strata is great enough to decompose the rocks and water subjected to it, and to account for the chemical action observed in eruptions.

What occurs on a small scale at every bend in the line of fracture occurs on a great scale on the flanks of all lines of elevation.

FIG. 3



The inelastic surface rocks are supported after elevation has taken place only at the line of fracture, where the elevation is the greatest, and at the line where the elevation ceases, as shown in Fig. 3. For a moment they bear their own weight and then crush down till they can rest fully on the mass below. Earthquakes of great violence would be felt, and under very favouring conditions a line of flanking volcanoes, parallel to the main range, would burst forth.

In all cases of surface movement, where the heat developed has been insufficient to cause an eruption, the rocks are heated and thus placed in a position more likely than before to cause an eruption when a new movement occurs. The rain water also percolates to them, getting heated and returning to the surface as geysers and boiling springs.

It will appear from what has been said that volcanoes are generally not deep seated. The mass of liquid lava which fills a crater rests on a cold and solid bottom instead of being in direct communication with the fluid centre of the earth. In the same way if shafts were sunk into the strata disturbed by the superficial action, the temperature would increase for some distance, but would afterwards decrease as we reached the part which had been affected only by the primary deep seated movement, and which had been increased in temperature only a few degrees.

The theory that the earth increases in temperature about one degree for every fifty feet as we descend is founded on observations made principally in mines in western Europe, that is, along a line of volcanic action, the present activity of which in England was shown by the earthquake of Lisbon affecting the waters of Loch Ness.

Superficial action must here still be taking place and maintaining the warmth of the upper strata.

This theory cannot be at all considered as proved by observation. It requires to be tested by sinking mines in various parts of the world, especially in areas where subsidence has been long continued.

We have spoken of the solid crust and liquid interior of the earth more for convenience of illustration than anything else. There is no sufficient reason, however, to suppose that any part of the earth is, or ever has been, fluid, but it is as well established as any other scientific knowledge founded only on inference, that as we descend, the elasticity increases, and for the purposes of our hypothesis, nothing more is required.

On the assumption we have made above, the temperature increases only about 2,000 degrees in 800 miles. If this is near the truth the earth must be solid to the very centre, and some explanation is required of the slight power of resistance to tensile strain which we know it to possess. The explanation lies in the increasing elasticity as we approach the centre.

Where stone is under compression, and is only kept by force from expanding, it has no tensile strength whatever to resist a strain tending slightly to lengthen it, or rather its strength is a negative quantity. The inner part of the earth is in this position, so that the whole strain is thrown on a thin outer layer which has to bear not only its own tendency to change its shape, but also that of the much larger inner part. It is, therefore, not surprising that it yields to very little more strain than that caused by the tides. That it does not yield to the tides alone is probably largely due to the rapidity of the earth's rotation, which carries away the part under the greatest strain so quickly from under the moon that the molecular motion has not full time to bring up all its forces against it.

We must now show that the elasticity we have assumed for the interior of the earth is sufficient to prevent further condensation except as the interior heat is radiated away.

The weight of a pillar of stone one square inch in area and one mile long, would be about 5000 lbs. At a depth of 800 miles the specific gravity is doubled, but the earth has there lost half of its attracting power, so the effective compressing force of equal bulks of stone would be the same in both positions. The total weight therefore which each square inch would at this depth have to carry would be $800 \times 5000 = 4,000,000$ lbs.

As the elasticity at the same depth is assumed to be two thousand times greater than at the surface, this would be equivalent to loading stone at the surface with a weight of 2000 lbs. per square inch, which it is well able to bear, especially if, as is probable, the resisting power of stone to compression is much increased by its increased density at the lower depth. There is, therefore, on this account nothing unreasonable in the assumption we have made, that the elasticity at a depth of 800 miles is not more than 2000 times greater than at the surface. Indeed, if the rocks at this depth are not greatly different from those we know at the surface, our assumption cannot be very far wrong. If the elasticity were much less than we have assumed it to be, the rock would be unable to bear the weight of the overlying strata, and would compress until sufficient heat had been evolved by the compression to give it the elasticity required. If on the other hand, the elasticity were much greater than our supposition, the rock would expand, lifting the weight above it until its elasticity had been sufficiently reduced by the loss of heat due to the expansion.

It now remains to compare the hypothesis with the results of observation. If it will not stand the test it must of course fall to the ground, but I hope to show that my deductions agree well with the records of volcanic action in various parts of the world.

It would follow from what I have been endeavouring to prove, that lines of elevation would tend to be continuous and of considerable length. This is so well known to be the case that I need not take up your time by giving illustrations.

Secondly, such lines would tend to run in the cardinal points of the compass. A glance at the map will show that this occurs so frequently as to constitute a rule, although there are many exceptions—New Zealand for instance is a notable exception.

The western slope of north and south mountains is generally much steeper than the eastern. This may, I think, be accounted for as follows:

If a ball be conceived to be rolling along a plane surface without friction and to receive a blow in the opposite direction to that in which it is rolling, it will, if the blow be of a particular energy, be brought to rest; that is the motion of the ball, as well as the whole energy of the blow, has disappeared as energy, and has been converted into heat.

If, on the other hand, a blow of equal energy had been given in the direction in which the ball was rolling, the velocity of the ball would be increased, that is, the ball would derive some energy of motion from the blow, and only a part of the latter would be converted into heat.

In the same way the earth masses at A, Fig. 1, receive a blow when they clash together. The molecular motion travels to the same distance in both; but in the western mass, the blow was administered in the opposite direction to that in which the mass was moving, and the greater part of its energy is converted into heat, close to the line of fracture, leaving only a small part to be carried on and distributed over the rest of the distance to which the action extends. The expansion depends on the heat evolved, so that it would nearly all take place close to where the blow was administered.

With the eastern mass the heat would be carried on more uniformly, giving a more gentle slope to the hills.

By the hypothesis, earthquakes and all the other sensible effects of elevation are quite superficial, extending only a few miles in depth. The great primary movement would be quite unfelt if the outer part of the crust were flexible. It is only the surface crushings and fractures which are felt.

This agrees with the observations of Mr. Mallet, who, from calculations founded on the direction in which the shock was felt by observers at some distance apart, has deduced the depth at which the jar was given in different earthquakes. Quoting from memory, and at second hand, I believe he states this to be not greater than 30 miles.

The elevation of a mountain chain does not add more matter to that part of the earth where it occurs; the matter which was there before is expanded, and thus has less specific gravity than the rest of the earth's crust. In the case of a great range like the Himalayas this loss of specific gravity might become sensible, and it has been found that this really is the case. The earth under the Himalayas has less specific gravity than elsewhere.

My hypothesis requires that there should be a tendency towards volcanic action along the flanks of lines of elevation, at a considerable distance from the latter. To show that this agrees with observation, I will quote from Scrope's work on Volcanoes, to which I am indebted for most of the facts recorded below:—

"In the body of this work it was stated that a more or less distinct parallelism, or coincidence, is traceable between the leading mountain chains of the two hemispheres and the linear bands of volcanic vents, active or extinct, insular or continental, by which they are traversed."

And again, after describing the great east and west line of elevation, extending from the north-west of Spain to China, he says:—

"Now, it is the fact that these several mountain chains are bordered at moderate distances, on one or both sides, by linear bands of rocks of volcanic formation, along which therefore eruptions have, at some time or other, taken place."

In New Zealand we see a line of extinct volcanoes, at the Waiau, Dunedin, Timaru, Lyttelton, and the Kaikoras, flanking the main range of the Southern Alps.

In 1835, at the moment when the coast of Chili was shaken by a violent earthquake, a submarine volcano burst out near Juan Fernandez, fully three hundred miles away from the centre of elevation.

That volcanic eruptions are most violent when different lines of elevation intersect each other, is proved wherever such intersections occur.

In New Zealand we have one such line passing along the South Island and thence to East Cape in the North Island, reappearing again probably at Samoa and the Sandwich Islands. This line is intersected between Tongariro and White Island by another line which forms the north part of the North Island; a line of active volcanoes and hot springs marking the intersection.

That Auckland does not belong to the same volcanic area as the rest of New Zealand is, I think, proved by the fact that only two out of the 234 shocks of earthquake which have been recorded have been felt there. One of them was felt nowhere else, the other was felt as a severe shock in every other town and in Auckland only as a very slight one. This fact is very remarkable, as Auckland is situated in the centre of a perfect nest of volcanic cones, and is, of all the places in the Colony, the one where manifestations of present activity would be looked for.

The most active volcanic area in the world is the group of islands around Borneo. Here three great lines of elevation intersect each other, one forming the Malay Peninsula, another passing through the Phillipines to Japan, and the third forming Sumatra, Java, and New Guinea, and after passing through New Caledonia terminating in the Province of Auckland, unless it again reappears in the Chatham Islands.

Another area scarcely less active than the above is formed by the intersection with the Andes of the line which forms the islands of Jamaica, San Dominga, and Puerto Rico.

On the theory that the lava poured out by a volcano is derived from the fluid centre of the earth, it has puzzled speculators to account for many peculiar occurrences which are capable of easy solution by the hypothesis which I have brought before you.

In March, 1861, the town of Mendoza was destroyed and 10,000 of its inhabitants killed by an earthquake, which was not felt on the other side of the range, only a few miles distant. If earthquakes are due to the sudden explosion of gas from the greatest depths of the earth, how can their effects be so local? If, however, they are due to the sudden fracture of a comparatively thin sheet of rock, there is no difficulty in understanding how their effects may be felt over only a few square miles. At the moment of this earthquake the volcano, at the foot of which Mendoza was situated, burst into eruption.

On the other hand, in February, 1797, when Riobamba was destroyed by an earthquake, the volcanoes of Cotopaxi and Tunguragua, at the foot of which the town was situated, were not in the least influenced, while Pasto, at a distance of 120 miles, "suddenly ceased to throw up its habitual column of water."

When the great earthquake visited Chili in 1835, its three great volcanoes burst into activity, and continued eruptive for months, while during the earthquake at Valdivia, in 1822, the neighbouring volcanoes were active for a few minutes only.

In 1772 a Javanese volcano, Papandayung, burst into activity. At the same moment two other volcanoes, distant respectively 184 and 352 miles, also became active, while many intervening volcanic cones remained undisturbed.

When, in 1843, Mauna Loa, one of the Sandwich Island volcanoes, was in violent eruption, the neighbouring permanently active crater of Kilauea, only fifteen miles distant, remained in its normal state.

To account for these and other facts the central fire theory has to be modified by most extraordinary suppositions, all, of course, resting on no foundation whatever.

First astronomers showed that the original idea was incorrect that the solid crust of the earth is very thin; it was shown that a less thickness than 400 miles would not accord with the observed precession of the equinox. Mathematicians also showed that the earth would not cool in the manner assumed, that is, only at the surface. It was then found that even 400 miles were too little for the thickness of the crust, and that 800 miles were necessary. This made it very difficult to believe that two pipes 800 miles long leading down to the fluid centre, could exist within fifteen miles of each other, and still be independent, as was necessary to account for the fact that Kilauea was not influenced by the eruption of its neighbour, Mauna Loa. A new disposition of the fluid matter was then devised, by which it was supposed to be placed as a fluid shell between a solid outer crust and a solid centre.

The fluid shell was then supposed to be divided by walls of lava into separate channels, each crater having a connection with its own channel; Mauna Loa and Kilauea, for instance, were not connected with the same channel. Papandayung, and the other two volcanoes which broke out at the same time with it, were supposed to be connected with the same channel, while the intervening craters were connected with different ones.

Where two neighbouring craters are sometimes in eruption together, and sometimes not, the separating walls of the different channels are supposed to be melted down, or formed by solidification, as might be required to meet the case.

These explanations are, however, nothing better than accounting for the earth's stability by placing it on an elephant's back. We are not told on what the elephant stands, nor what causes the subdividing channels. The explanation, indeed, requires explaining more than the subject matter.

Even if any amount of central fluid be granted, and channels subdividing it, the walls of which are formed or melted to meet every case as it may suit the convenience of the volcanologist, it is difficult to see how it explains volcanic action. The fluid matter either expanded, or it did not, after it received its excess of heat beyond that of the neighbouring solid masses. If it expanded, it would have no more tendency to rise to the top of a volcanic mountain, or even to rise a foot above its former level, than the Niagara River has to change its direction and run up the falls; if it did not expand, its excess of heat would be transmitted to the rest of the earth's mass at the rate of a mile a second, and it would not remain an hour in the fluid state, unless indeed it had sufficient heat to reduce the whole earth's mass to a fluid state along with it.

On our hypothesis, however, each volcano is separate and distinct—they are all due to an elevation extending over great distances, causing local action wherever the local circumstances are favourable. They may, therefore, burst out together or not; may remain long in eruption, or only a second or two, without in the least invalidating the hypothesis.

It is difficult to conceive how a channel of subterranean communication can exist over such great distances as are sometimes embraced in a volcanic throe. In 1755, for instance, when Lisbon was nearly destroyed by an earthquake, Kötlugja, in Iceland, burst into violent eruption, while the lakes of Scotland were at the same time thrown into oscillation. It would, however, militate greatly against our hypothesis if such long lines did *not* exist.

There remains one other test to which we can subject this hypothesis, but I am sorry to say I have not been able to collect sufficient information to apply it.

As stated above, the primary cause of all movement of elevation is the lengthening of the polar diameter of the earth. I have assumed that the elongation necessary to cause fracture is so small that the daily tides would greatly influence the time and manner in which it would take place, which it would do even if the crust were strong enough to resist a considerable elongation of the polar axis.

When the strain caused by the tendency to elongation became as great as the strength of the crust would bear, the crust would begin to yield, and as point after point of it gave way, lofty ranges of mountains would arise in every part of the world. The sea would be confined to deep and narrow valleys; on every range great glaciers would form; icebergs would be floated from the polar seas in immense numbers, and the earth would pass through a glacial period.

When the axis has reached its full length, and the crust was in equilibrium, elevation would cease—subsidence, which is never ceasing, would still be at work; the mountains would sink into the sea; glaciers would disappear, and a period of mild and insular climate would follow, such as seems to have characterised the deposition of the Coal Measures.

If we take 10,000,000 years as the length of this cycle, it would indicate 130 feet as the amount of elongation of the polar axis, the tendency to which would cause fracture of the crust. The elongation due to the tides is two feet, so that they should influence to an appreciable extent the times when eruptions would take place.*

* Instead of a short period of 10,000,000 years, the cycle may, perhaps, embrace the whole time covered by the geological record, and as far as negative evidence is of value the teaching of geology seems favourable to such a supposition. In the oldest formations marine fossils only, have hitherto been found, a few land fossils afterwards appear; they gradually increase in numbers, as compared with the others, until the land and lacustrine flora and fauna assume eventually an importance equal that of the marine. In the earlier formations the types of life which predominate in our Museums are such as prefer an insular climate; types suited to a rigorous continental climate gradually supplant these, and appear to have reached and passed the time of their maximum importance. All this may be due to the incompleteness of the record; but it is exactly what would follow from the supposition under discussion. Many former geological cycles may have existed, each cut off from its predecessor, and the last of them cut off from the present cycle by a long period, during which the whole globe was covered by a nearly shoreless ocean. In each cycle there would have been continents and mountains as at present, due to the elongation of the polar axis, and at the close of each, when the crust had yielded completely to the strains to which it was subjected, a long period of subsidence would follow, during which the differences between the actual length of the polar axis and the length which it tended to assume, was too small to cause fracture of the crust. Gradually the land would disappear, and with it the whole of the terrestrial flora and fauna, except, perhaps, a few genera, which might be preserved on islands. When by the continued retardation of the earth's rotation, the *theoretical* length of the axis became greatly different from the *actual*, fracture of the crust would again take place, and the land would reappear. All fossils of the former cycles would be destroyed by old age. Those of the intermediate oceanic period and of the earlier stages of the new cycle, if they lasted long enough for us to see, would, as the oldest fossils really are, be little more than indications of organic matter. The genera which had not been destroyed during the oceanic period would, however, spread over the newly formed land, and our earliest terrestrial fossils would be those of plants and animals with fully specilised organs, so that we should have no record of the evolution of the higher forms of life from the lowest.

The greatest influence of the sun and moon occurs on the days of half moon, but fracture would most likely take place somewhat later. The weeks following the days of half moon may be considered those on which the majority of great eruptions would take place.

I have only been able to ascertain the exact days on which 27 of these have been recorded—the earliest being the eruption of Monte Nuova, which occurred on the 29th September, 1538, and the latest that which took place in Iceland on the 11th June, 1873. Calculating the moon's age for the day on which each eruption occurred, I find that 61 per cent. are favourable to the hypothesis, and 39 per cent. unfavourable.

There have been 234 days since 1868, inclusive, on which shocks of earthquake have been felt in New Zealand—nearly all very slight. I cannot say the result is very favourable, as the number of those which occurred during the weeks following, exceed those during the weeks preceding half moon by only 3 per cent.

The total number of shocks contained in this analysis is far too small to be of any importance. As far as it goes, it is not unfavourable; indeed, the proportion of great eruptions which occurred during these weeks is very much greater than would be looked for.

It would, however, require a complete analysis of many thousands of shocks before it could be stated with any confidence that the result was favourable or the reverse.

It is, of course, the purest speculation to endeavour to estimate the per centage of influence which the tides would have; but they must have some influence if my hypothesis is correct.

I now leave my hypothesis in the hands of the members of the Society for their criticism. I believe it explains most of the facts which have been recorded by observers better than any of the theories generally received; at least it does away with a great deal of unscientific world making in which volcanologists are too fond of indulging. The only essential suppositions I have made which are not supported by experiment or the clearest inference, are that the earth owes its interior heat to condensation, and has lost by radiation not more than 49 parts out of every 50 of the heat acquired by the compression it has undergone, since its average specific gravity was equal to that of the surface rocks. These suppositions are not at variance with the Condensation Theory, by which Helmholz has calculated that the solar system has lost 453 parts out of every 454 it had when condensation began.*

* I also assume that the inner parts of the Earth are not very dissimilar from the outer part which we are acquainted with. The theory of a great inner heat requires that we must suppose the centre of the Earth to be formed of molten gold, or of some other substance of at least equal specific gravity. Such startling theories can only be accepted when proved by the clearest evidence.

Before concluding, I will allude to two theories of mountain formation which have been lately brought prominently before the Society—the "Contraction Theory" of the Rev. Mr. Fisher, and the "Denudation Theory" as explained by Captain Hutton.

The former explains the existence of mountains by the contraction of the earth's mass, due to the radiation into space of its heat. The upper part of the crust does not partake of this loss of heat, and consequently does not contract; it becomes, therefore, too large for the space it has to occupy, and in some manner, not clearly explained, the excess of matter is supposed to be arranged into mountains.

Captain Hutton's theory is, that the matter brought down by denudation spreads over the bottom of the sea, where it attains great thickness; the lower parts then become warmed, in accordance with the theory that, as we descend into the earth, the temperature increases. Expansion takes place, and the superincumbent mass is lifted in a domical shape above the sea level.

To both these theories there is what appears to me to be an unanswerable objection. They both assume that rock will not contract when subjected to a compressive strain slowly applied, while we know that in fact it will do so to almost any extent.

In both cases the pressure is far within the ordinary elastic limits of the material, and the only change that would take place would be that the molecules would be pressed closer together.

Long before the pressure became excessive, the molecules would have time to arrange themselves in their new form, and would be prepared to compress still further. We should have from both theories a denser rock but no mountains.

ART. LII.—*On the Old Lake System of New Zealand, with some observations as to the formation of the Canterbury Plains.* By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, 29th January, 1876.*]

HAVING succeeded in proving the former connection of the Islands of New Zealand, with its necessary sequence a great Cook Strait river, and a fresh water lake in the Harbour of Port Nicholson, I propose to enlarge the scope of the argument very considerably, for I can perceive that lakes have been very extensive throughout the North Island, and have played a remarkable part in the arrangement of the surface of the land.

When we reach the interior of the North Island, we find immense areas covered by pumice. This has been finally arranged in such a way that it could only have been done by the action of water. We find it spread out in large plains or in gentle undulations, and we also find it terraced. How are we to account for this? The pumice as thrown out by the volcanoes would not arrange itself in this manner. The action of rivers, of running water, is inadmissible. The pumice would be deposited only upon the old banks of rivers. A depression of the land to admit the action of the sea is inadmissible. We do not find in the pumice deposits any marine fossils, and if we were to admit the ocean without due precautions, all the pumice would be carried out to sea.

Circumstances force us to adopt the hypothesis of extensive lakes in the interior. When we have once got hold of the idea, I do not think the proof is very difficult.

For instance, the Upper Waikato forms a basin, the Lower Waikato forms another basin, each surrounded by hills on all sides. Before the river had cut a channel through the hills which separated the Upper from the Lower Waikato, the Upper Waikato must have formed a lake. Before the river had opened a channel through the ranges which separate it from the sea, the Lower Waikato must have formed another lake. Any one who knows the district must see this at a glance.

As the river gradually cut its way through the hills, water-logged* pumice would be left behind in terraces, but previously to this the pumice, by the distributing action of the waters of the lakes, would be spread over the whole area. There is, I think, no other way of accounting for the distribution of the pumice.

In the country skirting Ruapehu to the south, the outcrops of the marine tertiaries rise as a fringe. Before this fringe was broken through by the rivers, lakes must have existed at the base of Ruapehu. On the Ruamata Plains on the western side of that mountain, or perhaps, rather of Tongariro, I observed large deposits of pumice, evidently arranged by water, and necessarily by the waters of a lake.

I have not seen the large deposits of pumice to the north and east of Lake Taupo in the direction of the Thames and hot lakes, and shall, therefore, say nothing about them, except that I have no doubt that their distribution has been caused by water, and of necessity by the waters of a lake or lakes. To go beyond the pumice country, a great part of the Forty-Mile Bush, in the Provinces of Wellington and Hawkes Bay, must

* I am in doubt whether pumice will become water-logged. If not, we can easily account for its position by its being gradually left behind, as the river in cutting its way through the ranges, slowly lowered the waters of the lake.

have been a lake while the Manawatu River was engaged in cutting its way through the Gorge, and possibly there may have been a lake of some extent in the Patea country before the tributaries of the Rangitikei, the Hautapu, and the Moahuanga succeeded in excavating the deep canons through which they traverse the marine tertiaries.

I am tempted to mention a point connected with the vicinity of Wellington, and, therefore, with the theory of a considerable former elevation of land in this vicinity, and possibly, with a lake far exceeding in dimensions the present limits of the harbour. We find at considerable elevation rounded water-worn pebbles sparsely embedded in the clay and soil lying over the rock of the hills. How these pebbles got there has to me been a puzzle for a long time. I am inclined to think that a lake standing at an elevation of perhaps hundreds of feet over the present sea level is the only means of accounting for the phenomenon. I should say that these pebbles, as chiefly observed by me on the Peninsula, look as if they had been deposited at some distance from the head of the lake, in fact, where the deposit would be rare. I think further investigation will show that deposits of water-worn material, found along the ranges surrounding Port Nicholson, will be more easily accounted for by a theory of lacustrine origin than by bringing in the agency of glaciers.

To compare small things with great, it has been held that the Black Sea and the Mediterranean once formed a succession of lakes. Before the waters of the Black Sea had opened the channels of the Bosphorus and the Dardanelles, that sea would have formed the upper lake, with a subsidiary small one in the Sea of Marmora.

The soundings near Malta and Sicily show that, allowing for a former greater height of the sea bottom, a barrier probably existed there which enclosed the Eastern Mediterranean, and formed it and the Levant into a second lake; Malta being then connected with Africa. Indeed, the soundings show a channel which looks as if it had been excavated by the waters of a large river. The third lake would extend from the Channel of Malta to the Pillars of Hercules. It does not follow that these lakes were fresh water. Large basins of salt water may have been left during geological changes, and the influx of river water may not have been more than sufficient to balance the great evaporation of those regions, combined with the outpour into the Atlantic, which gradually removed the barriers. We may compare Lake Taupo to the Black Sea, the Upper Waikato to the Eastern Mediterranean Lake, and the Lower Waikato to the Western Lake.

Having prepared the way by the establishment of large lakes on the North Island for something similar with regard to the South Island, I now propose to consider the much vexed question of the formation of the Canterbury Plains. I think the subject requires more discussion.

The point to decide is, by what agency the gravels which cover the plains have been spread evenly round the contours of the skirting mountains?

There is little or no difficulty in accounting for the gravels. The rivers traverse ranges of mountains of which the rocks are peculiarly favourable for the formation of gravel, and, given sufficient time, possibly the agencies at present in operation would be sufficient for the production of all the deposit, without calling in the help of more ice. But the distribution of the gravel is the difficulty. Captain Hutton would submerge the whole area, and use the waters of the ocean as the distributing power. If a single marine fossil could be found in the gravels of the plains, this theory might be tenable, but the absence of such evidence in any part of the large area under discussion must, I think, be held to be absolutely fatal to the argument.

That the gravels have been distributed by water there can be no doubt, but rivers will not carry gravel up hill, or create a level beach-mark of gravel round the contours of the bounding hills. Having therefore excluded the action of the sea and of rivers nothing would appear to remain to perform the work but the waters of a lake.

To form the Canterbury Plains into a lake it is necessary to suppose a barrier of high land to the eastward. This is a serious mechanical operation, but not more difficult than it would be to submerge the plains beneath the sea. Let us see what arguments we can find in favour of the proposition.

It is considered by many to be an axiom, that where volcanic eruptions have broken out the district is an area of subsidence, and in this part of the world we have strong evidence of the correctness of this view.

We have the numerous volcanic islands of the Pacific with their fringing coral reefs, and we have every reason to suppose that the volcanic districts of New Zealand shew a subsidence from a former much higher level. Thus it is probable that when the eruptions of Mount Egmont first commenced the islands were, or had been shortly before, united, and that a gradual subsidence had been going on previous to the outbursts of this and other volcanoes to the northward. Apply this reasoning to the east coast of the South Island. We there find a line of volcanic eruptions, extending from Banks Peninsula to Dunedin, and shewing at Timaru, Moeraki, Waikouaiti, besides the before-named places.

If this line shews an area of subsidence at or about the time of eruption it pre-supposes a former greater height of land in that direction, and thus we get the conditions necessary to form the Canterbury Plains into a lake. I would suggest that at the period when the islands were united it is reasonable to suppose a greater extension of land generally, and perhaps particularly to the north-west and south-east of Cook Strait, and the east of the South Island.

It will be seen that I agree with Dr. Haast's view of the lacustrine distribution of the gravels of the plains. I hardly think, however, that there is a particle of evidence of the former glaciation of New Zealand. Glaciation is one thing, glaciers something totally different, and not inconsistent with a climate similar to what now exists. There is any amount of evidence of the former further extension of the glaciers of New Zealand; but this may have been owing to a greater extension of high, and particularly of plateau land, and to depression of the interior of Australia thereby extinguishing the cause of heated winds, without calling in the very serious change of climate involved in the term "glaciation."

The era in which the Canterbury Plains formed a lake must have preceded that of the eruption of Banks Peninsula, as Dr. Haast states that the latter shows none of the gravels of the plains on its surface.

One point of geological evidence often leads up to another. I have previously proved the connection of the islands, and this involves not only an elevation, but probably a large extension of land.

The elevation and extension were probably in two directions. To the westward and to the northward of the centre of Cook Strait; to the eastward of the South, and perhaps also a part of the North Island.

During tertiary times New Zealand must have been an archipelago. After the deposition of the marine tertiaries the country rose, and in its rise appears to have left barriers allowing the formation of large lakes in both islands. Subsequent depressions on both sides of the islands at the time of the volcanic outbreaks tended to obliterate the barriers of some of the lakes, but in the North Island these lakes remained until after the period of the great ejection of pumice from the central volcanoes of the Tongariri group, which, be it remembered have been the great pumice producers among the New Zealand volcanoes.

Thus my theory of the connection of the islands, of a Cook Strait river, and Port Nicholson having been a fresh water lake, has led in regular sequence of argument to a greater elevation of land in Pleistocene times, to great extension of lakes in the North Island, and to the conversion of the Canterbury Plains into a fresh water lake. Many subsequent changes have taken place upon these plains; but the distribution of the horizontal margin of the gravel must, I think, be held to have been effected by the waves and and movement of the waters of a large lake.

I am further tempted to suppose a former large lake in Cook Strait, through which the waters of the great Cook Strait river ran. My reasons for this are the configuration of the land, and the absence of soundings, denoting a former river channel in the broad part of the Strait. The distribution of gravel and clay, also, in what we may call the fringe of the west coast of the Province of Wellington, extending into Taranaki, being the belt of open and more level country than what exists further inland, shows, I think, the action either of a lake or of the sea in levelling the surface and distributing the deposition of the gravels and clays. But in this district there are found in places undoubted deposits of marine fossils, such as in the cliffs at Rangitikei on descending to Mr. Fox's house, and at the crossing of the Parewa, so that the question requires much further observation and investigation.

I am inclined to think that the large deposits of gravel and clay between the Manawatu and the Rangitikei, between the Rangitikei and Turakina, or we may say Whanganui, do not show any signs of marine fossils, except in one or two places, and as local changes of level may not have been unfrequent in these districts it is quite possible that the bulk of the gravels and clays may have been lake deposits, while a local depression may have allowed some intermixture of marine fossils, either in Pleistocene or in recent times.

There is abundant evidence that in the Province of Otago the lake system was formerly on a very extensive scale. The Clutha, the Taieri, and other rivers cut through barriers of hills or mountains, which previously must have remained as lakes, the waters of which poured into the upper basins.

Altogether it must, I think, be admitted that lakes during Pleistocene and recent times have been remarkably numerous in New Zealand, and have performed a great amount of work in levelling and distributing the superficial strata.

When we read of the small retrogression caused by the enormous rush of water at the falls of Niagara, and the estimates formed of the time which this force will take to excavate the river valley to the lake above, we may form some idea of the long periods of work which many New Zealand rivers must have had to excavate hard rock before the upper waters were released.

I am inclined to compare many New Zealand lake basins to the plains of Thessaly. These, with the mountains of Macedonia on the north, the Pindus Ranges on the west, Mount Œtna, or Othrys, on the south, present also a mountain barrier to the east. It is more than forty years since I have ridden over these plains; but when I think of the conformation of the surface, it strikes me that a large lake must have existed there before the days of Hercules, or of Agamemnon and the siege of Troy, and before the Peneus broke through the high ground between Olympus and Ossa. I may be mistaken in this idea, because I had not the time to visit the Vale of Tempe; but it strikes me that the remarkable rocks on the summit of which the Monasteries of Meteores are built are probably the wrecks of a former denudation effected while the lake was draining off.

The resemblance above pointed out is certainly greater than that "between Monmouth and Macedon."

ART. LIII.—*On the Igneous Rocks of the Province of Wellington.*

By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, 21st August, 1875, and 29th January, 1876.*]

THE volcanic group of Tongariro and Ruapehu, within which are situated the greatest volcanic mountains of the North Island, lies within the Province of Wellington, but it is not so much my intention to describe it as to call attention to the few scattered indications of trap dykes which are found in other parts of the Province.

I am in hopes that, by calling the attention of observers to the direction in which to look, further discoveries may be made, for, as far as I know, not a single additional igneous rock has been found since those that I discovered as far back as the year 1861.

Those which I found were not numerous. After several days' canoe voyage up the Rangitikei River, I came to a bar composed of large igneous boulders over which the river ran in rapids.

I came to the conclusion at the time that these were carried boulders, as I could not trace the rock into or under the tertiary cliffs forming the river boundary, but in thinking over the matter afterwards, I do not see very clearly how these large boulders could have been carried there. I would therefore suggest a further investigation, to see whether an igneous dyke does or does not run across the country in that locality. The boulders, if I remember right, are composed of a very hard doleritic rock.

In the valleys of the Upper Hutt, of the Waiohine, and of the Ruamahunga, I have found boulders of a vesicular trap, the small vesicles filled with what I took to be carbonate of lime.

As I found these boulders inside the gorges of the Hutt, of the Waiohine, and the Ruamahunga, and therefore in a position where it would be difficult to suppose that they could be carried from without, or from a lower level, I think it probable that trap-dykes may be found towards the central parts of the Tararua Ranges. As I found no trap boulders in the western streams, the Otaki and the Waikanae, I should expect to find the trap dykes more readily on the eastern and southern sides of the ranges than on the western side.

I found, at Waikekeno, on the East Coast, not far from Flat Point, reefs of diallage, or bronzite, standing up on the beach. My impression was that these formed parts of an east and west dyke, and that this may perhaps be traced in the direction of Tararua.

I found what we may call suspicion of igneous rocks at the Muka-muka Rocks; but of such an undeterminate character that it was difficult to decide whether they were igneous or not.

The above are all the igneous rocks as yet discovered within this Province; I think it is high time that we should find a few more. Mr. John Buchanan lately found an igneous boulder in the clay between Hill and Sydney streets; but there does not seem to be much evidence to show how it got there. It may have found its way in former ages from the sources of the Hutt River, or it may have been carried by man.

Along the West Coast we find plenty of igneous boulders brought down from Tongariro and Ruapehu by the rivers Whanganui and Wangaehu. These boulders are eventually washed out to sea and distributed along the coast as far as the Rangitikei, or even farther south. The pumice-stone, which is continually floating down the Wanganui and other rivers, is distributed over much larger areas. Indeed I suppose there is nothing to prevent it making long sea voyages, even to Australia or South America.

The object of this paper, however, is not to call attention to the volcanic products which come from Tongariro, but to point out how to get more information as to the trap dykes of the Province. In particular I would recommend person in the Wairarapa, of enquiring minds, to look well to the valleys of the Ruamahunga, the Waingawa, the Waiohine, and the Tauherinikau, examining the banks of these rivers towards their sources. An endeavour should also be made to trace the diallage at Waikekino inland, and persons living towards the sources of the Hutt River might be on the look out for igneous rocks. Any persons ascending the Rangitikei River should carefully examine the bars of igneous boulders and endeavour to get more information about their locality *in situ*.

Since the above paper on this subject was read before the Wellington Philosophical Society, I have perused in Vol. VII., of the "Trans. N.Z. Inst.," page 453, a paper by Mr. C. W. Purnell, on The Whanganui Tertiaries.

In this paper Mr. Purnell introduces to the Whanganui district a sub-marine volcano, and it may be at once perceived that I cannot leave this novel and unexpected visitor from the lower regions unchallenged.

I have further reasons for taking this step, as I understood that Mr. Duigan has also in a paper, read this year, introduced volcanoes into the Whanganui district. As I did not hear this paper read, and do not know its argument, I will confine my remarks to Mr. Purnell's paper, which is now before me, as a discussion of it will fully settle the question of Whanganui volcanos.

If any one is responsible for a correct statement of the igneous rocks of this Province, I am that person, and it would certainly be a curious fact if I had overlooked such a prominent matter as volcanoes at Whanganui, a district which I have traversed in all directions.

The necessity which Mr. Purnell seems to feel for establishing a sub-marine volcano is really quite unnecessary. The whole process of conveying volcanic material is going on every day and all day long before the eyes of any one who chooses to look.

Pumice floats down the Whanganui River in such quantities that it would be no difficult matter for a ship anchored in the river to intercept it by putting out nets, and so load the ship, and make the pumice an article of commerce. Volcanic ashes are no doubt also washed down, and the harder volcanic rocks are rolled down as boulders. When the Whanganui River stood at a higher level—that is to say, before it cut itself so deep a channel—its waters would spread more to right and left over the surrounding country, and would there leave deposits of pumice, of volcanic ashes, or even of hard igneous boulders.

Around the volcanic groups of Ruapehu and Tongariro there are immense areas covered with pumice. From this, pumice has been washed down the Whanganui River, and there, in many parts, forms thick deposits in the narrow valley. The river cuts through these deposits, and wearing away the banks, constantly floats immense quantities down stream, which are either deposited further down or carried out to sea.

When Ruapehu and Tongariro were in full blast, we may suppose the quantities of pumice and volcanic ashes brought down the river to have been enormous.

There are plenty of volcanic products at Whanganui; but none in original *situ*. From Taranaki volcanic boulders are rolled along the beach. From Tongariro similar boulders are brought down the river, and at last carried out to sea, while in addition, as above stated, pumice and possibly volcanic ashes are always travelling down the river.

It would require very strong argument to establish a volcano in the absence of any igneous rocks *in situ*. Now, in the Whanganui district, the whole country is composed of marine tertiaries up to the base of Ruapehu. There are no volcanic cones; there are no igneous dykes of any kind; there is not a particle of evidence that a volcano ever existed in the district.

With the exception of the volcanic group of Ruapehu and Tongariro, I think I may safely say that there is no evidence of any volcanic cone in the Province of Wellington, and even of igneous dykes few have been found. The same remarks will apply to the Province of Hawkes Bay without exception. Taranaki has its own volcano, but it is a magnificent one; while Auckland is thickly studded with volcanic cones of all sizes. Although Wellington has only the central group to boast of, yet this group, comprising Ruapehu, Tongariro proper, Ngauruhoe, and Puke Onake is superior to all the rest, even to Mount Egmont. There seems to be a strong tendency in the human mind to place volcanoes in the Whanganui district. Even Hochstetter has been persuaded by somebody to put one at Taupiri, where no volcano exists. Taupiri is composed of the usual marine tertiaries.

I hope Mr. Purnell will excuse my criticism. If he can find any volcanic or igneous rocks *in situ*, he may have a case for argument. I assert that there are none to be found thus in the Whanganui district, neither in the shape of volcanic cones, nor of dykes of dolerite, trachyte, basalt, greenstone, or any other igneous rock whatsoever.

One might as well place a volcano in London as at Whanganui. I will undertake to find plenty of igneous rock in London, brought as ballast. I have seen chalk flints in the road metal of the streets of Sydney. I did not, therefore, suppose that we must find a cretaceous formation there, because I saw that the flints had come from London as ballast.

If we find volcanic products, such as pumice or tufa in any district, and are unable to find a volcano *in situ*, from which these may have come, then it may be a fair argument to suppose that, at some time or another, a volcano must have existed, although all direct traces of it had disappeared. But when we find the clearest cause and effect before our eyes, there is not the slightest necessity for adopting hypotheses.

I am also extremly doubtful whether it would be competent for a submarine volcano to eject pumice. I never heard of such a thing. Pumice is simply fluid glass (obsidian) expanded by rapid passage into the atmosphere. An eruption under water, and therefore under great pressure, is not likely to permit the formation of this product.

I should be happy to oblige Mr. Purnell in any reasonable way; but a volcano at Whanganui is too much to ask for. It would be a great and unnecessary expenditure of hypothetical power.

Apart from the question of the volcano, I have read Mr. Purnell's paper with much interest, and I hope he will continue his researches, and give us further accounts of them.

ART. LIV.—*On the Probability of Finding Extensive Coal Deposits within the Province of Wellington.* By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, October 4, 1875.*]

WHERE coal is found in New Zealand I believe it invariably underlies the *cucullæa* beds, not that the sequence is necessary, because of course these beds may rest upon other rocks; but they may, at all events, be considered as an indication, and as showing the possibility of coal being present.

If we strike a line from the Mokau coal seams through the outcrop of the same mineral at Ohura and Tangarakau, the rivers of these names falling into the right bank of the Whanganui, we shall find a line of fracture and of fault, the coal seams dipping from that line, I think, to the south-west, that is to say, as far as an imperfect observation of some of them only enabled me to judge.

No coal as yet has been found on the eastern side of this line.

Now, it is reasonable to suppose that this line of fracture does not mark the eastern limit of the coal seams; but that these may be found to an unlimited distance further east, even up to the flanks of the Ruahine.

The *cucullæa* beds are found to the eastward of this line in the Whanganui River, and I think the same formation forms the prevailing rock of the Rangitikei, although it is long since I ascended that river, my fossils went astray on account of non-delivery by the Maoris, and, therefore, although the formation is similar in appearance to that on the banks of the Whanganui, I am not prepared to prove that it is of the same age.

We will extend the line above mentioned into the valley of the Waikato, and call it the western line of strike. The coal seams along this line of strike may be held, I think, to dip to the westward, and probably underlie all the country to the westward, although broken through and destroyed by the igneous rocks of Mount Egmont and other volcanic cones.

With regard to the Province of Wellington the problem to be solved is this: Does the western line of strike mark the limit of the coal seams towards the east, or do they underlie the *cucullæa* beds and the tertiaries to a greater or lesser distance further in that direction?

The probabilities are rather greater than less that the coal seams underlie the whole of the country from the western line of strike as far as the flanks of Ruahine—a great area of, say seventy miles by forty, about one million and three-quarters of acres.

But it is no easy matter to prove whether the coal measures underlie in this area or not. The upper tertiaries attain a great thickness throughout, and as they, doubtless, lie uncomformably on the coal measures, it would be very difficult at any one point to form an estimate of the depth at which the coal seams might be expected.

Possibly a lengthened and steady examination of the country by a competent geologist might show some outcrops of the coal, or, what is just as likely, this might be discovered by accident.

It would undoubtedly be a matter of great importance, now that the country is being opened by railways, to discover an extensive coal field on the West Coast, even should the coal be of medium quality only. It would probably be of similar character to that of the Waikato.

I believe that no outcrop of the coal has been found to the southward of Tangarakau. It would be of importance to find it nearer the coast, even as far west as the line of fault; but the thickness of the upper tertiaries probably presents the same difficulties there as those before mentioned.

It is by no means impossible that coal may be found on the eastern or Wairarapa side of the main range. The *cucullæa* beds are found in the valley of the Pahaoa River, and I think also in those of the Tauheru and the Whareama; but, certainly in some cases, and possibly in all, these beds rest on rocks older than the coal measures, probably triassic. Still the subject is worth investigation.

The western line of strike and of outcrop from Tangarakau, even as far as the Thames, is certainly a most remarkable fracture as regards its length and exposure of the outcrop of the coal seams. Of course the actual outcrop may lie a few miles either east or west of the line, as a lengthened fracture of rock could hardly be in a strict mathematical straight line; but the actual approximation to straightness of the line is very striking.

One difficulty in the discovery of what exists below is that the rivers lying between the Whanganui and Ruahine Range, viz., the Wangaehu, the Turakina, the Rangitikei and its tributaries, do not cut so deep into the tertiaries as the Whanganui River does, therefore *prima facie*, an exposure of an outcrop of coal is more likely to be found in the vicinity of the latter river than of those lying further to the east.

But the area is large, besides being densely wooded and difficult to traverse, and local dislocations may possibly be found to expose the coal seams if they exist.

Having now disposed of our local coal question, I will make a venture into theory and into the question of the origin of coal. The generally received theory on the subject, I take to be, that at the time of the deposition of the coal of the old European carboniferous formation, the earth still retained a great deal more of its original heat than now obtains, that, in consequence, dense vapours and a damp hot atmosphere prevailed, favourable to the growth of an extremely luxuriant vegetation, and from this accumulation of carbonaceous products the coal resulted.

Now, if this theory be correct, we should expect to find the same conditions extending over both hemispheres, and I think also we might expect the greatest coal formations in the tropical regions. What we actually find is as follows:—Large areas of carboniferous palæozoic coal in the Northern Hemisphere, in Europe, in America, and in China; I think I may say no palæozoic coal within the tropics, and possibly none in the Southern Hemisphere.

In Africa, so far as I know, no coal is found; in Australia, the coal is claimed by the Rev. W. B. Clarke to belong to the palæozoic era, while Professor M'Coy asserts that it is of triassic age. As Professor M'Coy is a palæontologist, and as the question is one of palæontology, *prima facie* we may assume that his view is the correct one.

In New Zealand the coal is of upper mesozoic age, probably lower cretaceous, and in South America all the coal that has been found is, I believe, of tertiary age, although, from the absence of books of reference, I am not able to speak positively as to its exact place.

This, however, is comparatively immaterial. The question of the existence of true palæozoic coal in the southern hemisphere lies between the arguments of Professor M'Coy and of the Rev. W. B. Clarke as to the age of the Australian coal.

But if we require a high temperature for the earth to form the palæozic coal, shall we not also require high temperatures for the formation of the secondary and tertiary coals?

We have a school of geologists who are very strong in argument in the present day as to the effects of cold glaciers and ice sheets covering the surface, not only in temperate regions, but even within the tropics.

Now these changes of temperature from hot to cold and then to increased warmth are inconsistent with a theory of changes from secular cooling, which ought to be constant in one direction, viz., from heat to cold, and ought not to show capricious action from heat to cold and then to heat again.

But is there not something weak in the original theory, viz., that the origin of the old carboniferous coal was caused by the dense vegetation of a period when the interior heat created dense vapours and a warm moist atmosphere, and thus produced an excess of vegetation.

Let us think over the matter. To produce a dense atmosphere from interior heat, it seems to me that we must go the length of supposing the waters of the ocean to be raised to the boiling point. Unless raised to that point, I do not see that the evaporation would be much greater than at present. Then, with the water at the boiling point, how are we to manage enough cold for precipitation?

With water at the boiling point, how are we to account for the existence of the corals, of the crustaceans, of the molluscs, etc., of the coal measures? how account for the similar organisms, including fish, of the old red sandstone and of the silurian rocks? These old molluscs and fish may have been good eating when boiled, but could not very well live and reproduce their species in boiling water.

Again, with the ocean at the boiling point, what would be the effect of the internal heat on the land? I would suggest that it would be to deprive the surface of moisture, which would be driven off in a state of steam, and would therefore render it unfit to support vegetation, instead of, as is supposed, to maintain that of a rank and luxuriant nature. A moderate increase of external heat, that is to say, of heat derived from the sun, would produce great changes, whether favourable to the production of a dense vegetation or not, might depend upon circumstances, but a vast increase of internal heat must be assumed to make any perceptible change in the climate as regards the growth of plants.

I may, however, be combating a shadow, because we have only to refer to Lyell to find an opinion of primary authority as to the origin of coal. He states as follows—"So long as the botanist taught that a tropical climate was implied by the carboniferous flora, geologists might well be at a loss to reconcile the preservation of so much vegetable matter with a high temperature, for heat hastens the decomposition of fallen leaves and trunks of trees, whether in the atmosphere or in water. It is well known that peat, so abundant in the bogs of high latitudes, ceases to grow in the swamps of warmer regions. It seems, however, to have become a more and more received opinion that the coal plants do not on the whole indicate a climate resembling that now enjoyed in the equatorial zone. The ferns range as far as the southern part of New Zealand, and Araucaria pines occur in Norfolk Island. A great predominence of ferns and lycopodians indicate moisture, equability of temperature, and freedom from frost, rather than intense heat, and we know too little of the segillariæ, calamites, asterophyllites, and other peculiar forms of the carboniferous period to be able to speculate with confidence on the kind of climate they may have required."

The above quotation fully disposes of the question of the formation of coal from an increase of vegetation caused by a supposed greater internal heat at the time of deposition, on the theory of secular cooking of the earth.

I should not have entered upon the question at all, had I not found, in the course of conversation, that many persons were fully persuaded of, and held as an article of faith, the idea of the growth of the coal plants from the effect of internal heat.

I hope that I have succeeded in showing the fallacy of that view, and that we must fall back upon the rays of the sun as the true producers of the coal vegetation. The existence of animal life in the palæozoic ocean proves that changes in the temperature of the ocean since that time, if any, must have been confined within narrow limits.

ART. LV.—*On the Cause of the former great Extension of the Glaciers in New Zealand.* By CAPTAIN F. W. HUTTON, F.G.S.

[*Read before the Otago Institute, May 11, 1875.*]

THE former great extension of our glaciers is too interesting a topic to have escaped discussion, and, consequently, we find that it has formed the subject of several papers read to the various scientific societies in New Zealand, in addition to the notices that occur in some of the reports of geological explorations in the South Island. Nearly all the authors of these papers are now agreed that the extension of the glaciers was owing to the elevation of the land; but this opinion, which I believe to be correct, has been arrived at in a very loose manner, and at the present time even it is not entitled to greater weight than that of a shrewd guess. In a former paper on the subject* I advanced a few arguments in favour of it; but I now know that these arguments are fallacious, as many of the shells there taken as subtropical forms range to the southernmost part of New Zealand.

Not liking to leave the question in this unsatisfactory state, I have lately turned my attention to it again, and think that I am in possession of sufficient information to put the subject on a tolerably sure foundation, and I wish, therefore, now to place my reasoning before you, in order that it may be discussed and corrected, if necessary.

In order to arrive at any definite conclusion, it is, in the first place, necessary to ascertain approximately the present height of the snow line in New Zealand. This is not an easy thing to do, for although the theoretical

* "Trans N.Z. Inst.," Vol. V., page 384.

height of the snow line is the position of the line of mean annual temperature of 32° F., its absolute height at any particular point depends on many local causes, as well as on the general one of the decrease in temperature in ascending from the sea level. We are not, however, without data for ascertaining the average height of the snow line with sufficient accuracy for our present purpose. Pembroke Peak, near Milford Sound, is 6,710 feet high, and not only is it always covered with snow, but a small glacier comes down from it towards Harrison Cove. The quantity of snow on this mountain is, no doubt, owing to local causes, and it would be incorrect to take the snow line in Otago at so low a level as this would give. On the other hand 8,000 feet would be too high an estimate, for there is no mountain in Otago, whatever be its aspect or steepness, that attains to this altitude without having snow upon it in places all the year round, and I think that 7,000 feet might be taken as the average height of the snow line in Otago.

In the North Island we have in Ruapehu an excellent standard for estimating the height of the snow line there. This mountain is 9,195 feet high, and its summit is always snow-clad, consequently we cannot take the height of the snow line in the centre of the North Island at more than 9,000 feet. If now, taking these two as fixed points, we calculate the altitude of the snow line at those places, where it is necessary that we should know it in order to follow out the argument, we find that at Mount Franklin, in the Nelson province, it would be 8,000 feet; at Wellington 8,300 feet, and at Auckland, 10,000 feet, which is rather higher than the snow line in corresponding latitudes in the Andes.

The next point is to try to estimate the amount of elevation that would be necessary to bring back the glaciers to their former size. Mr. A. D. Dobson, after a careful examination of the Nelson district, says* :—"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." This, if we take 8,000 feet as the present height of the snow line, would require an elevation of 3,500 feet to bring about. In my former paper on this subject I said that "an elevation of 2,000 to 3,000 feet would be sufficient to account for all the phenomena;"† and Mr. W. Travers says in his paper that it would require an elevation of not less than 4,000 to 5,000 feet.‡ But Mr. Travers estimates the height of the snow line in Nelson at 9,000 feet; and, if we reduce this to my estimate of 8,000 feet, it will be necessary to deduct 1,000 feet from the elevation he requires. This will

* "Trans. N.Z. Inst.," Vol. IV., page 339.

† "Trans. N.Z. Inst.," Vol. V., page 385.

‡ "Trans. N.Z. Inst.," Vol. VI., page 299.

bring it to between 3,000 and 4,000 feet, which is about the amount estimated in a different way by Mr. Dobson. This estimate I am willing to adopt, for, since my examination of the province of Otago, I think it more correct than my previous one.

Now the mean annual temperature of the following places is as under :—

	Mean Annual Temperature.	Latitude.
Monganui	60·1	35·1
Auckland	59·5	35·50
Wellington	55·5	41·16
Dunedin	50·7	45·52
Invercargill	50·3	46·17

And, if we take the mean annual temperature of the snow line to be 32° F., this will give a decrease of 1° F., in temperature for every 363 feet in altitude at Auckland, 353 feet at Wellington, and 374 feet at Dunedin. I will therefore adopt a mean of 363 feet for New Zealand.

From this it follows that a reduction of the temperature of Wellington to that of Dunedin would be equivalent to an elevation of 1742 feet, a reduction of the temperature of Auckland to that of Dunedin would be equivalent to an elevation of 3,194 feet, while the reduction of the temperature of Monganui to that of Invercargill would be equivalent to an elevation of 3,357 feet. So that in order to bring back the former extension of the glaciers, by change of climate alone, the mean temperature at Monganui would have to be reduced below the present mean temperature of Invercargill—that is to say, the whole climate of New Zealand would have to be reduced by more than 10° F.

Now in the pleistocene beds of Wanganui, Motarau, and Oamaru we find the following species of recent shells, none of which are as yet known to extend as far south as the coasts of Otago.*

	Wanganui.	Motarau.	Oamaru.		Wanganui.	Motarau.	Oamaru.
Dentalium zealandicum		*		*Turritella rittata* ...	*		
Murex octogonus	*			*Crypta contorta* ...	*	*	
Trophon paria	*	*		*Monilea egena*	*		
Fusus zealandicus ...	*			*Pholadidaa tridens* ...	*		
,, *triton*	*			*Zenatia acinaces* ...	*		
,, *nodosus*	*			*Venus zealandica* ...	*		
,, ,, var. *β*. ...	*			*Chione yatei*	*		
Cominella virgata ...			*	*Callista disrupta* ...	*		
Cassis pyrum	*			*Mysia zealandica* ...	*		

* Future research will no doubt reduce this list but it is not likely to materially affect the argument.

On the other hand, *Pecten radiatus*, which at present has only been found at Stewart Island, occurs fossil in the Wanganui pleistocene beds. There is, however, a considerable balance of evidence in favour of the climate of Cook Strait having been, in pleistocene times, warmer than the present climate of Otago.

In the newer pliocene beds of Shakespeare Cliff, Wanganui, we find, in addition to twelve of the foregoing, the following additional species :—

Murex zealandicus	*Pleurotoma buchanani.*
Fusus pensum.	*Crypta costata.*
,, *australis.*	,, *profunda.*
,, *mandarinus.*	*Buccinulus kirki.*
,, *dilatatus.*	,, *alba.*
,, *littorinoides.*	*Dosinia lambata.*
Pleurotoma novæ zealandiæ.	

all of which live north of Cook Strait, but none of them are known from Otago. However, in the same beds, *Pleurotoma lævis* and *Pecten radiatus* also occur, which at present are only know to live in Foveaux Strait. On the whole then the evidence is against the idea that a colder climate formerly obtained in New Zealand.

But this is not all, for the following species, none of which are now found alive in Otago, have survived from the miocene period, as they occur in upper miocene rocks (Pareora formation) between Cook Strait and Dunedin.

Fusus australis.	*Crypta costata.*
,, *mandarinus.*	,, *contorta.*
,, *dilatatus.*	,, *profunda.*
,, *nodosus*, var. β.	*Cylichna striata.*
Pleurotoma buchanani.	*Mactra inflata.*
Voluta gracilis.	*Zenatia acinaces.*
Struthiolaria scutulata.	*Venus zealandica.*
Turritella vittata.	*Mysia zealandica.*

On the other hand, there is in the Museum a *Cominella* from the miocene beds of Waikari in Canterbury, which appears to be identical with an undescribed species from Campbell Island.

As none of the shells in these lists can now live on the Otago coasts, we have every reason to suppose that if the sea at Monganui had ever been reduced to the present temperature of that at Dunedin, they could not have lived there either, and consequently they would have become extinct in New Zealand.

Now, as 27 out of these 36 shells are littoral species found only in New Zealand, we should have to suppose, if the extension of the glaciers was due to a change in the climate, that during the cold period they crossed the deep sea to Australia or Polynesia, and that on the return of a warmer climate they all returned again to New Zealand without leaving any behind, which is incredible. Consequently, since the miocene period, there can have been no reduction of temperature sufficient to account for the former extension of our glaciers, and we must necessarily look to elevation of the land as the main cause.

It is possible that the two may have been combined, but we have no proof of it, and it will require a more accurate knowledge of the geographical distribution of our shells, both living and fossil, than we now possess before this part of the enquiry can be successfully taken up, but at present the evidence seems to be in favour of there never having been a glacial epoch in New Zealand, and consequently none in the Southern Hemisphere.

ART. LVI.—*The Coals and Coal Fields in the Province of Auckland.*
By J. M. TUNNY, Provincial Analyist.

[Read before the Auckland Institute, 11th October, 1875.]

IN bringing this subject before the Institute, it is not so much with the idea of entering into the chemistry of the subject as to show the absurdity of importing every year, as we do, enormous quantities of coal at a very large cost to the Colony, when we already have in the Colony a superior article to that imported.

With this object in view I will, in the first place, mention that, during the year 1873, there was imported into New Zealand no less than 108,203¼ tons of coal; valued at £187,833; and, in 1874, 128,719 tons, valued at £211,081. Now, it will be at once seen, what a vast benefit it would prove if this large sum of money could be retained in the colony.

I will now show, that we have in the province of Auckland a very superior class of coals. For the sake of comparison, I will in the first place, give the analysis of the two coals principally used in Auckland—namely, the Bay of Island and the Newcastle coals :—

	Bay of Islands.	Newcastle.
Volatile and organic matter ...	29·94	24·80
Fixed carbon	61·20	68·60
Ash	1·60	3·60
Sulphur	3·26	2·60
Water	4·00	·40
	100·00	100·00

The valuable or heat-giving substances in a coal are the volatile or tarry matter and the fixed carbon. Now, on adding together the volatile matter and fixed carbon in the above, the Bay of Islands will give 91·14, and the Newcastle 93·4 per cent. of heat-giving substances, shewing that the latter has slightly the advantage. But the difference is so small that it would hardly be noticed in ordinary use.

The coal to which I have referred as being superior to that imported, is found on Mr. Frater's land at Whareori, near Whangarei, and of which the following is the analysis :—

(No. 1).—Whareori Coal.

Volatile and organic matter	25·50
Fixed carbon	69·48
Ash	·52
Sulphur	1·70
Water	2·80
	100·00

On adding together the volatile matter and fixed carbon in this sample, the result will be 94·98, or as nearly as possible 95 per cent. of heat-giving substances, thereby shewing an advantage over both the above. But, the superiority of this coal does not stop there, for it gives less ash, and what is most important to users of steam power, it gives less sulphur.

I may also mention that this is a coking or caking coal—a very important matter, when used for blacksmith work, etc.

The next coal to which I will refer, is that known as the "Whangarei coal," and which has, to some extent, been already tried. The following is the analysis :—

(No. 2).—Whangarei Coal.

Volatile and organic matter	31·40
Fixed carbon	51·60
Ash	6·00
Sulphur	2·00
Water	9·00
	100·00

The heat-giving substances in this sample, it will be seen, are considerably below those of the above coals. But, the distinctive character of this coal lies in the proportion of water, which will be seen to exceed that in the above samples, though not nearly to such an extent as the following one:—

(No. 3).—MIRANDA COAL.

(Found on Mr. Footes' land, at the Miranda).

Analysis—

Volatile and organic matter	33·60
Fixed carbon	44·00
Ash	2·80
Sulphur	·40
Water	19·20
	100·00

From the large proportion of water in this sample it would not prove a very good steaming coal, but still, it could be used for a great many purposes, and, as it can be got out very cheaply it could be sold at a somewhat smaller price than the others. I believe that a small quantity of this coal has already found its way into the market.

The last coal, to which I will call your attention, is found on Mr. Walton's farm (near Whangarei), and of which, the following is the analysis:—

(No. 4).—WALTON'S COAL.

Volatile and organic matter	46·40
Fixed carbon	38·40
Ash	6·00
Sulphur (not estimated)	—
Water	9·00
	100·00

This I have no doubt would prove a very fair coal for steaming purposes, though not quite suited for household use, as from the large percentage of volatile or tarry matter, it would be what is termed a smoky coal.

In conclusion I would remark that a better coal than that from Whareori could not be desired. It can be used for every purpose for which a coal is used, excepting the manufacture of gas, and I hope, before long, to see the Whareori coal as well known as that from the Bay of Islands.

NEW ZEALAND INSTITUTE.

NEW ZEALAND INSTITUTE.

Seventh Annual Report, 1874-75.

Meetings of the Board of Governors were held on the following dates, viz., 8th August, 21st December, 1874, and 11th March, 31st March, and 4th August, 1875.

Of the members who retire from the Board—W. T. L. Travers, Esq., F.L.S., and the Hon. E. W. Stafford, F.R.G.S., were reappointed, and the Hon. W. B. D. Mantell was appointed in the room of Sir David Monro, who withdrew. The Governors elected by the affiliated Societies are—His Honor William Rolleston, B.A.; Charles Knight, Esq., F.R.C.S.; and Thomas Kirk, Esq., F.L.S.

In conformity with Statute IV. of the Rules of the Institute, the following gentlemen were elected honorary members:—Alfred Newton, Esq., F.R.S.; Professor Wyville Thomson, F.R.S.; Robert M'Lachlan, Esq., F.L.S.

The number of members on the roll of the Institute is as follows:—

Honorary Members	19
Ordinary Members:—	
Auckland Institute	215
Wellington Philosophical Society	158
Otago Institute	166
Philosophical Institute of Canterbury	91
Nelson Association	57
Total	707

Two honorary members are lost to the Institute since last report, by the death of Sir Charles Lyell and Dr. J. E. Gray; several valuable contributions in the zoology of New Zealand have appeared from time to time in the Transactions from the latter gentlemen.

Each of the above members receives a copy of Vol. VII.; the free list, herewith appended, are also supplied with copies, and the remainder reserved for sale at £1 1s. each. Local libraries and institutes can obtain copies at half-price.

Publication of the Transactions.

The publication of the volume for 1874 (Vol. VII.), which took place in July last, was considerably delayed, owing to the difficulty experienced by the printer in obtaining the necessary number of hands to insure its completion at an earlier date. Its greatly increased bulk was also a cause of its not being produced sooner.

The volume contains 638 pages and 30 plates. Ninety papers are printed either in the Transactions or Proceedings, which are by 46 different authors. The space taken by each section of the volume is as follows :—

	Pages.
Miscellaneous	195
Zoology	137
Botany	46
Chemistry	30
Geology	57
Proceedings	101
Appendix	45
Table of Contents, Preface, etc.	27

A paper by the Rev. Mr. Stack, received too late for publication in its proper place in the volume, will be found in the Appendix among other papers. The papers by Mr. W. T. L. Travers, and Dr. Knight, had the advantage of being corrected for the press by the authors.

It has been found necessary to increase the edition from 850 to 1,000 copies. It will be at once apparent that the large increase in the number of members made this necessary. It is possible that the accession to the Institute of the two new Societies of Westland and Hawke Bay may necessitate a still further increase in the next volume.

During the Parliamentary recess a second edition of Vol. I. was printed at the Government Printing Office, with the consent of the Government. The expense of printing this edition is to be defrayed out of the sale of the volumes. The arrangement of the second edition, Vol. I., has been slightly altered from that of the first, and errors have been corrected. No material alteration has, however, taken place in the papers.

It is advisable again to call the attention of Secretaries of incorporated Societies and of authors to the necessity of sending manuscript in an easily readable form. The observance of this rule is of advantage both to the editor and authors, as the former is saved much unnecessary trouble, and the latter insure their remarks being correctly printed. It should be remembered that a volume written in 50 or 60 different hands, and in most cases not revised in print by the authors, is more liable to error than a work by one person, who is presumably able to decipher his own writing and set the printers right. Bad writing is also a source of expense, as papers, if at all illegible, have to be copied, and again they are liable to further error in being so copied.

The number of volumes now on hand is as follows:—Vol. I., first edition, 5 copies; Vol. I., second edition, 600 copies; Vol. II., 26 copies; Vol. III., 19 copies; Vol. IV., 43 copies; Vol. V., 80 copies; Vol. VI., 88 copies; Vol. VII., 260 copies.

The statement of the accounts of the Institute by the Honorary Treasurer is herewith appended, and shows a balance in hand of £48 19s. 11d.

Progress reports of the various departments under the Manager are also appended.

W. B. D. Mantell.

11th October, 1875.

Free List for issue of the Transactions.

No. Copies.

1 His Excellency the Governor, President of the Society.
12 Governors of the Institute. (See printed list in Transactions.)
19 Honorary members. (See printed list in Transactions.)
1 The Prime Minister.
1 The Colonial Treasurer.
1 The Native Minister.
1 The Under Colonial Secretary.
2 For Parliament.

Foreign Societies, Libraries, &c.

1 The Colonial Office, London.
1 The Agent-General, London.
1 Trübner and Co. (Agents), London.
1 The British Museum, London.
1 The Royal Society, London.*
1 The Royal Geographical Society, London.*
1 Ethnological Society, London.*
1 Geological Society, London.*
1 Zoological Society, London.*
1 Geological Survey of the United Kingdom, London.*
1 Geological Magazine. (For Review.)
1 Literary Institute, Norwich, England.*
1 The University Library, Edinburgh.*
1 The Royal Society, Dublin.*
1 The Philosophical Society of Leeds, England.*
1 Smithsonian Institute, Washington.*
1 Geological Survey of India.*
1 Royal Society of Tasmania Library.*

1 The Public Library of Melbourne.
1 South Australian Institute Library.*
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1 University Library, Sydney.
1 Public Library of Tasmania.
1 Legislative Library, Adelaide.
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1 Academy of Natural Science Library, Philadelphia, U.S.*
1 Academy of Natural Science, San Francisco.*
1 Oxford University Library, England.
1 Imperial German Academy of Naturalists, Dresden.*
1 Cambridge University Library, England.
1 Linnean Society.*

Contributions and Exchanges.

1 His Excellency Governor Weld, Tasmania.
1 Professor Balfour, Edinburgh.
1 Professor M'Coy, Melbourne.
1 Chairman of School Library Committee, Eton, Bucks., England.
1 Chairman of School Library Committee, Harrow, England.
1 Chairman of School Library Committee, Rugby, Warwickshire, England.
1 President of Natural History Society, Marlborough College, Marlborough, Wilts.
1 Colonel Jewett, New York.
1 Dr. Wojeikof, of St. Petersburgh.
1 Hon. Mr. Casey, Victorian Government.
1 Dr. Hann, for the Royal Imperial Institute for Meteorology and Earth Magnetism, Hohe-Warte, near Vienna.
1 Dr. Berggren, University of Lund, Sweden.

Libraries and Societies in New Zealand.

1 Secretary, Auckland Institute.
1 Secretary, Wellington Philosophical Society.
1 Secretary, Philosophical Institute of Canterbury.
1 Secretary, Nelson Association.
1 Secretary, Otago Institute.
1 General Assembly Library.
9 Provincial Council Libraries.

* Exchanges.

Publishing Branch.

1 Editor.
1 Assistant Editor.
2 Draftsmen.
1 Lithographer.
1 Government Printer.

Total, 104 copies.

MUSEUM.

The alteration and extension of the buildings of the department, which have, since last report, been undertaken by the Government, will, it is believed, when completed, leave little to be desired in that direction for a considerable time.

These works, which were commenced in November last, and are still in progress, but rapidly approaching completion, affecting as they have done almost every portion of the building, have necessitated the exclusion of the public for a long period, but this loss will be amply compensated for when the collections, together with the large and valuable additions expected from Europe on the return of the Director of the Geological Survey, shall have been arranged in the Museum, while the erection of office accommodation will remove many obstacles to the progress of departmental work.

There have been 4,813 specimens added to the Museum during 1874–75, over 4,000 of which have been collected in the field by the officers of the department. Owing to the extensive alterations which have been going on in the Museum building, the number of presentations for the past year falls short of what it has been in former years.

A large and valuable collection has been taken to England by Dr. Hector with a view to identification and exchange, so that next year considerable additions will be looked for in the objects of interest in the Museum.

Mammalia.—A specimen of the humpback whale, *Megaptera australis*, has been recived from Mr. G. Gooch, from the Kaikoura Beach. Two specimens of the blackfish, *Globiocephalus macrorhynchus*, and one skeleton of *Eubalæna marginata*, from Mr. Charles Traill, of Stewart Island. Captain Fairchild also procured for the Museum a specimen of a new species of cowfish.

Birds.—Fifty-seven specimens have been added to this department since last report, the chief of which are twenty-seven foreign birds sent by Dr. Otto Finsch, of Bremen. A fine specimen of peacock (*Pavo cristatus*), by Mr. J. Monteith; and a large specimen of the Patagonian penguin, presented by Mr. C. Traill, and mounted by Mr. Morton.

Reptilia.—The only entries under this head are a collection of lizards from the Brothers Islands, and from Stewart Island, by Mr. C. Traill.

Fishes.—No additions of any importance have been received under this head.

Invertebrata.—Little has been received beyond a collection of Tasmanian insects from Mrs. Battersbee.

Palæontology.—During the present year large collections have been made from parts of the Canterbury, Marlborough, and Nelson Provinces, with a view to determining the relations which exist between the bituminous coal of the West Coast and the Saurian beds of the Waipara, but the evidence obtained is not sufficient at present to settle this satisfactorily. Much interesting information has, however, been obtained, together with good collections from the Waipara, Weka Pass, Culverden, Rakaia, and Trelissic beds; and the lower beds of the Trelissic outlier have been shown to be of the same age as those of the Waipara, the *Inoceramus*, *Belemnites*, &c., of which, in addition to the Saurian remains, distinctly pronounce them as secondary.

A survey of the coast line between Cape Kidnappers and Castle Point has also been accomplished, and a collection comprising over 750 fossils been made from the tertiary, cretaceo-tertiary, and secondary rocks of the district, of which the latter prove to be of Jurassic age.

A further collection has been obtained from the Taipos, on the east coast of Wellington and Napier, comprising several new species; and from the Tairua Valley a collection has been made, showing the rocks of that district to be of the same age as those of the Ahuriri formation, which appear at Napier and Castle Point.

A survey of the country between Raglan and the Miranda Redoubt, in the Province of Auckland, has been completed, and careful collections made from the various localities where fossils are found. About 1,300 specimens were collected on this trip, and it is interesting to note that, for the first time in the North Island, fossils (*Monotis salinaria*) were discovered in the older rocks forming the Hakarimata Range, thus fixing their horizon as much younger than was originally supposed, probably Triassic. With the exception of this instance, no fossils were obtained in rocks of greater age than the brown coal of the Waikato basin; but collections were made from all the younger beds which show a direct sequence until reaching the Kawhia limestone, an equivalent of the Napier limestone of the East Coast.

At Wangaroa North the secondary rocks of the East Cape District and East Coast of Wellington again appear, and there is now in the Museum a collection from these rocks comprising *Inoceramus* and many other forms, and a collection has also been made from the greensands which lie unconformably upon them, and which, from the presence of *Pecten hochstetteri*, etc., appear to be the equivalents of certain sandstones in the Raglan Harbour. No other beds of the coal series appear in the district here examined.

Large collections from the various localities at present represented in the Museum have been sent home for identification by competent authorities, with a view to establishing a distinct basis for the classification of the formations appearing in this country; and the collections in the Museum at present have been worked out, and are exhibited as nearly as possible in their geological sequence, but provisionally only, under the title of their geographical distribution.

Laboratory.

The number of analyses made during the year is 315, viz., of coals, 33; minerals, 75; metals and ores, 48; gold, 14; examinations for adulterants, 128; and 178 miscellaneous.

The particulars of these analyses will be found in the Annual Report by the Analyst.

W. B. D. Mantell.

Accounts of the New Zealand Institute for 1874–5.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand, August, 1874	209	9	5	Expense of Printing Volume VII.	€23	18	0
Vote for 1874-75	500	0	0	Extra expense on Volume VI.	15	12	6
Contribution from Wellington Philosophical Society for 1874	28	3	6	Expense of Editing Volume I., 2nd Edition	25	0	0
Sale of Transactions	4	8	6	Miscellaneous items	28	11	0
				Balance..	48	19	11
	£742	1	5		£742	1	5

A. Ludlam, Treasurer.

Wellington, 11th October, 1875.

PROCEEDINGS

OF

INCORPORATED SOCIETIES.

WELLINGTON PHILOSOPHICAL SOCIETY.

First General Meeting. 7th *August*, 1875.

T. Kirk, Esq., F.L.S., in the chair.

New Members.—The following new members were elected:—The Hon. Colonel Feilding, of London; John Ballance, Esq., M.H.R., Wanganui; Major Charles Brown, Taranaki; Henry T. Clark, Esq., Under-Native Secretary; S. Herbert Cox, Esq., F.C.S., F.G.S., Assistant-Geologist Government of New Zealand.

The Chairman then introduced the new President, Dr. Buller, C.M.G., F.L.S., F.G.S., etc.

The President delivered the following

ADDRESS.

Gentlemen,—At the opening of each annual session of the Wellington Philosophical Society, something in the nature of an address is expected of the President; and as the Society has seen fit to elect me to this honorable post, I must endeavour, to the best of my ability, to fulfil its duties in this respect.

In selecting then a subject for the few remarks I shall offer this evening, I feel that I cannot do better than follow the example of my able predecessors in this chair, by reviewing briefly the scientific work done by our Society during the past year, as recorded in the volume of the "Transactions of the New Zealand Institute" just issued from the press. But, before doing this, I am anxious, with your indulgence, to step out of the beaten track and take a wider range, for the purpose of briefly noting the progress and development of scientific research in this Colony during a somewhat longer period.

My distinguished predecessor, the Hon. Mr. Mantell, has on a former occasion recalled the circumstances under which, in 1851, the New Zealand Society (the parent, as he termed it, of the New Zealand Institute) was founded by His Excellency Sir George Grey. That Society flourished for a time, and promised to take firm root among the colonists; but immediately on the departure of its chief patron and promoter it languished and ultimately became defunct through lack of funds. Years passed on, and a new Society was formed on the ruins of the old one, and of this I had the honor to be chosen Secretary. The original name of "The New Zealand Society" was at first retained, but this afterwards, at the instance I believe of Bishop Abraham, changed to that under which we have assembled this evening. It is just sixteen years this month since we held our first meeting in one of the upper rooms of the old Provincial Government Buildings—a very modest place compared to the one which, by the courtesy of his Honor the Superintendent, we are allowed to occupy this evening. Casting my mind back to these early efforts to kindle in our midst the torch of science, it seems to me that a glance (however hasty and imperfect) at the state of our knowledge, at that time, of the natural history and resources of the country, as compared with what it is at present, will best illustrate the rapid progress that has since been made in every department of natural and physical science.

At the time to which I refer the scientific literature of the Colony consisted of Dr. Hooker's "New Zealand Flora," Dr. Mantell's chapters on New Zealand in his "Fossils of the British Museum," the "Zoology of the Voyage of the 'Erebus' and 'Terror,'" Dr. Dieffenbach's two volumes of "Travels," which contained much information on geology and some valuable natural historal appendices, Professor Owen's early memoirs on *Dinornis* and its allies in the "Transactions of the Zoological Society," besides a few minor works and scattered papers in the proceedings of various learned bodies. With the exception of the Botany, which had been explored at a very early date by Banks, Solander, Sparmann, and the two Forsters, and had afterwards been exhaustively treated by the accomplished Director of Kew, no department of New Zealand biology had been, in any sense, properly worked. The lists of the "Fauna" appended to Dieffenbach's "Travels," although useful to students in the Colony as a basis to work upon, were enumerations of such species only as were known to science, and they were confessedly imperfect. In every section of zoology the number of recorded species has been considerably increased. For example, the whales and dolphins positively mentioned by that author as inhabiting the New Zealand seas were only four; the number has since been increased to 21, and new species are being continually added. Of the 84 species of birds enumerated, no less than 17 were of doubtful authority; the number of well ascertained species has now reached 155, and of most of them the life history has been exhaustively written. The 6 lizards have since increased to 14, not including one or two doubtful species. The list of fishes was then 92; it now comprehends 163 species, and fresh discoveries are being constantly made. Although the list of mollusca even then included 240 species, the number has now increased to 502; the radiata and crustacea have been largely multiplied, while the list of insects has increased to nearly 1000 recorded forms. In botany, large and important additions have been made in every section, chiefly through the zeal of local collectors in both islands. Dr. Hooker's "Hand-book of the New

Zealand Flora," published in 1864, enumerates 935 species of flowering plants, to say nothing of the immense variety of ferns and lycopods, mosses and jungermannia, lichens, fungi, and sea weeds. The pages of our "Transactions" contain many subsequent additions by Kirk, Buchanan, Travers, and other local botanists.

Of the physical geography and geology of the country comparatively little was at that time known, while a great part of the interior was still a *terra incognita*. Even the Southern Alps had not been explored, and nothing was known of those glaciers since discovered by Dr. Haast, which are said to surpass in magnitude and grandeur the well-know glaciers of the European Alps.

In the field of palæontology, however, even before that date, some important discoveries had been made. Mr. Mantell, the first scientific explorer of the moa beds of Waikouaiti and Waingongoro, had forwarded to Europe a magnificent collection of fossil remains, which, after "exciting the delight of the natural philosopher and the astonishment of the multitude," found a fitting resting-place in the galleries of the British Museum, and were, in due course, minutely described by Professor Owen in several elaborate memoirs read before the Zoological Society of London. Later years have yielded, in the South Island, fresh treasures to an almost unlimited extent, and the group of colossal moa skeletons, brought together through the energy of Dr. Haast, and now to be seen in the Canterbury Museum is, I think, one of the most striking and interesting exhibitions on this side of the Line. The principal recent discoveries are the wonderful Saurians, from the Waipara beds and elsewhere, so fully described in last year's volume of "Transactions;" the gigantic bird of prey *(Harpagornis moorei)*, from the tertiary deposits at Glenmark; the great wingless goose *(Cnemiornis calcitrans)*, from Otago; and the giant fossil penguin from the tertiary rocks on the west coast of Nelson, all of which have been exhaustively dealt with in papers read before the various local societies, and published by the Institute.

In the same year that our Society was resuscitated (1859), a real impetus was given to the cause of science in New Zealand by the arrival of Dr. Hochstetter, of the Novara Expedition, who, at the invitation of the Government, remained for a time in the Colony, and made a careful exploration of a large portion of the North Island, and of the Province of Nelson also, and published the results in a standard work of considerable popular interest and of recognized excellence. The Colony showed its appreciation of Dr. Hochstetter's labours, by commencing in the various provinces systematic geological and topographical surveys, for the purpose of ascertaining and developing the natural resources of the country. Dr. Haast, who had assisted in this preliminary investigation, became Provincial Geologist of Nelson, and afterwards of Canterbury. Mr. Crawford was appointed to Wellington at the instance of Sir Roderick Murchison; and Dr. Hector, who was specially retained in England, came out as Provincial Geologist of Otago. Then commenced a period of scientific activity, which found a tangible expression in the New Zealand Exhibition at Dunedin, in 1865, and culminated in the New Zealand Institute, with Dr. Hector as Manager and Director—an organisation which may now be regarded as one of the settled institutions of the country, and of which our Society has been for a period of seven years an affiliated body. Not only has the Institute been a rallying point, so to speak, for the young scientific societies in various parts of the Colony; but it has also, through its official branch, the Geological Survey, done much valuable work in every department of natural and physical science. The volumes of geological reports issued year by year, all of them replete with original research; Dr. Hector's valuable treatise on "Whales and Dolphins;" the excellent synopsis of the "Fishes of New Zealand," compiled by Captain Hutton; the Critical Lists of Mollusca by Dr. E. von Martens, of Berlin (prepared at the expense of the Institute); and much other work of a similar kind, bear testimony to the ability and activity of this department; and it is not too much to say that the growth and progress of the Institute is due in a very large measure to the individual zeal and energy of Dr. Hector.

From year to year the scientific work of the New Zealand Institute has kept pace with the rapid progress of the Colony, and the seventh volume of the "Transactions" is in every way worthy of its predecessors, both as to bulk and quality. On a cursory perusal, it is evident that our Society has done its fair share of work during the year, no less than twenty-four of the papers selected by the Governors as worthy of publication having emanated from our members.

As most of you are aware, our Vice-President, Mr. Travers, is one of the most industrious of our working members, and the present volume contains a lengthy contribution from him, entitled "Notes on Dr. Haast's supposed pleistocene glaciation of New Zealand." The author dissents entirely from the learned Doctor's views, as propounded in his report to the Provincial Government of Canterbury in 1864, and since repeated; and following up his former article on "The extinct glaciers of the South Island," he has now placed before us an able exposition of his own views on this subject. It is not within my province, as President, to express any opinion on the questions at issue, even were I competent to do so; but, without pledging myself to some of the views advanced, I can recommend the article to the careful study of all those who take an interest in the past physical history of "the land we live in."

Another important paper read before the Society during the past year, is that by Dr. Hector on "Whales;" and the excellent plates which accompany it, from photographs by Mr. Travers, add much to the interest of the article. It contains a full description of *Neobalæna marginata*, founded on a specimen which was captured among a large school of blackfish at Stewart Island, and forwarded to the Colonial Museum by Mr. Charles Traill; also of the "sulphur-bottom" (*Physalus australis*), the skeleton of which is now in the Wellington Botanic Gardens; and of that interesting form of ziphoid whale known as *Berardius hectori* from a specimen cast ashore in Lyall Bay in January last.

It is to be hoped that Dr. Hector will be able to carry out his intention of publishing while in England a monograph of the *cetacea* inhabiting the southern seas, for which, as he informs me, he has collected and taken home ample material. There is probably no other section of zoology in which a contribution of this sort would be more acceptable to the *savans* of Europe, owing to the present neglected state of its literature, and the confusion of nomenclature in which many of the species are involved.

There is another article from the same pen, on "New Zealand Ichthyology," which contains descriptions of no less than sixteen new species of fishes, all taken recently on our coast, thus proving that this field of investigation is far from being exhausted.

In the section Botany, the first article is a paper read by Mr. Buchanan in November last, on "The Flowering Plants and Ferns of the Chatham Islands," the materials being drawn from the collection in the herbarium of the Colonial Museum, nearly the whole of which was made by Mr. Henry Travers during his two expeditions to those Islands in 1866 and 1871. The article throughout bears testimony to Mr. Buchanan's usual care and accuracy, and the illustrations, five in number, are very beautifully executed. That of the so-called Chatham Island lily (*Myosotidium nobile*), a handsome plant, with large glossy leaves and clusters of blue flowers, which I was fortunate enough to discover during a visit to the Chathams just twenty years ago, is especially noticeable.

Our late President, Dr. Knight, resuming a subject in which he has already made several important contributions to science, presents us with a valuable paper on "New Zealand Lichens," and with another containing descriptions of some new species of *Gymnostomum*, all the carefully-drawn illustrations being from the author's own pencil.

The papers on chemistry have emanated, as usual, from Mr. Skey, the analyst to the Geological Survey, the value of whose work in this department of science has already been brought prominently before you by a former occupant of this chair.

I will not detain you longer, as there are several papers to be read; but I would just point out that the eminently practical treatise by Dr. Lemon on "Duplex Telegraphy," and the suggestive paper by Mr. M'Kay on "The Hot Winds of Canterbury," show that other subjects have been discussed, and that the attention of our Society has not been confined to any particular branch of scientific inquiry; that, on the contrary, it has during the past year kept in view the avowed object of its existence, namely, "the development of the physical character of the New Zealand group: its natural history, resources, and capabilities."

Mr. C. C. Graham, in proposing a vote of thanks to the President, said that the Society was fortunate in having at its head one who had so thoroughly identified himself with the furtherance of science in New Zealand. The able *résumé* contained in Dr. Buller's address gave a clear view of the rise and progress of science in this Colony, and of its rapid development during the past few years. He asked the meeting to join with him in congratulating their President on the scientific honours which had fallen upon him. Although born and bred in the Colony, he had through his devotion to science, achieved a position of great distinction, and was therefore entitled to the thanks of all who had the interest of the country at heart.

The vote was carried by acclamation.

PAPERS.

The President said he had received a letter from Dr. Hector containing a series of very interesting ornithological notes made during a voyage to England. (See *Transactions*, page 199.)

1. A paper was read by the President from the Ven. Archdeacon Stock, containing remarks upon a large bat that had been seen by him in 1854, which he believed to be a new variety. (See *Transactions*, page 180.)

Mr. Kirk stated that he had seen a large bat at the Clarence River, but he had been unable to distinguish it from *Scotophilus tuberculatus*.

2. The President read a paper entitled "Notes on *Gerygone flaviventris*." (See *Transactions*, page 181.) The paper contained extracts from "The Birds of New Zealand," and observations in reply to a paper from Mr. Justice Gillies, in last year's volume of *Transactions*.

3. A paper entitled "Remarks on Dr. Finsch's Paper on Ornithology" in Vol. VII., of the *Transactions*, was also read by the President. (See *Transactions*, page 194.) The paper contained criticisms on Dr. Finsch's views respecting classification, as propounded in a paper read before the Otago Institute.

A discussion ensued, in which the author of the paper and Messrs. Kirk and Graham took part, on the question, "What constitutes a species?" The

President contended for the specific value of *Apteryx mantelli* of the North Island, on the ground that it was readily distinguishable from the other bird, and that the variation was constant; while Professor Kirk agreed with Dr. Finsch, who proposes to call it *Apteryx australis* var. *mantelli*, considering that the bird discovered in the North Island is merely a variety of the species in the South (*Apteryx australis*) the slight difference between them being insufficient to warrant their separation.

Second General Meeting. *21st August*, 1875.

W. T. L. Travers, Esq., Vice-President, in the chair.

New Members.—The following new members were elected:—L. H. B. Wilson, H. C. W. Wrigg, R. P. Orme, C.E.

1. Mr. Carruthers then read a paper on "Volcanic Action regarded as due to the Retardation of the Earth's Rotation." (See *Transactions*, page 352.)

The discussion of the paper was postponed until next meeting, so that members might have an opportunity of reading the paper.

2. A paper by J. C. Crawford, F.G.S., on the "Igneous Rocks of Wellington" was read by the Chairman. The paper pointed out the course that past explorations had taken in regard to the igneous rocks of the Province, and suggested that further information should be obtained on the subject. (See *Transactions*, page 375.)

Third General Meeting. *6th September*, 1875.

Dr. Buller, President, in the chair.

New Members.—Charles Dopping Irvine, B.A., C.E.; Dr. Rudolph von Mirbach; William H. Watt; Charles T. Benzoni.

1. The discussion on Mr. Carruther's paper on "Volcanic Action regarded as due to the Retardation of the Earth's Rotation" (See *Transactions*, page 352) then took place.

Mr. Irvine contended that—

1st. Mr. Carruthers' hypothesis was based on an assumption, a mere deduction, *a priori*, that the earth had undergone a retardation in the rate of its motion on its polar axis, and that there may be other causes at work tending to increase its rate of rotation. Mr. Carruthers advanced no observations to prove his assumption.

2nd. Granting a retardation of rotation, and also that the earth is a solid mass, then that the result of retardation would *not* be an elongation of the polar axis, caused by pressure from the equator on the internal mass; but, on the contrary, a flood of water inundating the polar regions, and flowing from the equator to the poles. The central fire theory is based on observed facts. He agreed with Mr. Mallett's observations, and places the depth at which rocks would become molten at from twenty to thirty miles from the surface. He is supported by the writings of Sir J. Herschel, 1866.

Mr. Carruthers quoted "astronomers and mathematicians," but did not give their names. Mr. Irvine considered that the central fire theory completely accounts for all phenomena connected with earthquakes and volcanoes, and is in no way disproved by Mr. Carruthers. He thought that Mr. Carruthers' hypothesis fails when applied to the moon, and does not account for the extinct voclanoes and evidence of earthquake action observed there. The central fire theory agrees with Le Placis' nebular hypothesis, and fully accounts for the presence of volcanic action in all cosmical bodies.

Mr. Crawford remarked that, according to Burton, the temperature in the mines at Brazil did not increase at the same rate as in mines in other parts of the world.

Mr. Carruthers, in reply, stated he had brought no proofs that the earth's rotation was retarded, as he had taken the fact for granted. The tides *must* cause or tend to cause such retardation, and the astronomers had calculated the amount of it to be that stated in the paper. He had not considered it necessary to raise the question. The effect of any retardation would be, as stated by Mr. Irvine, to heap up the water of the ocean at the poles, and this would, in proportion to the specific gravity of water, as compared with that of earth, counteract the tendency of the crust to break. He thought it unnecessary to calculate to what extent this counteracting tendency had acted, as we know that the ocean is not heaped up at the poles, while the age of the earth is so great that a very large amount of elongation of the polar axis must have taken place on account of the retardation of the rotation. The only fact on which the central fire theory was founded was that in mines in Western Europe the heat always increased with the depth below the surfaces. As Mr. Crawford stated, in Brazil this was not the case, and even in Europe the increase of heat varies so much that it cannot be due to any cosmical cause. At Rotomahana it increases 100° in six inches. Is this a fair measure of the increase of heat at this point as we approach the centre of the earth? Yet it is on similar facts that the central fire theory rests. Mr. Carruthers contended that the increase of heat at Rotomahana and elsewhere is due to the same cause, namely, volcanic action. If there really is such a great heat in the inner parts, they cannot be formed of any material similar to that of the surface rocks, as is shown by the specific gravity of the earth. As to the fact that the moon is mountainous, although its velocity of rotation is small, this does not disprove the hypothesis. The moon has had a greater velocity of rotation than it has now, and has lost it owing to the earth's attraction; the energy of motion would there, as here, take the form of volcanic energy. At the same time the paper did not pretend to explain volcanic action in the moon. There is there a tide of 127 feet, which must have a great influence on the solid crust, although it is perhaps doubtful whether any amount of tide would cause volcanoes. The velocity with which molecular motion is transmitted through stone is greater than the velocity of rotation, and the heat generated by any bending of the crust which may take place would be spread over the whole crust, and not localised.

4. Mr. Travers read a paper entitled, "Notes on the Extinction of the Moa." (See *Transactions*, page 58).

The Hon. Mr. Mantell said that Mr. Travers' paper was one of the most interesting on the subject of Moas that he had heard, and he would move, as the hour was late, that the discussion of the paper be postponed until next meeting, in order that members might have an opportunity of considering the matter. This was agreed to, and the meeting adjourned.

Fourth General Meeting. *4th October*, 1875.

Mr. Travers in the chair.

1. The Hon. Mr. Mantell noticed the addition of three interesting fish to the Museum, viz., *Beryx affinis*, *Scopelus hectori*, n.sp., collected by Mr. Robson, Cape Campbell; and *Upenioides vlamingii*, collected by Mr. Buchanan, Blind Bay. He also read notes by Mr. Buchanan on the present state of the Colonial Botanic Gardens, and a list supplied by Mr. T. Mason of plants injured by the frost during the nights of the 5th, 6th, and 7th August, 1875, at the Taita, Wellington.

Plectranthus eckloni,	severely	*Aralia papyrifera*	slightly
Templetonia retusa,	,,	*Crassula*, vars.	severely
Heliotrope,	,,	*Greevia occidentalis*,	slightly
Cinchona,	,,	*Lagunaria pattersoni*,	,,
Bourardia hogarthii,	,,	*Browallia jamesonii*,	severely
Salvia splendens	killed	*Pelargonium zonali*,	slightly
,, *mauve*,	severely	,, ,,	severely
Linum triginum, where exposed	,,	*Cestrum aurantiacum*	,,
Ageratum mexicana	,,	*Canna* ,,	,,
Echeveria	,,	*Barkleya syringæfolia*	,,
Brugmannsia	,,	*Lantana*,	slightly
Mackaya bella,	,,	*Arduina grandiflora*,	severely
Fuschia corymbosa,	,,	*Erica cavendishii*,	slightly
,, *fulgens*,	,,	,, *pubescens major*,	,,

Fuschia microphylla, severely
,, other varieties, slightly
Acmena floribunda, ,,
,, *kingiana*, ,,
Plumbago capensis, severely
Duranta plumeri, ,,
Wigandia carcasana, slightly
Lasiandra macrantha, ,,
Pleroma sarmentosa, severely
Cuphea platycentra, ,,
,, larger var. ,,
Justicia, slightly
,, *ventricosa*, var., slightly
Azalea indica, ,,
Asclepias carcassarica, severely
Hedychium, var., ,,
Ficus macrophilla, where exposed ,,
Ficus syringæfolia, slightly
,, *cristata*, ,,
Sedum, variegated severely
Cantua dependens, slightly
Hakea eucalyptoides, flower buds killed

New Zealand trees and shrubs :—

Pohutukawa (Metrosideros tomentosa) slightly
Karaka (Corynocarpus lævigata) ,,
Tapata, ,,
Cyathea dealbata, white fern, ,,
Cyathea medullaris, black fern, slightly
Dicksonia antartica, wekiponga, uninjured
Coprosma baueriana, slightly
,, var. variegata, ,,
Pisonia sinclarii, severely.

Mr. Travers stated that he had he believed discovered a new fish, which had been sent to Captain Hutton for description. On its return from Dunedin, it would be deposited in the Colonial Museum.

Mr. Kirk did not agree with Mr. Buchanan's view that the trees in the Gardens were injured by the weight of parasites; if they were injured at all, it must be owing to the decay of the timber and not from the weight of the parasite. He drew attention to the report of the wild flora at Kew. He considered it a pity that the planting in the Garden was confined chiefly to the pines; he thought that deciduous trees should be introduced, and that more attention should be devoted to native plants. The various grasses also should be planted to afford information to the farmer.

Mr. Mantell said that the want of deciduous trees has long been felt, and that, as the locusts are disappearing, there will be some chance that they will flourish.

Mr. Travers was glad to say that the sparrows were helping to rid us of this insect.

2. Discussion on Mr. Travers' paper on "Moa."

Mr. Kirk read extracts, bearing upon this question, from a letter addressed to him by Judge Maning. (See *Transactions*, page 102.)

Mr. Mantell hoped that when further collections of the bones were made, they would be made systematically. He read notes regarding the finding of a body in a cave at Sumner, which went to prove that it could not possibly be of the great antiquity attributed to it.

3. "On the habits of the Frost Fish." By C. H. Robson. (See *Transactions*, page 218.)

Mr. Travers could hardly agree with Mr. Robson's theory that this fish committed self-destruction by rushing on shore; but that probably, as with the ling, the wind-bladder becoming inflated, it floats belly upwards and is driven on shore; possibly it tries to get into shallow water from its enemies.

4. "Is access to the Sea necessary to Eels," by James Duigan." (See *Transactions*, page 221.) This paper went to prove that access to the sea could not be necessary, and instanced the Virginia Water, Wanganui, as a place where eels live, and from which it would be impossible for them to get to the sea.

Mr. Mantell said that eels travelled for long distances through the grass.

Mr. Travers pointed out that there was a creek supplied from the Virginia Water, and they might get that way. He still thought it was necessary for at least the young fish to frequent the sea.

Mr. Kirk thought it quite possible for eels in Virginia water to visit the sea. He did not think there were any eels in New Zealand that did not go to sea.

5. "On the probability of Finding Coal in Wellington Province," by J. C. Crawford. (See *Transactions*, page 379).

Mr. Mantell said that he thought the discussion of this paper should be postponed until next meeting, when perhaps the author would be present.

Mr. Travers said that coal had been found in Wanganui.

Fifth General Meeting. *29th January*, 1876.

Dr. Buller, President, in the chair.

New Members.—The following new members were announced:—A. Hamilton, Geo. Hunter, M.H.R.; Francis W. Frankland, Martin Chapman, Wellington; Dr. S. L. Muller, Blenheim; Dr. S. M. Curl, Rangitikei; Arthur Wicksteed, Wanganui.

It was announced that the Annual Meeting would be held in February, it had been delayed to allow the Treasurer to get in some outstanding subscriptions.

PAPERS.

1. "On the Old Lake System of New Zealand, with Observations as to the Formation of the Canterbury Plains," by J. C. Crawford, F.G.S. (See *Transactions*, page 369.)

2. Further paper on the "Igneous Rocks of Wellington;" a postcript

to a paper read on 21st August, 1875, by J. C. Crawford, F.G.S. (See *Transactions*, page 376.) This was a reply to papers read by Mr. James Duigan and Mr. Purnell at former meetings of the Society.

3. Further contributions to the "Lichen Flora of New Zealand," with specimens and drawings, and also a paper on a new species of *Fabronia*, by Dr. Knight, F.L.S. (See *Transactions*, pages 312, 313.)

4. "On the probable Origin of the Maori Races," by W. S. W. Vaux, M.A., F.R.S., communicated by Dr. Hector, C.M.G., F.R.S. (See *Transactions*, page 1.)

The Hon. Mr. Mantell explained that, as the paper was being printed, and would appear in Vol. VIII. of the *Transactions*, it would only be necessary for him to read the title and explain generally its scope and object, which he did briefly.

5. "Notes on the Ornithology of New Zealand," by Dr. Buller, C.M.G. This dealt with many new and interesting facts, and formed a continuation to the article published in last year's *Transactions*. (See *Transactions*, page 181.)

6. "On the Nesting Habits of the Huia (*Heteralocha acutirostris*)," and specimens of the egg and embryo chick were exhibited. (See *Transactions*, page 192.)

7. The Hon. Mr. Mantell then read the introductions to the undermentioned papers by W. Skey:—

(*a*) "On the oxidation of Silver and Platinum at common temperatures by oxygen in presence of water." (See *Transactions*, page 332.)

(*b*) "On the electromotive order of certain metals in Cyanide of Potassium," with reference to the uses of this salt in milling gold. (See *Transactions*, page 334.)

(*c*) "On the absorption of Antimony and Arsenic from acid solutions of their oxides by charcoal." (See *Transactions*, page 337.)

(*d*) "On the solubility of the alkalies and their carbonates in ether." (See *Transactions*, page 338.)

8. Dr. Buller then read some notes on the following specimens, either lately received by him or into the Colonial Museum:—

(*a*) On varieties of *Carpophaga novæ-zealandiæ*. (See *Transactions*, page 196.)

(*b*) On a specimen of *Thalassidroma nereis*. (See *Transactions*, page 197.)

(*c*) On the occurrence of *Nyroca australis*. (See *Transactions*, page 197.)

(*d*) Supposed new species of shag (*P. finschii.*) (See *Transactions*, page 197.)

(*e*) On *Prion banksii* as a species. (See *Transactions*, page 197.)

The President stated that Mr. Crawford, their representative, had been elected a Governor of the New Zealand Istitute, and that Professor Rolleston, F.R.S., of Oxford, also nominated by this Society, had been elected Honorary Member of the Institue.

SIXTH GENERAL MEETING. 12*th February*, 1876.

Dr. Buller, President, in the chair.

New Members.—Morgan Carkeek and Ebenezer Baker announced as new members.

1. The Hon. Mr. Mantell read a paper by C. H. Robson on "Moa Remains found at Cape Campbell;" and in the short discussion that followed, Mr. Mantell stated that he was not yet convinced of the extinction of the Moa, and that, till the whole country had been thoroughly explored, it was, to his mind, an unsettled question. There was a collection of specimens on the table to illustrate the paper. (See *Transactions*, page 95.)

2. The President read a paper "On a remarkable instance of Double Parasitism," by Thomas Kirk, F.L.S. (See *Transactions*, page 329.)

Mr. Travers made some remarks on the specimen of *Loranthus* that was exhibited to the meeting.

3. The President read the following papers, and exhibited specimens in illustration of his remarks:—

"On the relation of *Apteryx* to *Dinornis*."

"On the validity of *Aplonis zealandicus* as a New Zealand Bird." (See *Transactions*, page 198.)

"On a remarkable variety of *Porphyrio melanotus*." (See *Transactions*, page 197.)

"On the specific value of *Eudyptula undina*." (See *Transactions*, page 198.)

The President read interesting extracts from a letter recently received from Dr. Finsch, of Bremen.

Mr. Travers, in reference to the *Aplonis zealandicus*, said that years ago he met with a single specimen in the South Island. This was its only known occurrence since the voyage of the "Astrolobe."

4. The Hon. Mr. Mantell read a paper on the "Supposed Oxidation of Gold and Mercury by Oxygen in Presence of Water," by Mr. Skey. (See *Transactions*, page 339.)

The Annual Meeting then took place.

Annual Meeting. 12*th February*, 1876.

REPORT OF COUNCIL.

In consequence of the extensive alterations and additions that have been lately carried on in the Colonial Museum, the Society was deprived of the use of the Maori house as a meeting room, but through the courtesy of His Honor the Superintendent, the Provincial Council Chamber was placed at the disposal of the Council, and there most of the meetings have been held. The Council begs to record its sense of the valuable accommodation thus afforded.

The first meeting was held on the 7th August, 1875, when the session was opened by an address from the President, Dr. Buller, C.M.G., in which he reviewed the practical work done by the Society during the past year, and traced the progress of scientific research in this Colony since the resuscitation of the Society in 1859. Five meetings have taken place, at which the following papers and communications were read and discussed.

GEOLOGY.

1. "On Volcanic Action regarded as due to the Retardation of the Earth's Rotation," by J. Carruthers, C.E. (See *Transactions*, page 352.)

2. "On the Igneous Rocks of Wellington," by J. C. Crawford, F.G.S. (See *Transactions*, page 375.)

3. "On the Probability of finding Coal in the Province of Wellington," by J. C. Crawford, F.G.S. (See *Transactions*, page 379.)

4. "On the old Lake System of New Zealand," with observations as to the formation of the Canterbury Plains," by J. C. Crawford, F.G.S. (See *Transactions*, page 369.)

5. "Further remarks on the Igneous Rocks of Wellington," by J. C. Crawford, F.G.S. (See *Transactions*, page 376.)

ZOOLOGY.

1. A letter from Dr. Hector, containing interesting ornithological notes made during his voyage to England. Communicated by Dr. Buller. (See *Transactions*, page 199.)

2. "Remarks by Ven. Archdeacon Stock on a large New Zealand Bat seen in 1854." Communicated by Dr. Buller. (See *Transactions*, page 180.)

3. "Notes on *Gerygone flaviventris*," in reply to Mr. Justice Gillies, by Dr. Buller, C.M.G. (See *Transactions*, page 181.)

4. "Remarks on Dr. Finsch's paper on the Ornithology of New Zealand, in Vol. VII. 'Trans. N.Z. Inst.,' " by Dr. Buller. See *Transactions*, page 194.)

5. "Notice of New Fishes received at the Colonial Museum," by the Acting-Director.

6. "On the Habits of the Frostfish," by C. H. Robson. (See *Transactions*, page 218.)

7. "On the question, Is access to the Sea necessary to Eels?" by James Duigan. (See *Transactions*, page 221.)

8. "On the Ornithology of New Zealand," by Dr. Buller. (See *Transactions*, page 181.)

9. "On the Nesting Habits of the Huia (*Heteralocha acutirostris*)," by Dr. Buller. (See *Transactions*, page 192.)

The following notices by the President, Dr. Buller, with illustrative specimens:—

10. "On the Occurrence of *Nyroca australis* in the Wellington Province." (See *Transactions*, page 197.)

11. "On Remarkable Varieties of *Carpophaga novæ-zealandiæ*." (See *Transactions*, page 196.)

12. "On a New Species of Shag, proposed to be called *Phalacrocorax finschii*. (See *Transactions*, page 197.)

13. "On the Distinctive Characters of *Prion banksii*." See *Transactions*, page 197.)

14. On a specimen of *Thalassidroma nereis* received at the Colonial Museum." (See *Transactions*, page 197.)

15. "On the Existence of *Apteryx oweni* at High Altitudes in the North Island." (See *Transactions*, page 193.)

BOTANY.

1. "Notes on the present state of the Botanic Garden in Wellington, with description of plants therein," by John Buchanan.

2. "Further Contributions to the Lichen Flora of New Zealand," by Dr. Knight, F.L.S. (See *Transactions*, page 313.)

3. "On a remarkable instance of Double Parasitism," by T. Kirk, F.L.S. (See *Transactions*, page 329.)

4. "Notice of the discovery of *Pilularia* in New Zealand," by T. Kirk, F.L.S.

CHEMISTRY.

1. "On the Oxidation of Silver and Platinum at Common Temperatures by Oxygen in presence of Water." (See *Transactions*, page 332.)

2. "On the Electro-motive Order of certain Metals in Cyanide of Potassium with reference to the use of this Salt in Milling Gold." (See *Transactions*, page 334.)

3. "On the Absorption of Antimony and Arsenic from Acid Solutions of their Oxides by Charcoal." (See *Transactions*, page 337.)

4. "On the Solubility of the Alkalies and their Carbonates in Ether," by W. Skey. (See *Transactions*, page 338.)

MISCELLANEOUS.

1. "Notes on the Extinction of the Moa," by W. T. L. Travers, F.L.S. (See *Transactions*, page 58.)

2. "Extracts from a Letter by Judge Maning bearing on the question of the Extinction of the Moa," communicated by T. Kirk, F.L.S. (See *Transactions*, page 102.)

3. "On the probable Origin of the Maori Races," by W. S. W. Vaux, M.A., communicated by Dr. Hector, F.R.S., C.M.G. (See *Transactions*, page 1.)

4. "On Moa Remains discovered at Cape Campbell," by C. H. Robson. (See *Transactions*, page 95.)

These papers have all been handed to the Manager of the New Zealand Institute for publication in Vol. VIII. of the "Transactions and Proceedings."

There are now 188 members on the books of the Society, 27 new members having been elected since the last annual report was presented.

As will be seen by the Treasurer's balance-sheet, there is at the present time a sum of £101 0s. 4d. to the credit of the Society, notwithstanding that a sum of £118 9s. 6d. has been expended in books, of which £100 has been remitted to London for that purpose.

Dr. Hector, who kindly undertook the selection of these books, has intimated by letter that he has purchased largely for the Society, both in Edinburgh and in London, and no doubt in the course of a few months a consignment will reach the Colony.

Application has been made by the Council to the Hon. Mr. Mantell, Acting-Director of the Colonial Museum, for the continued use of this fine lecture-room, in which the members are now assembled; and there is every reason to hope that the Society will be permitted to hold its meetings for the future in a place so admirably suited to the purpose.

The thanks of the Society are also due to the Director of the Geological Survey Department, for the arrangement whereby the library of the Society is safely accommodated in one of the new Museum rooms, and made accessible to members at all convenient times.

Adopted, and ordered to be printed.

The statement of accounts by the Treasurer was then read, and (having already been audited) was adopted by the meeting. The balance-sheet showed that the year had commenced with a credit balance of £162 5s. 8d.; subscriptions during the year had been £144 17s., making the total receipts to be £307 2s. 8d. Expenditure was represented by—Purchase of books, £135 13s. 6d.; miscellaneous items, including honorarium to Secretary and Treasurer, £35 3s. 10d.; printing and advertising, £5 10s.; sixth of annual income paid to New Zealand Institute, as per rules, £29 15s., thus leaving a credit balance with which to begin the present financial year of £101 0s. 4d.

The following gentlemen were elected officers for the ensuing year:—President, Dr. Buller, C.M.G., F.L.S.; Vice-Presidents, T. Kirk, F.L.S., and C. C. Graham; Council, W. T. L. Travers, F.L.S., J. C. Crawford, F.G.S., Dr. Hector, C.M.G., F.L.S., J. Carruthers, C.E., Hon. W. B. D. Mantell, J. R. George, and J. Marchant; Secretary and Treasurer, R. B. Gore; Auditor, Arthur Baker.

The Hon. Mr. Waterhouse said he could congratulate the Society on the selection of officers, and he felt no doubt whatever that in the hands of these gentlemen the affairs of the Society would be wisely administered. At the same time he agreed with some observations which had fallen from the President about the attendance of members at the ordinary meetings, and he was himself of opinion that some steps ought to be taken to popularise the character of the Society, so as to create a more general interest in its operations. Before going home he had, at one of the meetings of the Society, ventured to suggest an annual *soirée* or *conversazione*, in which the ladies could take a part, as a means of making the institution popular, and thereby extending its usefulness. The idea was not adopted by the Council, and he thought there would be no harm in his repeating the suggestion now.

Mr. George said that the only reason for not acting on Mr. Waterhouse's suggestion was the want of a suitable room for such an entertainment. The fine lecture hall in which the members were now assembled would obviate this difficulty.

Dr. Buller said that in England it had become the practice for each of the leading scientific societies, at least once in the year, to hold a popular *soirée* of the kind indicated by Mr. Waterhouse.

Mr. Travers said that a popular lecture on some scientific topic, in connection with the proposed entertainment, would be the best means of combining interest with instruction; and he referred to the great success which had attended Mr. Fitzgerald's lecture on Art, and several other lectures delivered under the auspices of this Society. He added that he would be quite willing to contribute his share to any future effort of the kind.

The Hon. Mr. Mantell feared that tea and coffee could not be supplied, without putting his own kitchen under requisition, as was done during the General Assembly ball in the Museum building; but he was nevertheless in favour of Mr. Waterhouse's proposal, and would suggest that a special meeting of Council should be held at an early date, for the purpose of considering the matter in detail.

The President thanked Mr. Waterhouse for bringing the subject forward, and declared the Annual Meeting closed.

AUCKLAND INSTITUTE.

First Meeting. 17*th May*, 1875.

J. C. Firth, President, in the chair.

New Members.—J. Batger, Captain Daveney, J. Hay, J. Lindsay, C.E., C. C. Macmillan, J. E. Pounds, B. Tonks.

The President delivered the

ANNIVERSARY ADDRESS.

We commence this evening the eighth session of the Auckland branch of the New Zealand Institute, and it has fallen upon me as President to deliver the usual opening address.

The struggles and exigencies characteristic of colonial life, whilst they may sometimes impart greater vivacity and piquancy to our little communities, often offer great obstacles to the steady progress of Institutes such as ours.

Nevertheless, the progress of the Colony every year gives us more men of wealth, leisure, and cultivated intellect, capable of rendering the pursuit of the various objects of the New Zealand Institute more easy and more successful. But from the energy and enterprise, characteristic of the majority of colonists, combined with the educational advantages which are every day being brought within the reach of all, we may look for valuable assistance from all classes of colonial society in carrying out the really noble objects of the Institute.

For myself, I have only to say that, though I make no pretension to be a man of science, I, nevertheless, take a deep interest in the scientific and social questions of the day, and I claim the right to bring these questions, so far as time and opportunity will permit, to the test of the philosophy of common sense.

From a scientific point of view, the times in which we live are characterised by close, patient, minute and accurate investigation; by daring hypotheses, and by an unmistakeable idolatry of law.

Nothing can be more admirable than the researches of Tyndal and Darwin; but it will hardly be denied that some of their theories manifest a development of the imaginative faculties, which is, at least, remarkable in those who, *par excellence*, claim to speak only of what they know. Even some of the facts upon which these castles of the imagination are built are as unsubstantial as the theories themselves. A striking instance of this occurs in Darwin's valuable work on the "Descent of Man." He says, Vol. I., page 183:—"In all parts of Europe, as far east as Greece; in Palestine, India, Japan, New Zealand, and Africa, including Egypt, flint (stone?) tools have been discovered in abundance; and of their use the existing inhabitants retain no tradition." So far as the above statement relates to New Zealand, the learned author is mistaken as to the actual fact. For not only are there *traditions* of the use of stone tools in New Zealand; but there are now living New Zealanders (Maoris) who have *used* these stone tools. The earlier settlers of this Colony may even be said to have themselves lived in the stone age.

I shall not occupy your time by citing any further instances of the strange, curious, and indeed, grotesque assumptions which characterise the materialistic school of Philosophy, because, I apprehend, you are probably familiar with them. But, in the interests of science and morals, it is necessary to direct your attention to that singular phase of this revived philosophy, represented—I think better than by any other term—by that of the Idolatry of Law.

Now what is law, at whose shrine some of our philosophers appear to pay an idolatrous devotion? Is it not the opposite of chaos, chance, or accident? Is it not the embodiment of order and design; a regulated and regulating force potent to develope certain results from certain causes known or unknown? Evolution and atomic combination are laws, or the results of law. What, then, I repeat is law? Is it not a definite, intelligent arrangement, involving, by its very existence, the prior existence of an intelligence superior to itself? In a word, does not the existence of a law involve the certain and prior existence and potent action of an intelligent, forceful, dominant LAWGIVER? It is the practical ignoring of such a Lawgiver which deprives the admirable investigations of the school of philosophy under review of their chief value and crowning virtue, and which, in so doing, relegates us to the cheerless domains of a materialism as degrading to man as it is inimical to his true welfare. For who can doubt, if it be possible to reason the Creator and Controller of the universe out of the minds of men, that what to-day may be but the fantastic dogma of the philosophic few, may become the popular belief of to-morrow, and so strike at that great principle of responsibility which lies at the foundation of the well-being and the happiness of mankind.

The want of the age is undoubtedly the *right interpretation* of scientific discovery. Without the acknowledgment of a Supreme Creator and Controller such an interpretation is impossible, and *mystery* must continue to be written on all the wonderful phenomena by which we are surrounded. What have the so called definitions of the school-men of science given us more than a nomenclature. For, after all, WHAT is the subtle essence of such forces as gravitation; of such imponderables as light, heat, electricity? We have labelled them, indeed, as a chemist labels his drugs, and we know much of their qualities and uses. But what has been done to define their original elementary essence. What has been done to determine the origin, the *whence they sprung* of these potent forces which so mysteriously pervade the illimitable unknown.

In truth, scientific deduction as yet has but mounted the lower steps of the ladder of knowledge. A nobler philosophy will yet impel true science to climb upwards till it arrives at the conception of the Creator and Controller of all.

The investigation of truth is one of the main objects of the New Zealand Institute, and it is because I believe it is important to take care that our enquiries should not be biased, nor our intellects blinded by the current materialism of the day, that I have considered it within the scope of my duty to bring under your observation some of the obstacles which are being raised to the impartial pursuit of truth, as they have presented themselves to my own mind.

Permit me now to direct your attention to some of the lines of enquiry along which our investigation may advantageously travel. These may be said to lay in the past as well as in the present.

It has been stated that New Zealand is destitute of a past. I do not concur in this view. We have but to look around us to see, on every side, the memorials of a past full of interest and abounding in sentiment.

Scattered all over the North Island are the ancient fortresses and battle grounds of a noble race. Call it a race of savages, if you will; still a race remarkable for its hospitality, its generosity, and, above all, for its valour. For centuries to come the two great Maori fortresses of One-Tree Hill and Mount Eden in our own vicinity, will stand lasting memorials of the Maori race; and in the eyes of future antiquarians will undoubtedly possess a very deep interest. The Native Land Courts, in the eyes of the present generation of colonists, are chiefly interesting as the means of investigating Maori titles to land, and as the agency for peacefully transferring, by consent of the Maori proprietors, these lands to European owners. But the archives of these Courts recording, as they do, the traditions, the love passages, the warlike deeds of an ancient race, will possess an unfading interest to the future ethnologists, novelists, and historians of this country. The present generation of colonists has advantages for enriching the stores of Maori lore which no other can possess. I think, therefore, that the Colony is under great obligations to Sir George Grey, Mr. C. O. Davis, Judge Maning, and Mr. John White for their admirable efforts to rescue from oblivion the manners, legends, proverbs, and characteristics of this deeply interesting people. There is yet much to be done, which, to be done well, can only be done now; and I think, to those of our members who have peculiar facilities for the work, there can be few objects more deserving their attention than the preservation of memorials of the Maori.

If any testimony were needed of the patriotism and valour of the Maori race, I have but to point to the long, unequal, and valiant struggle the Maori race has made against us with indifferent arms, without extraneous support, without any chronicle of their achievements—save that furnished by their opponents—maintaining a long struggle against 10,000 of the flower of English troops, and against an equal number of sturdy colonists fighting *pro aris et focis*, provided with every appliance of modern warfare, and even yet—after a ten years' struggle—still unsubdued. I think we shall find it difficult to parallel, even in Greek or Roman story, their unaided, patriotic, and valiant contest. I am convinced that in each succeeding generation, a truer estimate will be formed of the many noble qualities of this heroic race now departing silently and surely from the land of their fathers.

Let me therefore urge upon you to seize every opportunity to preserve the implements, the fortifications, the sayings, and doings, in a word, the memorials of a people which has done so much to invest the past of the land we live in with a halo of noble and romantic sentiment.

Whilst then we endeavour to rescue whatever is of value in the past, let me remind you that the present demands our attention. Our efforts must be directed to stimulate the pursuit of art, science, literature, commerce, and social economics, so that the *present* of the land of our adoption may do its part in creating, and be worthy of, the great *future* in store for us and for our descendents.

To this end a close observation of facts, not only by scientific members but by non-scientific members, is indispensible. In this Colony nature presents so much that is new, so much that is difficult, so much that is interesting to ourselves and to the outside world, that we may well prosecute our work with vigour. The Province of Auckland especially offers a field for enquiry which will not only well repay the philosophic enquirer, but will reward the unscientific observer. The neighbourhood of the city abounds with picturesque evidences of powerful volcanic action. Our fern-covered plains, though evidently full of vital energy, do not yield readily to the efforts of the agriculturist—probably from the long continued acid exudations of successive growths of fern root—to turn that energy to the vigorous production of plants and grasses of economic value. Our mountain ranges covered with noble trees, with whose valuable properties we are as yet but partially acquainted, and which indeed we are recklessly destroying without care or thought for the future. Our hills and valleys rich with mineral deposits such as gold, silver, copper, coal, and iron, frequently occurring under circumstances and in combinations new to science. All these elements of wealth, power, and happiness require new and economic applications of skill and scientific knowledge, so that the greatest practical results may be obtained with the least expenditure of force or waste of power.

Nor must it be forgotten that whilst this Colony possesses a wealth of undeveloped vegetable and mineral productions, it is singularly destitute of animal life, thus offering a wide field for the introduction of innumerable varieties of fish, birds, and animals. Again, the vegetable kingdom, though so full of forms of rarest beauty, is yet destitute of a thousand fruits, vegetables, and trees for which our unrivalled climate offers a congenial home.

Nor must it be forgotten that in the extensive district from Lake Taupo to the Bay of Plenty, there exists a wonderful variety of geysers, boiling springs, hot lakes, fairy-like cascades, enchanting terraces, and mineral waters of great healing powers. I have no doubt that this wondrous district will one day be visited by philosophers, tourists, and invalids from many lands. Can it be doubted that the pilgrims who, in coming years, will visit these shrines of beauty and health will carry away with them very pleasant memories of a land in which they will not have sought in vain for pleasure, health, and knowledge?

That the district in which these natural wonders are to be found ought without delay to be acquired by Government, there can be no doubt; when acquired, our Government may well be urged to follow the example of the United States, and declare the district an inalienable reserve for all time for the health and recreation of the people.

Important as it may be to push on agriculture, to make

"Our valleys wave with golden corn,
With fleecy flocks the hills adorn."

Necessary as it is to introduce a thousand fruits, vegetables, and trees suitable for our unrivalled climate, we ought not to forget that other things are needed to build up a nation besides sheep and oxen, fruits and corn. Education, good drainage, abundance of pure water, convenient and durable houses, parks for recreation, ready access to the beautiful in art, to the noble in literature, to the grand in nature—all exert a potent and most salutary influence in building up the social life of the people upon a sure foundation.

It is not given to every one to be a Bacon, a Newton, or a Faraday, but it *is* within the power of all to cultivate habits of observation. Even our children will derive for themselves great advantage, and may confer upon others even greater advantages by learning to observe. Let it be remembered that to observe accurately and to record correctly the operations of nature, is to contribute to the general stores of knowledge, and to be a benefactor to mankind at large.

In conclusion, we have come to a new land, where we have much to create, to introduce, and to develope, to a land full of hidden resources and full indeed of difficulties, yet we have at least this advantage that we have few of the burdensome excrescences and social anomalies incidental to older countries.

Whilst there is abundant room for the pursuit of abstract truth, for the elucidation of those occult questions which occupy the philosophers of our time, there is yet room and verge enough for the cultivation of patriotic sentiment, of everything that is beautiful in art, useful in science, and noble in literature, and for the widest development of those economic and social problems of a more practical kind, which necessarily come home to the early settlers of a colony like New Zealand.

We have taken hold of the heroic work of colonization, and it is for us to show that we are worthy of the great race to which we belong, and of the grand future in store for us.

PAPERS.

1. "On the best Line for the Submarine Cable between Australia and New Zealand," by the Rev. A. G. Purchas, M.R.C.S.E. (See *Transactions*, page 166.)

Mr. C. O'Neill, M.H.R., gave some interesting particulars respecting the construction of submarine cables, and stated the terms of the contract proposed to be entered into with the Government of New South Wales. He believed that the position of the *termini* had not been settled.

Messrs. Pond, Morton, and Power also spoke on the subject.

The President suggested that a copy of the paper should be forwarded to the Commissioner of Telegraphs, as it contained information that might prove of considerable service to the Government.

2. "On the Coleoptera of Auckland," by Captain T. Brown. (See *Transactions*, page 262.) The author reviewed the principal divisions of the class *Coleoptera*, represented in the Province of Auckland, giving the names and other particulars of the more prominent species.

The President was glad to find that the entomology of New Zealand, so long neglected, was now receiving elucidation at the hands of several competent observers. Although not possessing any scientific acquaintance with the subject, he had observed a considerable number of species that were highly injurious to the agriculturist, and thought that a series of observations should be made with the view of ascertaining their habits, and of determining how their rapid multiplication could be prevented. He alluded to the serious nature of the ravages of the Colorado beetle (*Doryphora decem-lineata*) in the United States during the past few years, and to the still greater damage caused by the *Phylloxera* in the vine-growing districts of France. Had we possessed a full acquaintance with these insects at the outset of their destructive career, it is probable that much of the subsequent loss and ruin would have been avoided.

The Rev. Dr. Purchas said that several insects were being gradually introduced that would ultimately prove very undesirable colonists. For instance, a wood-borer—the name of which he was not acquainted with—was a most pernicious species, perforating the wooden lining of houses until it crumbled into a mass of dust. He had also seen furniture attacked by it.

Second Meeting. 14*th June*, 1875.

J. C. Firth, President, in the chair.

The Secretary read the list of donations to the Library and Museum during the last month.

PAPERS.

1. "On the Mollusca of Auckland Harbour," by T. F. Cheeseman, F.L.S. (See *Transactions*, page 304.)

The President directed attention to the collection of shells formed by the author to illustrate his paper, and which was now exhibited. It was a matter of surprise to him to find so many different kinds inhabiting so small an area.

2. "Notes on the recent observations for the Transit of Venus," by T. Heale.

3. "Notes on the Mason Bee," by Major W. G. Mair.

The President said that members would doubtless like to know what had been done by the Council towards the erection of a new Museum. It would be remembered that a subscription list was opened at the Annual Meeting, and most liberally headed by two donations of £500 each. Since then, further application had been made to the members, and the subscription list had been raised to £1,700, and, from verbal promises that had been made, he had no doubt would ultimately reach over £2,000. The Council had caused plans of a suitable building to be prepared; the cost of which was estimated at £3,100. It would thus be seen that a sum of about £1000 would be required over what would be realised by subscriptions. He felt sure that this amount would have been given by the Provincial Government, had its financial position allowed it; but, as nothing could be expected from this quarter at present, the Council proposed to introduce a short Bill into the General Assembly, authorising them to mortgage a portion, or the whole, if necessary, of their site. The erection of the building would be commenced immediately upon the passing of the Bill.

THIRD MEETING. 16*th August*, 1875.

T. Heale in the chair.

New Members.—J. T. Boylan, F. D. Fenton, P. Herapath, D. M'Indoe, W. W. Taylor.

The Chairman drew the attention of the meeting to the valuable library bequeathed to the Institute by the late Mr. G. F. Edmonstone, consisting of 550 volumes, mostly relating to various branches of physical science. Mr. Edmonstone had not long been a member of the Institute, and his thoughtful consideration for them should not be easily forgotten.

PAPERS.

1. "Notice of the discovery of Moa Remains at Ellerslie, near Auckland," by T. F. Cheeseman, F.L.S.

Mr. Cheeseman remarked that he had visited the cave at Ellerslie, and had explored it carefully, and gave a description of its position and size, the whole length of the two unequal compartments into which it was divided being 98 feet, and its height in no place exceeding eight feet, the floor being composed of basaltic lava. The Moa bones, all more or less decayed, were found only in the smaller compartment, and that, prior to this discovery, he was not aware of any Moa bones having been found or known to exist north of Raglan and the Upper Waikato.

The author stated that some time ago Dr. Alder Fisher informed him that he had seen Moa bones in a small cave near the Ellerslie race-course, and at his request he had made an exploration of the cave in question. A considerable number of Moa bones were obtained, but in such a bad state of preservation as to be useless for scientific purposes. Hardly any perfect examples were seen. Human bones were found in the same cave, and a considerable number in an adjacent one, but were evidently much more recent than those of the Moa.

Mr. H. A. H. Monro said that it was surprising to him to hear it stated that the Maoris knew nothing of the Moa. Not only was there the evidence of the numerous derivative words in their language, but they had distinct traditions of it, and could relate how their forefathers attacked and captured it, and how the Moa defended itself. In fact, it appeared to him that there was an overwhelming amount of evidence in favour of the supposition that the Moa had been exterminated by the Maori at a not very distant period of time.

2. "Notes on the Sword Fish, *Ziphius gladius*," by T. F. Cheeseman, F.L.S. (See *Transactions*, page 219.)

Various portions of the skeleton, both of this species and of the allied *Histiophorus herschelli*, were exhibited from the Museum collections.

3. "Remarks on the *Psalaphidæ* of New Zealand," by Captain T. Brown. (See *Transactions*, page 271.)

This paper contained an enumeration of the *Pselaphidæ* hitherto found in New Zealand, together with some cursory remarks, and also enclosed detailed descriptions of the various species by Dr. Sharp of Dumfries.

Fourth Meeting. 13*th September*, 1875.

Rev. A. G. Purchas, M.R.C.S.E., in the chair.

The Secretary read the list of donations to the Library and Museum since the last meeting.

PAPERS.

1. "Notes on Quartz Crushing at the Thames," by J. Goodall, C.E. (See *Transactions*, page 176.)

This paper gave rise to an animated discussion, in which several members took part.

2. "A Sketch of Polynesia," by J. Adams, B.A.

The Chairman congratulated the meeting on the commencement of work on the new Museum Buildings, after which the meeting separated.

Fifth Meeting. 11*th October*, 1875.

J. C. Firth, President, in the chair.

New Members.—Ven. Archd. E. B. Clarke, W. S. Young.

Mr. Goodall offered some remarks supplementary to his paper on "Quartz Crushing at the Thames," read at last meeting. He considered that the machinery in use was excellent, and that the improvement needed was in the mode of treating the ore.

Mr. Stewart said that, in his opinion, the machinery was far from being good, and indicated several directions in which improvements might be made.

PAPERS.

1. "The Coals and Coal Fields of the Province of Auckland," by J. M. Tunny, Provincial Analyst. (See *Transactions*, page 387.)

Mr. Goodall said that this paper was a most important one, and well deserved consideration at the hands of the Institute. He was sorry that Mr. Tunny had not mentioned the specific gravity of each of the samples of coal analysed by him, for there were properties apart from its chemical composition that affected the heating qualities of coal.

Mr. Stewart said the opinions commonly entertained as to the relative advantages of Newcastle and Bay of Islands coal were clearly erroneous. In many respects the Bay coal was the best of the two; nor was it the only good coal in the Province. The Waikato coal had now been used for many years for steaming purposes, and had been found to answer well. He was convinced that our present mines, under proper management, would, in a few years, banish all foreign coal.

The President said that, from his own experience as a coal consumer—perhaps one of the largest in Auckland—he was satisfied that the Bay coal was far superior to Newcastle for steam purposes. The principal objection to its use for domestic purposes was in its friable nature; but this had been made too much of. He would like to see the Whareora coal—so highly recommended by Mr. Tunny—introduced in quantity into the Auckland market.

2. "Analyses of a few of the Auckland Fire Clays," by J. A. Pond. (See *Transactions*, page 348.)

Samples of the clays mentioned in this paper, together with several articles manufactured from them, were exhibited to the meeting.

3. "Descriptions of a new species of *Hymenophyllum*," by T. F. Cheeseman, F.L.S. (See *Transactions*, page 330.)

Mr. Goodall called the attention of the meeting to the practice of slaking lime with salt water, now becoming very prevalent in Auckland. It was hardly necessary for him to state that, so long as this custom was in force, dry walls could not be expected in any buildings, however carefully other points were attended to.

Mr. Heale said that it was usual to attribute the efflorescence, so commonly seen on plastered walls in Auckland during damp weather, either to the use of shell-lime, in which a small proportion of salt might naturally be expected to occur, or to the sea-sand used in the preparation of the mortar. He could not but think that the proportion of salt in shell-lime would be very minute; and sea sand, even if taken wet from the beach, could not contain more than five per cent. of sea water. On the other hand, lime, during the process of slaking, would take up fully twenty-five per cent. of sea water, and in this way a very considerable quantity of salt would be introduced into the mortar; so large, in fact, that he should not have supposed that lime-burners would have had resort to a practice so obviously injurious to the quality of the lime if he had not himself seen salt water used.

Sixth Meeting. *6th December*, 1875.

J. C. Firth, President, in the chair.

New Members.—W. Carder, A. Howden, G. Kitchen, R. Walker.

PAPERS.

1. "Notes on the discovery of Moa and Moa-hunters' remains near Whangarei," by G. Thorne, jun. (See *Transactions*, page 83.)

Mr. Firth asked if the human remains found were contemporaneous with those of the Moa.

Mr. Thorne exhibited some charred human bones that he considered to be certainly of the same age. With respect to the other human remains, he had not the same confidence, as it was possible that they had become mixed with the Moa bones through the blowing away of a stratum of sand in which they had been buried, and which stratum might be of long subsequent age to the period of the formation of the kitchen middens amongst which the Moa remains were found.

2. "On the evidences of recent changes in the elevation of the Waikato district," by J. Stewart, C.E.

The President said that the course of the Waikato was full of interesting problems from its exit from Lake Taupo to its entrance into the sea. One curious feature was that, instead of running along the valleys, as was usual with rivers, it crossed the mountain ranges at right angles, thus forming deep gorges, of which that at Taupiri was a good example.

Dr. Purchas said that no doubt the Waikato ran into the Thames or Piako before the gorge at Taupiri was removed, and allowed the river to find its way into the Middle Waikato Basin.

3. "Notes on the Introduction and Acclimatization of the Salmon," by James Stewart, C.E. (See *Transactions*, page 205.)

Annual General Meeting. 21*st February*, 1876.

J. C. Firth, President, in the chair.

New Members.—J. Taylor, Rev. Dr. Wallis.

The list of donations to the Library and Museum during the last two months was read by the Secretary.

The Annual Report and Financial Statement was then read by the Secretary, when it was resolved, on the motion of Mr. Firth, seconded by Mr. Goodall, "that the report, as read, be adopted, and printed for circulation among the members."

Election of Officers for 1876:—President, His Honor Mr. Justice Gillies; Council, R. C. Barstow, J. L. Campbell, M.D., J. C. Firth, J. Goodall, C.E., Hon. Col. Haultain, T. Heale, Rev. J. Kinder, D.D., G. M. Mitford, Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., F. Whitaker; Secretary and Treasurer, T. F. Cheeseman, F.L.S.; Auditor, T. Macffarlane.

A vote of thanks to the retiring President concluded the business.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. *4th March*, 1875.

R. W. Fereday, Vice-President in the chair.

New Members.—Sir Thomas Tancred, Bart.; J. Dawe, B.A.; W. Reece; J. C. Wason; J. M. Brown, M.A.; M. Studholme; J. C. Veel, M.A.

No papers were read.

Second Meeting. *1st April*, 1875.

R. W. Fereday, Vice-President, in the chair.

New Member.—B. Parkerson, junr.

Dr. Powell exhibited the flower of a species of *Odontoglossum*, and made some remarks thereon.

Third Meeting. *6th May*, 1875.

R. W. Fereday, Vice-President, in the chair.

Resolved—That Dr. Von Haast's resignation be accepted.

Mr. Fereday exhibited the section of a wattle-tree, 3ft. 9½in. in circumference two feet from the ground, and nine years old.

Fourth Meeting. *3rd June*, 1875.

R. W. Fereday, Vice-President, in the chair.

Dr. Powell was unanimously elected President.

"An Account of the Maori Manner of Preserving the Skin of the Huia (*Heteralocha acutirostris*), (Buller)," by J. D. Enys. (See *Transactions*, page 204.)

Fifth Meeting. *1st July*, 1875.

Dr. Powell, President, in the chair.

New Members.—Samuel Charles Farr, Michael Hart, junr.

No papers were read.

Sixth Meeting. *5th August*, 1875.

Dr. Powell, President, in the chair.

New Members.—Dr. T. O. Rayner, Professor Cook.

"An account of the Maori House attached to the Christchurch Museum." Rev. J. W. Stack. (See *Transactions*, page 172).

SEVENTH MEETING. *2nd September*, 1875.

Dr. Powell, President, in the chair.

Letter read from the Secretary of the Otago Institute forwarding resolutions, *re* the publication of Mr. McKay's paper on the Sumner Cave, passed on August 20, 1875.

The President read a statement of the case at issue between the Board of Governors and Dr. Von Haast, which he had prepared for transmission to the President of the Royal Society, and which was unanimously approved by the meeting.

EIGHTH MEETING. *7th October*, 1875.

Dr. Powell, President, in the chair.

New Member.—Rev. R. Jackson.

Messrs. Joseph Palmer and C. R. Blackiston were appointed Auditors.

"A paper on the climate of Canterbury, together with a chart illustrating the same;" also, "Table of Ocean Surface Temperatures, from Lyttelton to London *viâ* ship Jura, 1st March to 3rd June, also from Bristol to Lyttelton, *viâ* Matoaka, 5th September to 28th November, 1860;" also, "Comparison of Sea about New Zealand and the North Atlantic;" also, "Table of Temperatures round the Middle Island of New Zealand on board the "Maori," 13th February to 3rd March, 1875." M. Dixon.

NINTH MEETING. *4th November*, 1875.

Dr. Powell, President, in the chair.

ABSTRACT OF REPORT OF COUNCIL FOR 1875.

In submitting their annual report for the year 1875, the Council congratulate the members of the Institute upon the increase in their numbers; but they regret that the average attendance should have diminished. They are also sorry to observe that few papers have been contributed, and that several valuable ones have been sent for publication to the English scientific periodicals instead of appearing in the "Transactions of the New Zealand Institute." The particulars of the unfortunate difference which has arisen between the Canterbury Philosophical Institute and the Board of Governors of the New Zealand Institute need not, the Council are of opinion, be recapitulated here. Full details of the question at issue have been forwarded to the President of the Royal Society of London, and the Council await with confidence his decision thereon. They cannot, however, forbear expressing the satisfaction they have derived from the cordial support afforded to them by the Otago Institute in this matter.

The Institute numbers 102 members, thirteen having joined during the year, and two members have died.

Eleven general meetings have been held, including three special meetings, at which ten papers have been read, of which seven have already been printed.

Professor Rolleston, M.D., of Oxford, has been unanimously recommended to the Board of Governors as an honorary member of the New Zealand Institute, upon the understanding that, should he be nominated by any other affiliated Society, H. W. Bates, Esq., F.L.S., Assistant Secretary Royal Geographical Society, 1, Saville Row, Burlington Gardens, London, W., should be recommended.

Dr. Julius von Haast, F.R.S., has been chosen to vote at the election of the Board of Governors.

Election of Officers for 1876:—President, Ll. Powell, M.D.; Vice-Presidents, J. W. S. Coward and Professor Bickerton; Honorary Treasurer, J. Inglis; Honorary Secretary, J. S. Guthrie; Council, Dr. Julius von Haast, Rev. J. W. Stack, Rev. Charles Fraser, Messrs. G. W. Hall, H. J. Tancred, and R. W. Fereday; Auditors, Messrs. Joseph Palmer and C. R. Blakiston.

Special General Meeting. 20*th November*, 1875.

Dr. Powell, President, in the chair.

Honorary Member.—C. M. Wakefield.

On behalf of the Council and a few personal friends, the President, Dr. Powell, presented Mr. Wakefield with an album, containing 69 views of Canterbury. On the title page was the following inscription:—"This album of photographic views of Canterbury, New Zealand, is presented to Charles Marcus Wakefield, Esq., Honorary Member of the Philosophical Institute of Canterbury, New Zealand, as a parting gift from the President, Council, and a few members, personal friends, of the Philosophical Institute of Canterbury, in recognition of his unwearied exertions in the performance of his duties as Honorary Secretary for several years. November 20, 1875."

"On a new species of Butterfly," by R. W. Fereday. (See *Transactions*, page 302.)

OTAGO INSTITUTE.

FIRST MEETING. 11*th May*, 1875.

J. S. Webb, President, in the chair.

New Members.—W. D. Montague, J. S. Connell.

The President delivered the following

ADDRESS.

An opening address from your Chairman at the first meeting of the session does not form part of our recognized programme. Neither do I think that any general remarks that I could address to you would be of that interest which should characterise any paper read here, unless, in imitation of the customs of more important societies, it should contain a *resumé* of all that has been done during the past year in some department of science, a task quite beyond my abilities. I must ask you, therefore, to allow me to-night to offer a few remarks on a special subject, remarks too general in their character to form what we usually understand by a scientific paper, but which will, I hope, be found of interest. They form the forerunner of a paper in which the same subject will be treated in a more technical manner, which I shall have the honour to submit to the Institute as soon as other engagements admit of its completion—"On recent attempts to estimate the Temperature of the Sun."

All recent discoveries in physics have tended to establish what is now accepted as a fundamental theorem of scientific cosmogony, viz., that the sun and all orbs of which we know anything at all, including our earth itself, are heated bodies, which must in the end succumb to the effects of their constant radiation of heat into the cold wastes of space. Although we have no data by which to determine whether the sun itself has reached that stage of aggregation at which its temperature must be constantly falling, the idea that it has both reached and passed that point in its history seems to be generally prevalent in the scientific world.

It has been established that, so far as we are able to probe it, the temperature of the interior of the earth is very considerable. Prevalent theories as to the past of our globe lead to the conclusion that this internal temperature is sufficient to maintain the central portions of the sphere in a molten condition; and, though this has been energetically disputed, on the ground of its alleged disaccordance with the phenomena of nutation and precision, it remains certain that the internal heat is adequate to maintain the surface at a temperature considerably above that of external space, even in the absence of the sun. But whatever this temperature might be, it is certain that the conditions under which life is now maintained on the earth are derived from the additions which the solar radiation constantly makes to the intrinsic heat of our planet.

It becomes then a point of the highest interest to ascertain the actual temperature of this great ruler of our system, what its present rate of cooling would be if that temperature were not continually restored, and what means of maintaining that temperature appear to exist. It is with the first of these that we have to do, but it may not be without interest to state here one of the most probable estimates that has been made as to the other two. Ericsson has calculated that, if the contraction which constant radiation of heat must necessarily effect in the sun, should proceed at the rate of one foot of his radius in 3 days and about 34½ minutes (3·024 days), the development of heat would equal the radiation from the solar surface, as he determines it. Contraction at this rate would in about 2,000,000 years reduce the sun's diameter by one-tenth. The thermal energy at the sun's surface would, during the whole period, be maintained constant at its present figure, but the diminished size of the solar disc would result in a diminution of the temperature communicated to the earth, at its present distance, by an average of nearly 13° Fah. Although this would involve a notable change in the conditions of life on the earth, and would probably be sufficient to depopulate its arctic regions, the change would not reduce the average temperature of tropical regions to that which at present prevails in Dunedin. This is, of course, all pure speculation, because the data assumed cannot be verified. My object to-night is indeed to show that they are very unreliable. We may, nevertheless, rest content in the conviction that the secular cooling and contraction of the sun, if it should actually be proceeding in the manner which Ericsson assumes, will have no effect on the conditions of life upon the earth within a period utterly beyond our powers of conception; for, though we can express millions of years in numbers, the idea which we form in our minds of such a lapse of time is really of the vaguest description. At any rate, there appears to be every reason to believe that before the earth becomes too cold to be inhabited by beings like ourselves, there will be ample time for "social evolution" to carry our race to that future of perfect development towards which we are taught to believe that it is inevitably tending.

The subject we have in hand excited, not long ago, considerable attention amongst scientific men, on account of the publication by Father Secchi, in his work, "Le Soleil" (Paris, 1870), of his estimate of the solar temperature as not less than 10,000,000° Cent. (say 18,000,000° Fah.) The learned Director of the Roman Observatory, in the calculations by which he arrived at this enormous temperature, rejected the received law of radiation established by Dulong and Petit, as a result of their experiments on the rate of cooling of various bodies. A rather smart discussion occurred, in which many eminent men took part, each of whom appears to have retired from the controversy without seeing reason to modify his own opinion, a circumstance which may assure us that we are yet a long way from a sure ground on which to base a definite calculation of the solar temperature.

Attempts have been made by many physicists to determine the radial energy of the sun since the day when Newton first made the calculation by which he estimated that the comet of 1680 was subjected at its perihelion to a temperature of 1,484,000° Fah. As a preliminary to certain considerations which have occurred to my mind during the study of this subject, I must ask you to allow me to describe briefly the methods which have most recently been employed to test the energy of the solar radiation, and the deductions which have been drawn from observations thus conducted.

The method which I have selected for description is that of the thermo-heliometer. This instrument, which has been variously fashioned in accordance with the ideas of those who have used it, consists essentially of two concentric cylinders placed within one another. The annular space between these is filled with water or oil maintained at a known constant temperature. At one point a tube passes through both cylinders by means of which a thermometer is introduced into the interior of the smaller one. The bulb of this thermometer is blackened, and the rays of the sun are allowed to fall upon it through the circular opening at one end of the cylinder. The whole apparatus is of course attached to a heliostat, by means of which the axis of the cylinders is kept constantly directed to the face of the sun. The thermometer thus exposed to the sun's rays shows a rapid increase of temperature up to a certain point, after which its indications vary directly with the increasing or decreasing altitude of the sun, so long as the sky remains equably clear. From a multitude of observations taken at different zenith distances of the sun, it is not difficult to calculate what temperature would be indicated by the thermometer if the sun were actually overhead. These measures, at various altitudes of the sun above the horizon, also give us the means of determining the mean absorption of heat by the atmosphere, since the difference between the effective radiation at low altitudes and at noon is caused solely by the difference in the depths of air which the solar rays traverse. The results obtained by different observers with instruments constructed on this principle vary with the amount of precaution taken to secure (1), the steadiness of temperature on the environment; (2), freedom from draughts and other causes which disturbe the indications of the thermometer; and (3), equable heating of the whole mass of the bulb of the instrument by the sun's rays.

Mr. Waterston used one of these instruments in India, and determined the singular fact that, whatever the temperature of the environment, the difference between it and that of the thermometer exposed to direct solar radiation was always the same. His experiments were made with temperatures varying from 60° Fah. to 220° Fah.

Father Secchi, for the basis of his calculations, adopted the experiments made by M. Soret on Mont Blanc and in other mountainous regions, in order that he might avoid as much as possible the errors introduced into the results by atmospheric influences. He obtained a difference of 29·02 Cent. (= 52·24 Fah.) between the temperature of the thermometer and that of the *enceinte*.

M. Pouillet appears to have obtained a somewhat higher figure. Mr. Ericsson, whose observations have decidedly been conducted with greater care to avoid disturbing influences, and with more completeness than those of any other observer, arrived at 67·20° Fah., as the effective intensity of solar radiation at aphelion, and 72·68° Fah. for perihelion. The difference between these two temperatures coincides very closely with that which he has calculated as the necessary effect of the nearer approach of the earth to the sun at the latter period of the year.

The figures thus ascertained require correction (1) for the absorption by the earth's atmosphere, which is approximately known; and (2) for that of the sun's absorption, as to which the widest differences of opinion exist. It then remains to determine what the temperature of a body must be which can radiate so large a quantity of heat across the space which divides the sun from the earth. Here, again, irreconcilable differences of opinion exist as to the law of radiation. Pouillet, and with him a number of eminent French physicists, have adopted the law of cooling established by Dulong and Petit. According to this, the radiation increases so much more rapidly than the temperature, that an increase of 600° in temperature multiplies a hundredfold the energy of radiation. Using this law Pouillet fixed the temperature of the sun's surface, or rather that portion of it which is effectively radiated into space, at from 1,461° to 1,761° Cent. (= 2,630 to 3,170 Fah). Vicaire, adopting Secchi's value of the solar radiation, obtains by the same law a temperature of 1,398° Cent., or about 2,520° Fah., and estimates that, when all the necessary corrections have been made, the result must still be less than 3,000° Cent.—say 5,400° Fah.

Both Secchi and Ericsson refuse to accept Dulong's law, and fall back on that of Newton, who assumed that the intensity of radiation from a hotter body to a cooler one must be proportionate to the differences of their temperatures and to the distance between them. The latter element of the calculation is of course treated in the same manner by both parties. Proceeding in this matter, Ericsson fixes the solar temperature at 4,035,584° Fah.; whilst Father Secchi makes it at least 18,000,000° of the same scale. The widest difference in their treatment of the question lies in their respective estimates of the absorbing power of the sun's atmosphere. I need not stop to consider the arguments they adduce, each in support of his own view. So far as they differ on other points, I have no hesitation in accepting Ericsson's results as the more reliable of the two. As to the influence of the absorbing media in the neighbourhood of the sun, there can be no doubt that it is much better, in the present state of our knowledge, to limit our investigation to a search for the value of the effective radiation, instead of seeking to calculate what actual internal temperature this must indicate.

We find, then, that the basis of all these various calculations of the temperature of the sun is the ascertained difference between the temperature established in a terrestrial object on which the rays of the sun shine directly, and the general temperature of surrounding objects more or less completely screened from those rays. It appears to me that the indications thus trusted to are not satisfactory definitions of the work which the solar rays are actually performing. They fall very far short of this, because what we want to know is not the difference which has thus been measured, but the difference between the actual temperature the sun's rays can create in terrestrial objects, and the temperature at which those objects would rest if the heat radiated from the sun were withdrawn.

The earth itself is a heated body, and a certain temperature would exist at its surface if the solar radiation ceased entirely. This temperature would steadily fall, in consequence of the earth's own radiation into space; but what we need to ascertain is the initial temperature for the moment of withdrawal of the solar heat, if such an event could happen. The difference of this temperature, and the highest which a thermometer will indicate when subjected to the action of a vertical sun on the clearest day, with a corrective introduced for the (approximately known) absorption of the terrestrial atmosphere, is the nearest measure we can obtain of the actual solar radiation. Evidently this quantity will greatly exceed any of those which have hitherto been adopted by physicists.

It can hardly prove impossible to determine how much of the average temperature at the surface of the earth is due to the solar heat and how much to the internal heat of the earth. The condition of affairs produced by our long polar winter nights offers us data in one direction. That which obtains in arid equatorial wastes will serve us in the other direction. Even when all the necessary data are collected, the problem will not be easy of solution; but an approximate estimate cannot be beyond the power of our scientific men, armed with all the knowledge of the laws and character of heat which has already been accumulated. It appears to me that this estimate is the absolutely necessary basis of any such calculations as Secchi, Ericsson, and others have been attempting.

Again, as the basis appears to me yet wanting, so also is it with the methods of working back from it to the desired object—the temperature of the sun, and on this point, also, I ask leave to submit one or two considerations.

We have discarded from our minds the old idea that heat is a distinct unponderable substance, which so many considerations force upon us, that it is only a vibratory motion in what we call ether and in the ultimate molecules of those bodies which display it. Nevertheless, we are a long way from being able to conceive distinctly the character of this motion which we call heat. The discussions which have taken place on this subject of solar temperature and radiation appear to me to be clouded by the old notion of heat as a communicable substance. Not that any such idea was present in the minds of eminent men who have busied themselves with the question. But the want of a terminology in which to express definitely our modern ideas of heat makes itself felt the moment that any discussion of this sort is enterprised. This will remain very much the same until we can cease to speak of heat and define its manifestations as this or that species of molecular action, and we are a very long way yet from this desirable position. When we speak of the effects of solar radiation, we are, after all, only relating the effect this will produce in the body we use as a heat measurer—say in the mercury of a thermometer bulb. We know very well that the sun's rays never, under identical circumstances, communicate such a temperature as we speak of to the atmosphere. We talk of the different powers of absorbing heat possessed by different bodies. The phrase is borrowed from our discarded theories of caloric. We want to know not how hot the mercury becomes, but how many thermal units per second radiated to it are necessary to maintain it at that temperature in spite of the influence of all the surrounding circumstances. Time must be an element in the definition of solar heat-energy, and before we claim that a certain temperature must exist at the surface of the sun, we must learn the relations between what we call radiation of heat and its constant re-development at the radiating surface. All our experiments on this subject have hitherto (with few exceptions) been conducted with bodies which were actually cooling rapidly. If the sun must be put in the category of bodies which are in process of cooling down—and we have as yet no evidence to prove this, or even to negative a contrary supposition—its rate of cooling, as compared with human eras of time, must be infinitesimally slow. For any period over which our experiments can be extended it may be assumed that the heat expended in radiation is simultaneously re-developed in the photosphere of the sun. Before, then, we can say what heat-energy at the surface of the sun, the work its rays do at this distance, implies we have a great deal to learn, and a totally new series of experiments to make.

Other considerations lead us to the same doubt of the reliability of the estimates that have hitherto been made of the solar temperature. What is it that we call a ray of heat from the sun? It is at the earth's surface a vibration of the ether, a series of waves whose lengths may vary somewhat, but is never very different from $\frac{1}{39,000}$ part of an inch, travelling at a speed somewhat less than 200,000 miles per second. We have only to draw together as many of them as will pass through an aperture measuring a few square feet, and at the point of their intersection they cause such a commotion as will dissipate into vapour any terrestrial substance whatsoever. But if we let the focal point form in mid air, or in any gas, nothing happens to give us evidence of this storm of molecular motion. Yet, if it were what we call an enormous temperature that existed there and vapourized the granite which we subjected to its action, it must be still present when nothing is presented to its action. Since then these rays emanated from masses of incandescent gas and vapour, the molecular motion, which we call the temperature of the sun, may differ very little from that induced in the molecules of a gas in which a bundle of these rays is concentrated by our lens. The sun's rays, which at once drive asunder the molecules of a solid body until they have assumed vibrations and motions amongst themselves, which define the condition we call vapour, will pass through that vapour itself with scarcely any effect upon it, so far as we have been able to observe their action. Is it necessary to suppose that there is no limit to that molecular agitation we call heat? or that the molecules of the incandescent gases of the photosphere must vibrate a million times more energetically than those which exist at ordinary temperatures on the surface of the earth? Again, we may well ask what meaning do we attach to "increase of temperature?" What is the change in the nature of the vibration we call heat which corresponds to our words hotter and colder? As we at present conceive it, increased temperature means a greater amplitude of vibration in the heated molecule. Must there not be a limit to the excursions of the swinging atom? In that train of vibrations, which we call a ray of heat, we can approximately measure the distance from one wave crest to another, and, so far as we know, the variation in this distance for different temperatures is proportionately very slight indeed. If then the amplitude of vibration, the height of the wave, be continually increased, is it not certain that a point must be reached at which the magnitude of the excursion of the vibrating particle will be so great as of necessity to alter the wave length, if it be further increased? We need to be a great deal more competent to answer such questions as these before we can assure ourselves that any of our observations yield us the data, or any of our calculations form the logical processes, which will lead us to a definition of the temperature of the sun.

1. "On the cause of the former great Extension of the Glaciers in New Zealand," by Captain F. W. Hutton. (See *Transactions*, page 383.)

Second Meeting. *25th May*, 1875.

J. T. Thomson, Vice-President, in the chair.

New Members.—C. W. Purnell, J. A. M'Arthur, E. R. Ussher.

1. "On New Zealand Surveys," by J. S. Connell. (See Appendix, page 27.)

Third Meeting. *13th July*, 1875.

J. S. Webb, President, in the chair.

New Members.—J. E. Denniston, A. Burt, R. A. Lawson, A. Armstrong.

1. "On the Building Materials of Otago—Part I.—Building Stones," by W. N. Blair, C.E. (See *Transactions*, page 123.)

Fourth Meeting. *27th July*, 1875.

J. S. Webb, President, in the chair.

New Members.—T. Stevenson, Rev. Lindsay Mackie.

1. "On the Glacial Epoch and its Cause," by L. O. Beal.

Fifth Meeting. *10th August*, 1875.

J. S. Webb, President, in the chair.

New Members.—J. Davidson, J. E. H. Harris, A. Wilson.

The President announced that the Secretaries of the Academy of Sciences of France had presented to the Institute some valuable publications on the subject of the Transit of Venus.

A vote of thanks was carried to the donors of these publications.

1. "On the Longitude of Wellington, in reply to Remarks by Dr. Hector,"* by J. T. Thomson.

Mr. R. Gillies said he thought that Mr. Thomson had established his point, provided his figures were correct. Dr. Hector had assumed that he had got his longitude by chronometric observations by simply accepting Sydney and Melbourne observations as his basis, forgetting that he was building a chronometric on a previous local observation. He regretted that Dr. Hector should have gone so much out of his way to throw a stone at

* See "Proceedings N.Z. Inst.," Vol. VII., page 502.

Messrs. Thomson and Jackson. There was no necessity for the paragraph, it could have been left out without impairing the usefulness of the report.

After some remarks by Captain Hutton,

Mr. J. M'Kerrow pointed out that Captain Nares' remarks as to the serious consequences that might ensue from adopting a longitude for the time ball not in accord with the chart longitudes of the New Zealand coasts were so evident as to require no argument. It was curious that Captain Nares should have been misinformed on the subject. In setting Captain Nares right, it was singular that Dr. Hector should not have referred to the longitude as determined by Captain Carkeek, but only to that of Messrs. Thomson and Jackson, as though they had been the occasion of Captain Nares' warning. In regard to the discrepancies in the determination of absolute longitude between the Australian and New Zealand observers, it was worthy of note that Carkeek, Jackson, and Thomson, each for his own observatory, had determined by long and repeated series of observations, principally of moon culminations, the longitude absolutely and independently, and that these determinations were published long before the means were available for comparison by connection of observations. The very near agreement of results when connection was made was indeed remarkable. Dr. Hector's selection and adding up of longitudes to tally with an already accepted result was of no weight, and the allusion to the Board of Longitude at Wellington only excited a smile. The determination of longitude by that body consisted in their taking a chart longitude, and converting it into time. The recommendation to the observers of the transit of Venus to accept a longitude so obtained was simply a burlesque. Had Major Palmer succeeded in obtaining good observations, he and his party would have devoted several months to the determination of absolute longitude at Burnham. At Queenstown, Professor Peters determined the longitude absolutely. He also, in concert with the officers of the "Swatara," determined the longitudinal difference between Queenstown and the coast line, with the view of sending an officer to connect through, as soon as New Zealand is connected with the telegraphic system of the world.

Sixth Meeting. 24*th August*, 1875.

J. S. Webb, President, in the chair.

New Members.—E. Campbell, Dr. J. Gillies.

PAPERS.

1. "On the Maori Kitchen-Middens of Shag Point," by Capt. F. W. Hutton. (See *Transactions*, page 103.)

2. "Notes on Moa Caves in the Wakatipu District," by Mr. Taylor White. (See *Transactions*, page 97.)

Professor Coughtrey could not agree with Dr. Haast's views. He thought that the evidence was not yet sufficient, and that it would be better to wait before propounding theories.

Mr. B. Gillies, Mr. A. Bathgate, and the President were all of opinion that Dr. Haast was wrong in supposing that the final extinction of the Moa was so very long ago.

Mr. C. W. Purnell said that we ought to be thankful to Dr. Haast for having raised the question. He thought that there was no doubt but that the Morioris inhabited New Zealand before the arrival of the Maoris.

SEVENTH MEETING. *4th September*, 1875.

J. S. Webb, President, in the chair.

New Members.—W. Norrie, F. Humphries, J. E. Brown, B. S. Booth, A. Bolland, J. Shaw, Mr. Justice Williams.

1. "On the Habits of the Trap-door Spider," by Mr. R. Gillies. (See *Transactions*, page 222.)

Mr. A. Bathgate said that he had noticed Trap-door Spiders at Cromwell; but the holes were much smaller, and not so deep as those described by Mr. Gillies.

EIGHTH MEETING. *28th September*, 1875.

P. Thomson, Vice-President, in the chair.

New Members.—L. C. Orbell, J. C. Buckland, Rev. J. U. Davis.

PAPERS.

1. "Improvements in Ship's Boats," by R. McNaughton, C.E. (See *Transactions*, page 168.)

2. "On the Building Materials of Otago. Part II.: Bricks, Concretes, and Roofing Materials." By W. N. Blair, C.E. (See *Transactions*, page 123.)

NINTH MEETING. *12th October*, 1875.

J. S. Webb, President, in the chair.

New Members.—W. G. Rutherford, J. E. Coyle, R. Banks, Dr. Inglis.

It was resolved that this Institute records its opinion that it is desirable that the erection of the new Museum building be proceeded with at once, as the work is one of urgent importance, and because any delay now may result in the Museum being closed altogether for a lengthened period; and that this resolution be communicated to the Government.

PAPERS.

1. "On a New Direct Vision Solar Eye-piece for large Telescopes," by H. Skey. (See *Transactions*, page 172.)

2. "Maori Mythology;" Part III., by Rev. J. F. H. Wohlers. (See *Transactions*, page 108.)

TENTH MEETING. 26*th October*, 1875.

J. S. Webb, President, in the chair.

New Members.—Sydney Muir, J. S. Welch, G. McLean.

Dr. H. Filhol was nominated for election as an honorary member of the New Zealand Institute.

Mr. J. T. Thomson was appointed to vote for the election of Governors of the New Zealand Institute.

PAPERS.

1. "Critical Notes on the New Zealand *Hydroidea*," by Professor Coughtrey. (See *Transactions*, page 298.)

2. "Contributions to the Ichthyology of New Zealand," by Capt. Hutton. (See *Transactions*, page 209.)

3. "Description of the Cow Fish (*Tursio metis*) of the Sounds on the West Coast of Otago," by Capt. F. W. Hutton. (See *Transactions*, page 180.)

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

First Meeting. *12th August*, 1875.

T. Mackay, C.E., in the chair.

Secretary reported having received from the New Zealand Institute 50 copies of Vol. VII. of the "Transactions and Proceedings of the New Zealand Institute."

Second Meeting. *1st November*, 1875.

T. Mackay, C.E., in the chair.

The Bishop of Nelson was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act. The nomination for the election of honorary members of the New Zealand Institute was made in accordance with statute IV.

Third Meeting. *6th March*, 1876.

The Bishop of Nelson, Vice-President, in the chair.

The report and accounts of last year were read and adopted.

Election of Officers for 1876:—President, Sir David Monro; Vice-President, the Bishop of Nelson; Council, A. S. Atkinson, Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Joseph Shephard, Geo. Williams, M.D.; Hon. Treasurer, Alexr. Kerr, F.R.G.S.; Hon. Secretary, T. Mackay, C.E.

The Secretary reported having received from the Director of the Geological Survey and Museum two copies of a recently published Geological Sketch Map of New Zealand; also of fourteen packages of seeds of Californian trees; and further, that in accordance with his arrangement with the Director, he had placed the seeds in the hands of Dr. Boor for distribution to certain nurserymen and others in Nelson for their propagation.

The Secretary reported having handed over to the Nelson Institute 88 publications, principally of a scientific character.

WESTLAND INSTITUTE.

REPORT.

During the past year the Institute has added considerably to its Museum, and has been enabled to forward several botanical, zoological, and geological specimens to kindred Institutes and Societies in New Zealand and the neighbouring colonies. No great progress has yet been made in the way of acclimatization, beyond the introduction of a few hares and pheasants, which have been placed on Mr. Harris's run at the Kokatahi, and are progressing favourably. Mr. Patrick Comiskey, though not a member of the Institute, read an interesting paper at a meeting held on the 21st October, on the subject of "Water supply for the purpose of working large tracts of auriferous ground." On the 22nd of June, Captain Turnbull, Chief Harbour Master of Westland, read a paper throwing some light on the question of the wreck recently discovered at the Haast, and illustrating the action of the ocean currents on the west shores of New Zealand.

The Haast Wreck and Ocean Currents.

In accordance with my promise to this Society, made some time ago, I now undertake to endeavour to show how the currents from the Eastern Coast of Australia have been traced to our shores, that is to the West Coast of the Middle Island, and more especially that portion of the Coast situated south of Hokitika.

In the year 1866 a piece of wreck was found in the bush about 300 feet above high-water mark, on the eastern bank of the Tauperikaka River, about three miles south of Arnott Point. The discoverers of this piece of wreck reported that the vessel to which it belonged had been diagonally built, and fastened with screw trenails. Some portion of the wreck was cut off, and along with the screw trenails and metal fastenings was sent to Hokitika, and upon such portions being examined many suppositions were raised as to its identity, such as the probability of its being a portion of La Perouse's missing vessels or some missing whaler, and other speculations as wide of the mark. The Maoris of the coast were not lost sight of; they were interrogated but without success, and all remained a mystery until the early part of last year when some large pieces of the wreck were, at the request of Mr. Mueller, cut from the other remaining portion and forwarded to Hokitika, and a portion of them was sent to Wellington to Dr. Hector, for the Colonial Museum. In the meantime, I had interviewed an old whaler, now residing at Hokitika, named Thomas Shannon, who had been on this coast as far back as 1840–41 sealing; and from him I found that he was in the vicinity of the Tauperikaka in 1841, and that he neither heard nor saw anything of such a wreck. The party to which he belonged was made up of old whalers and Jacob River Maoris. Several of those men had been on the coast for many years, and were all ignorant of such a wreck. He thinks that had any member of their party been aware of the existence of such an object of interest, he must have heard of it, and, as circumstances brought the party to this particular part of the coast during the season of 1841, he thinks that it would not have escaped his observation; but it may not be uninteresting to quote here in full his narrative, as it was taken down by me and forwarded to his Honor the Superintendent of Westland (then in Wellington). He says his name is Thomas Shannon, and that he is fifty years of age, and that he sailed from London in the barque "Speculation," Captain Robinson, on a sealing voyage to Desolation or Kerguelan Land; but, owing to the loss of their tender at Saldanha Bay (West Coast of Africa), the voyage was abandoned and they proceeded to Sydney, and thence to the Bay of Islands, where refitting, they proceeded to Auckland Islands and then south above the Antarctic Circle, where, meeting with severe weather, they had to return north to Bluff Habour to refit, having been in company far south with Commander D'Urville, and also with the American Survey expedition, under the command, as far as he can recollect, of Captain Keller. Leaving the "Speculation" at the Bluff, he joined a whaling party at Jacob River, under Captain Howell, and the following season, 1841-42, proceeded to the West Coast of this Island on a sealing expedition in open boats. That season, he says, their operations extended as far as the Blue River, three miles north of Arnott Point, sealing, and at the same time looking for a tribe of Maoris to chastise them for killing and eating a boat's crew the previous season, whilst on a sealing voyage from Jacob River. At that time there were several Maori villages on the coast from Jackson Head to the Bruce Bay of the present day; but, as the inhabitants were then cannibals, the Jacob River Maoris would hold no intercourse with them. On the approach of the sealers they took to the bush, and the only satisfaction they had was burning the villages. Nothing was known of any wreck on this part of the coast, nor was there any sign at the Blue River or at Arnott Point of any wreck, but on their return south, after passing Milford Sound, they came across several pieces of cedar logs showing evidences of fire, or that a vessel had been burnt at sea with a cargo of cedar wood on board. The timber was strewn on parts of the coast from a little south of Milford Sound, up south as far as Windsor Point, south-east corner of Preservation Inlet. No portion of any wrecked vessel was seen or heard of except one in Facile Harbour (Dusky Sound), the date of the loss of which vessel seems uncertain, and in fact, is unknown.

as no particulars of her loss were current among the sealers, except that she was a teak built ship, and that portions of the skeletons of her crew were found and buried upon Green Island (Facile Harbour), and were supposed from the smallness of their stature to be Lascars. No name of the vessel, or further information relative to her loss, was known on the coast. Thomas Shannon is of opinion that the pieces of wreck brought up to this port from the Haast, are a portion of a Netherland built vessel, and as to her construction, he assures me that during the early time he was on the coast of New Zealand, he never heard of or saw any vessel of the same construction as the one after which inquiries have been made. I may state that in 1866–67 there was a portion of a ship's figure-head laying in the bush about seven miles south of the position of the wreck, and near to an old camping-ground or village of the Maoris on the south side of the Waita River, but which, I have been told, was since burned by the people who followed the rushes in the Haast district; the figure-head was a representation of a woman, but it had been much disfigured.

Meanwhile the piece of wreck forwarded to Wellington has been examined by several nautical men, amongst whom were Commander Edwin, R.N., Captain Johnstone (Marine Board), Captain M'Lean, s.s. "Otago," Captain M'Intyre, and several others. The last-named gentleman started the idea that it much resembled and corresponded with the construction of the "Schomberg," of Liverpool, wrecked on Moonlight Head, South Coast of Australia, in November, 1854. A piece of the same was forwarded to Captain M'Lean, s.s. "Otago," taken by that gentleman to Melbourne, and examined by several gentlemen, amongst whom was the Inspector of Telegraphs for Victoria, who had seen the remains of the "Schomberg" only recently in the vicinity of Cape Otway. That gentleman at once pronounced it to be a portion of the wreckage at the Otway, and to be in as good preservation as any part he had seen. Captain M'Lean at once sent the piece home to Britain to the builders of the "Schomberg," Messrs. Hall, of Aberdeen, asking them their opinion as to its identity with the vessel in question, but no answer has yet been received. While this inquiry was going on at Wellington and Melbourne, I fortunately came across Mr. Andrew Murray's able treatise on "Ancient and Modern Shipbuilding," published in 1861, and that gentleman in his work gives a detailed account of the construction of the "Schomberg," and, in explanation of the diagrams showing the fastenings, he points out the fact that the Messrs. Hall, of Aberdeen, were the first to use screw trenails in the fastenings of ships, and, upon a close comparison, I find that the thickness of planks, the position in which they are placed to each other, and, lastly, the fastenings, correspond exactly with what we find in the piece of wreck mentioned before, and from all the evidence which we have laid before us, I am of opinion that the portion of wreck in question is none other than a piece of the hull of the wrecked ship "Schomberg."

Supposing this to be the case, the question then arises, how did it reach our shores? There can be but one answer, that is this, the currents of the ocean brought it to us. And by which route did it come? Did it come down to the southward of the West Coast of Tasmania, or did it come to the eastward, through Bass Straits, and thence down to the eastward of Tasmania, and reach the coast of New Zealand?

I am inclined to think the latter course is the true one, because, in the first place, from the position of the wreck on the coast of Australia, near Moonlight Head, the currents are found to set along to the eastward round Cape Otway, and thence to the eastward through Bass Straits, and then to the open ocean of the Pacific, there meeting the great Australian current setting down the coast to the south and east of our shores.

In proof of the actual existence of this current setting south, I have examined the logs of several vessels from Melbourne to this port, and find that in moderate, variable weather and winds, the currents set to the east of south in accordance with the amount of wind. Thus in one case a vessel was set 13·6 miles per day during a passage of eleven days from Banks Straits to the West Coast; another vessel was set 14·5 miles per day during a passage of ten days; whilst another, which experienced heavy weather from the N.E. to N.W. showed a drift of 21 miles per day. In fact, I have not, as yet, found an instance of vessels meeting a set to the N.E. and N. in the middle passage, and I have no doubt that during stormy N. and N.W. weather the current will be found setting with a much greater velocity. I should mention here that Thomas Shannon has referred to having seen cedar logs on the coast south of Milford Sound, and extending as far up as Windsor Point. I am not aware that cedar is found in Tasmania or New Zealand, and as neither of these colonies produces such timber, the only conclusion must be that the cedar came from New South Wales, and that the great Australian current was the power by which it was carried to the shores of the Middle Island, and that the same current carried to our shores the piece of wreck in question, which was found amongst the scrub near Arnott Point.

It may be asked how the wreck came to be found so far inland and amongst the small timber. I am of opinion that during a heavy gale from the N.W., the water of the ocean is forced up on our coast, and rises to a much higher level than usual, instances of which have come under notice. At Hokitika, on the 4th of August, 1874, when a heavy sea from the N.W. and a high tide occurred at the same time, the whole of the west side of

Revell-street was flooded, and I am informed by Mr. Marks, a resident for several years at the Haast, that at that date (the 4th August) the sea forced itself as far inland as the position of the wreck, although that was the only time in five years he had seen such a sea on the coast. As to the actual time the piece of wreck reached New Zealand shores, or when it left the scene of disaster to the "Schomberg," nothing definite can be arrived at, but from Moonlight Head to the point at which it was found, the distance, by the route by which it is supposed it came, is approximately 1,200 miles, and taking an average of the drift of the three vessel's logs, which is only an approximation the daily drift would be (16·4 miles), and the lone voyage would be accomplished in seventy-three days nearly.

By the kindness of Mr. Mueller, Chief Surveyor of the Province, I am enabled to further illustrate by map the action of the ocean currents in the direction already mentioned. On this map the set of the various currents between Australia and this coast are clearly shown, and I have also sketched out the course taken by the schooner "Sarah and Mary" on her last trip from Melbourne, as defined by the ship's log during a thick and rough passage of eleven days, here showing by a line marked black where the vessel should have been according to the ship's reckoning, and where, by the line marked red, the ship was when the land was first sighted off this coast.

In conclusion, I may be allowed to say that, in presenting this paper to the Institute, I do so with no pretensions to its possessing any literary or scientific merit, but as a humble endeavour in a somewhat rough, nautical way to throw such additional light on the subject of ocean currents, in connection with the discovery of the wreck referred to, as my daily avocation and recent enquiries have thus enabled me to do.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

At a meeting held 21st February, 1876, the President, his Honor T. D. Ormond, Esq., in the chair, it was resolved, on the motion of the Vice-President, the Bishop of Waiapu :—"That one-third of the annual revenue for 1875, or £20, be granted and laid out for the formation of a Scientific Library."

Through the illness of some, and absence (on public duty) of others, of the officers, and through no member sending in to the Secretary the required notice of having any paper ready, no meetings were held during the period of the session of 1875. Many valuable zoological and other specimens were, however, collected, and papers by members are promised for the present year.

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 1875.

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 1875.

Place.	Mean Annual Temp.	Mean Temp. for (Spring) Sep., 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	62.3	59.0	69.7	65.0	55.7	15.5	50.0
Auckland	59.7	56.1	67.3	62.5	53.1	14.1	51.9
Taranaki	57.5	54.2	64.2	60.2	51.6	16.6	52.0
Napier	58.4	55.9	67.4	59.7	50.7	18.1	58.0
Wanganui	55.7	52.9	64.5	57.4	48.1	20.3	58.0
Wellington	55.6	52.8	63.3	57.7	48.4	12.2	47.5
Means, etc., for North Island	58.2	55.1	66.0	60.4	51.2	16.0	58.0
South Island.							
Nelson	55.2	53.3	63.7	55.5	48.1	22.2	61.0
Cape Campbell ..	58.4	55.5	65.4	60.3	52.3	13.0	44.5
Christchurch ..	52.4	50.9	62.0	53.8	42.7	14.7	56.9
Hokitika	53.1	51.1	60.2	55.2	45.9	13.4	42.6
Dunedin	50.3	48.4	57.9	52.0	42.9	13.6	51.0
Queenstown ..	*51.8	48.0	59.9	51.4	—	16.3	58.2
Southland	—	—	57.5	50.8	—	—	—
Means, etc., for South Island	53.5	51.2	60.9	54.1	46.3	15.5	61.0
Means for North and South Islands	55.8	53.1	63.4	57.2	48.7	15.7	61.0

* For 10 months only.

TABLE II.—BAROMETRICAL OBSERVATIONS.—RAINFALL, etc., recorded for the year 1875.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapor 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 ..	30.016	1.390	.455	80	52.530	5.7
Auckland ..	29.988	1.564	.411	79	51.310	6.3
Taranaki ..	29.956	1.445	.373	78	66.960	6.3
Napier	29.940	1.611	.411	81	38.260	3.0
Wanganui ..	30.059	1.420	.334	73	47.940	5.0
Wellington ..	29.935	1.661	.360	81	65.827	5.4
Means for Nth. Island	29.981	1.515	.390	78	53.804	5.3
SOUTH ISLAND.						
Nelson	29.895	1.573	.346	77	69.070	5.3
Cape Campbell	29.990	1.450	.373	77	21.510	6.6
Christchurch ..	29.906	1.681	.331	81	32.310	6.0
Hokitika ..	29.934	1.650	.344	83	130.790	5.1
Dunedin ..	29.695	1.550	.295	80	42.631	6.0
Queenstown† ..	29.663	1.670	*.250	*64	†31.760	5.8
Southland ..	29.840	1.560	—	—	44.180	6.8
Means for Sth. Island	29.846	1.590	.323	77	53.178	5.9
Means for Nth. and Sth. Islands	29.913	1.552	.356	77	53.491	5.6

* For 10 months only. † For 11 months only.

TABLE III.—WIND for 1875.—Force and Direction.

Place.	Aver. Daily Veloc. in mls.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	‡ Calm.
NORTH ISLAND.										
Mongonui ..	165	17	37	41	42	48	65	35	79	1
Auckland ..	312	34	49	37	24	46	86	61	26	2
Taranaki ..	118	39	51	21	98	11	74	38	33	0
Napier	205	61	78	10	23	71	49	33	31	9
Wanganui ..	277	5	10	0	36	0	31	19	166	98
Wellington ..	227	6	21	1	115	0	10	9	199	4
SOUTH ISLAND.										
Nelson	133	67	91	23	67	10	47	11	49	0
Cape Campbell	—	11	3	7	71	75	2	29	161	6
Christchurch ..	140	3	96	45	36	8	133	9	35	0
Bealey	142	12	15	18	37	14	16	19	181	53
Hokitika ..	—	58	70	105	19	8	40	35	27	3
Dunedin ..	165	18	75	17	9	36	88	35	4	83
Queenstown ..	†112	3	22	0	20	1	26	15	110	137
Southland ..	181	4	70	48	14	9	104	38	68	0

† For 11 months only.

‡ 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.

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 Vapor 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.
46·7	16·5	66·2	29·963*	1·470	·266	81	104·595	5·4

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1875.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Napier	18	..	7*	..	..	..	..	..	5	..	..	..	3
Opotiki ..	..	..	..	14*	..	..	..	..	..	..	..	..	1
Maketu ..	..	..	..	14*	..	..	..	..	..	..	..	..	1
Wanganui ..	..	..	7*	25*	..	..	4*	..	..	..	..	..	3
Wairoa ..	..	..	..	17	..	..	..	..	..	..	..	..	1
Foxton ..	..	..	7*	..	..	..	..	20*	..	..	..	..	2
Wellington	4	..	7*, 13*	19	12, 24	..	..	25	5, 25* 28*	..	..	..	10
Nelson ..	..	..	7*	..	..	..	..	..	18*, 25*	..	..	..	3
Havelock	..	..	..	..	..	..	..	..	21*, 25* 28*	..	..	..	3
Cape Campbell	..	..	..	..	..	..	..	..	19, 20, 22, 25, 28	..	..	..	5
Blenheim ..	..	..	..	..	24*	..	..	..	25, 28*	..	..	..	3
Christchurch ..	..	..	7*	..	..	..	..	..	..	..	..	..	1
Queenstown ..	..	..	..	..	..	..	23	..	5	..	..	13, 15	4
Riverton ..	..	..	..	..	..	..	23	..	..	..	..	..	1
Invercargill ..	..	..	..	..	..	..	23*	..	..	..	..	..	1
Wallacetown ..	..	..	..	..	..	..	23*	..	..	..	..	..	1

The figures denote the days of the month on which on or more shocks were felt. Those with an asterisk affixed were described as *smart;* those with a dagger as *severe shocks*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. This table is therefore not reliable so far as indicating the geographical distribution of the shocks.

TABLE VI.—COMPARATIVE ABSTRACT for 1875, and previous Years.

STATIONS.	Barometer.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour	Mean Deg. of Moisture (Saturation = 100)	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and date.	Mean Amount (0 to 10).
NORTH ISLAND.														
Mongonui	30·016	1·390	62·3	15·5	50·0	—	—	·455	80	52·530	160	165	590, 11 Dec.	5·7
Previous years ...	29·973	—	59·9	—	—	—	—	·417	76	54·224	165	—	—	—
Auckland	29·988	1·564	59·7	14·1	51·9	154·2	26·4	·411	79	51·310	200	312	1212, 5 July	6·3
Previous years ...	29·930	—	59·6	—	—	—	—	·412	79	45·012	185	—	—	—
Taranaki	29·956	1·445	57·5	16·6	52·0	195·0	—	·373	78	66·960	169	118	455, 23 Aug.	6·3
Previous years ...	29·983	—	57·4	—	—	—	—	·373	78	56·612	159	—	—	—
Napier	29·940	1·611	58·4	18·1	58·0	144·0	—	·411	81	38·260	114	205	798, 15 Dec.	3·0
Previous years ...	29·917	—	58·1	—	—	—	—	·390	75	35·653	93	—	—	—
Wanganui	30·059	1·420	55·7	20·3	58·0	165·0	26·0	·334	73	47·940	121	277	630, 4 & 30 Nov.	5·0
Previous years ...	30·070	—	55·9	—	—	—	—	·330	72	38·420	128	—	—	—
Wellington ..	29·935	1·661	55·6	12·2	47·5	155·0	28·0	·360	81	65·827	176	227	750, 9 Dec.	5·4
Previous years ...	29·890	—	54·5	—	—	—	—	·328	72	50·872	155	—	—	—
SOUTH ISLAND.														
Nelson	29·895	1·573	55·2	22·2	61·0	—	—	·346	77	69·070	106	133	356, 20 Mar.	5·3
Previous years ...	29·901	—	55·6	—	—	—	—	·367	74	62·629	88	—	—	—
Cape Campbell ..	29·990	1·450	58·4	13·0	44·5	—	—	·373	77	21·510	106	—	—	6·6
Previous years ...	29·940	—	58·1	—	—	—	—	·348	72	28·150	109	—	—	—
Christchurch ..	29·906	1·681	52·4	14·7	56·9	153·0	14·2	·331	81	32.310	135	140	1319, 6 June	6·0
Previous years ...	29·871	—	53·7	—	—	—	—	·327	77	25·727	116	—	—	—
Bealey*	29·963	1·470	46·7	16·5	66·2	—	1·8	·266	81	104·595	160	142	399, 7 June	5·4
Previous years ...	29·782	—	46·4	—	—	—	—	·262	81	97·529	175	—	—	—
Hokitika	29·934	1·650	53·1	13·4	42·6	—	23·2	·344	83	130·790	186	—	—	5·1
Previous years ...	29·932	—	52·6	—	—	—	—	·358	86	113·116	189	—	—	—
Dunedin	29·695	1·550	50·3	13·6	51·0	162·0	23·0	·295	80	42·631	158	165	630, 7 July	6·0
Previous years ...	29·873	—	50·6	—	—	—	—	·280	73	33·022	166	—	—	—
Queenstown ..	29·663†	1·670†	51·8‡	16·3‡	58·2‡	—	24·0	·250‡	64‡	31·760†	114	112†	279, 25 Nov.	5·8
Previous years ...	29·987	—	51·1	—	—	—	—	·253	67	30·590	124	—	—	—
Southland	29·840	1·560	—	—	—	157·0	—	—	—	44·180	201	181	560, 12 July	6·8
Previous years ...	29·796	—	49·9	—	—	—	—	·274	75	45·779	159	—	—	—

* 2014 feet above sea level.

† Eleven months only

‡ Ten months only.

Notes on the Weather during 1875.

January.—On the whole, fine pleasant summer weather; the rainfall is over the average for the same period in previous years, but fell principally in the early and latter parts of the month; wind prevailed from the westward, and with few exceptions was moderate; at times extremely warm weather was experienced. Earthquakes reported at Napier on 18th, at 1 a.m., slight; and at Wellington on the 4th, at 6.30 p.m., also slight.

February.—Exceedingly dry weather throughout the Colony for this period. Temperature in excess of the average for the same month previous years; winds moderate and changeable. Aurora visible in south on 27th.

March.—Except at Nelson, Bealey, and Hokitika, the rainfall has been generally under the average, and strong equinoctial gales occurred between 19th and 24th, with barometer down to 29°·1. High barometer throughout, on the 10th reaching 30°·666, fine dry weather. Earthquakes reported on the 7th at Foxton, Wanganui, Napier, Wellington, Nelson, and Christchurch, about 5.18 a.m., generally described as sharp; also on the 13th at Wellington at 5.13 p.m., smart. Meteor seen in the south on 21st, direction W. to E.

April.—Very small rainfall for this period, at some stations considerably below the average. The temperature throughout was much higher than usual; and a high atmospheric pressure prevailed, on the 9th reaching to 30°·770 inch at sea level, with fine, bright, pleasant weather. The winds were moderate and generally easterly. Altogether remarkably fine and mild for the time of year. Earthquakes reported by observers:—Wellington, 19th, at 3 a.m., slight; through the Manager Telegraph Department:—at Opotiki and Maketu on 14th, at about 2.30 a.m., strong; and on 17th at Wairoa, Hawke Bay, at 7.15 a.m., smart; also on 25th at Wanganui at 11.5 p.m., long and smart.

May.—The rainfall at nearly all the stations was excessive for this period, and the degree of moisture higher than usual. Wind prevailed from S.W., and some strong gales occurred, with thunder, hail, and snow. Earthquakes, at Wellington on 12th, at 10.30 a.m., slight; at Blenheim on 24th, at 4.45 p.m., very smart; and at the Hutt, Wellington, same date, slight, at 5 p.m.

June.—Strong south-westerly winds prevailed throughout, with a very heavy rainfall; on the 4th and 5th a very severe gale was felt at most of the stations, but especially in Canterbury, where the wind and floods caused considerable damage.

July.—Generally dull showery weather during this month, with westerly winds, often stormy; severe gales occurred at Auckland on 4th from S.W., and at Hokitika on 11th and 12th, from the same quarter. Earthquakes reported by observers at Wanganui on 4th, at 2 a.m., rather heavy; and Southland on 23rd, at 4.15 a.m., sharp. By telegraph, on 4th, Wanganui, as above; and on 23rd at Queenstown, at 4.15 a.m.; Invercargill and Riverton, at 4.30 a.m., smart shock with noise.

August.—Westerly winds prevailed during this period, but no storms of any note are recorded. The rainfall throughout is about the average. The temperature is rather lower than usual for the time of year. On the whole the weather may be considered as seasonable. Earthquakes reported by telegram at Foxton on 20th, at 6.15 a.m., lasting about fifteen seconds; at Wellington, by observer, on 25th, slight, at 7.30 p.m.

September.—Rainfall in the north was in excess of the average for the same month in previous years; but in the south it was generally less than usual. The temperature was throughout below the average. Westerly winds prevailed generally, and on the whole moderate. Earthquakes were reported by observers at Napier, Wellington, and Queenstown on 5th, at 11.15 p.m., slight; at Nelson on 18th, in the forenoon, smart; at Nelson and Wellington on 25th, at about 6 p.m., smart, with noise; also at Blenheim and Havelock, same date and time, by telegraph; at Wellington, by observer, and at Blenheim and Havelock on 28th, at about 1.30 a.m., sharp, with noise; two sharp shocks also reported by telegram at Havelock on 21st, at 6.28 and 6.55 p.m., with noise. The observer at Cape Campbell reports shocks occurring on 19th, 20th, 22nd, 25th, and 28th.

October.—Very wet unpleasant weather experienced during this period, the rainfall at most places being excessive; strong westerly winds prevailed, and frequent gales; very severe for time of year.

November.—A severe, wet, and stormy month for the time of year; rain very much in excess; temperature below the average, and low barometer readings. Wind prevailed from the westward generally, and gales were of frequent occurrence, accompanied often with thunder and lightning.

December.—Excessive rain almost throughout, with prevailing westerly winds. Early and latter part of the month generally stormy; frequent thunderstorms occurred; temperature higher than usual for the time of year; sultry and oppressive weather prevailing during middle period; the low barometer reading recorded on the 8th, 29°·300; was followed by a strong westerly wind, with rain. Earthquakes were reported by Queenstown observer as occurring at that place on 13th, at 6 a.m.; and 15th, at 11 a.m., both slight.

On New Zealand Surveys. By J. S. CONNELL.

[*Read before the Otago Institute, May 25, 1875.*]

IT has been thought by some with whom I have lately conversed, that a paper on the above subject might, at the present time, be acceptable to the members of this Institute, and possibly interesting to the public.

For a number of years past the feeling has been growing in the public mind, that the surveys, at least in many parts of the Colony, were in an unsatisfactory condition, and the matter was, during the last two sessions of the General Assembly, pretty freely ventilated.

During his recent visit to the Colony, Major Palmer, of the Royal Engineers, was requested to examine into the condition of the Survey Departments of the various Provinces, to report thereon to the Colonial Government, and to submit such a scheme as he might deem necessary for the reform and correction of that branch of the public service.

His report, together with the recommendations he had to give, has now been made. It discloses a state of affairs in some of the Provinces which, although known pretty generally to the profession to exist, has never before been tabulated and duly recorded.

The report is therefore exceedingly valuable, in so far as it contains a correct statement of facts connected with the actual condition of the surveys of the Colony.

The remedy, however, proposed by Major Palmer, is open to criticism, and I venture to doubt whether it is indeed *the* remedy, which under the special circumstances of the case is required.

It is of very great importance, in coming to the consideration of any practical subject such as the one now before us, that the mind should be perfectly clear as to the special result desiderated, and should have in full view the entire existing state of surrounding circumstances.

To apply this to the concrete and to the subject before us.

A system of survey might be admirable, if the special result desiderated were a correct record of the relative position of existing objects, such as buildings, fences, roads, railways, canals, &c., &c., and yet might be quite unsuitable where the problem was to give possession of a portion of the earth's surface not possessing any permanent marks, or bearing upon itself evidences of its boundaries.

Or, shortly—It is one thing to survey and record an already existing possession; it is another to create it.

Where the problem is an accurate survey of existing possessions, there can be, I think, little doubt but that the system adopted in England, and recommended by Major Palmer for adoption here, is the best one.

It matters little if twenty or even fifty years elapse before its details are completed. The boundaries of estates, the position of which upon the land itself, have been recognised for centuries, are not likely to vanish, nor any question as to the whereabouts of a canal or of St. Paul's Cathedral likely seriously to disturb any one's repose.

The surveyor may leisurely proceed with his 36-inch theodolite to measure the various angles of his great triangulation, and may occupy his time in solving the interesting geographical and geodetical problems which meet him in dealing with a large portion of the area of our globe, without a single person feeling the want of his services or being possibly aware of his very existence.

It is, however, quite another matter where the surveyor is required to deal with naked portions of the earth's surface, and, *with the least possible delay*, divide the same into suitable portions for the occupation of the colonist.

He is required, first, upon the earth itself, to mark the boundaries of the various properties; and secondly, to construct on paper, on a proportional scale, a faithful record corresponding in every particular with the actual marks upon the ground, and bearing upon it a record of the measurements of every line of his survey.

This document is called a plan of the survey. If the work of measuring the various boundaries and lines upon the ground is correctly performed, and the plan is a complete and faithful record, the boundaries can be reproduced at any time upon the ground, from the information furnished by the plan, provided these boundaries are not *entirely* obliterated; and hence, in every sound system of colonial survey, it is recognised as requisite that the boundaries of properties which, from the nature of the circumstances, can only be marked in a temporary manner, must be connected or tied to some existing marks or objects not likely to be easily destroyed.

This has unfortunately been neglected in many of the Provinces of New Zealand, and hence *one* source of the existing confusion.

But not only is it apparent that boundaries should in this manner be connected to permanent recognised marks or stations, but it is further evident that, inasmuch as the power of reproducing lost boundaries correctly is only possessed where the original detail work has been correctly performed, it is absolutely necessary that some means should be available for testing the accuracy of the detail work itself, and this in two directions.

Every line on the earth's surface has two qualities, length and direction, and it is just as necessary that we should have some means of testing the accuracy of the given direction of a line as its length, ere the check can be complete.

The *only* efficient and proper manner in which this can be done involves the necessity of knowing, and that antecedently to any detail survey being made—

1st, The true lengths of the various lines joining the permanent stations to which a detail survey is connected; and

2nd, The inclination of such lines to a uniform standard of direction, and, as a matter of course, to each other.

The lines joining the various permanent stations I shall hereafter call Trig lines, and the permanent stations Trig stations.

It is quite true that it is possible to dispense with the knowledge of the inclination of each of the Trig lines to a common standard of direction, but it is absolutely necessary that their inclination to each other, and their true length, should be known, to furnish a sufficient means by which the accuracy of detail surveys can be efficiently checked; and the advisibility of having a standard of direction amounts almost to a necessity.

The only means by which practically the length and direction of Trig lines can be correctly ascertained I need scarcely say is by triangulation, founded upon a carefully measured base line; and therefore all competent surveyors are perfectly agreed as to the necessity for this work being undertaken.

There appears, however, to be some difference of opinion as to whether it is an imperative necessity that triangulation should *precede* detail survey, or whether it may not be possible to permit the detail surveys to go on with triangulation to follow.

Major Palmer adopts the latter view; I, myself, in common I believe with many other colonial surveyors, hold to the former with extreme tenacity.

The special system of triangulation, which it is most advisable to initiate and adopt must depend entirely upon the views which may be adopted on this point.

Certain geographical and scientific advantages of considerable importance and of great interest are unquestionably obtained as the ultimate result of the system Major Palmer advocates, but with the terrible consequence attached of losing all control and abandoning all check upon the detail survey of the Colony for many years.

It is true that Major Palmer recognises that it is advisable that "due exertions should be made to cause the triangulation in all possible cases to precede the detail survey;" but his system not only makes no provision for its doing so, but renders it impossible that, in the Provinces lying furthest from his bases such as Auckland and Otago, the detail survey should be overtaken by the triangulation for many years.

Major Palmer recommends that, in the meantime, the system known as "poling" should be adopted. (See his report, page 25.) This system consists simply of erecting the permanent stations to be used in the triangulation and requiring detail surveys to be tied to them. (I shall hereafter call the system of triangulation recommended by Major Palmer "Standard Triangulation," to distinguish it from Minor Triangulation.)

By this system (viz., that of "poling") when the standard triangulation is ultimately completed, and the lengths and direction of the trig lines ascertained, it will be easy to discover the errors which have been made in the detail survey, executed many years previously, and affecting titles which have been long issued.

This appears to my mind very like making a provision for locking the stable door after the steed is stolen.

What is really needed is not a system which will enable us to discover error, but one which will render its occurrence impossible.

There are many other serious objections to the adoption of the system known as "poling," besides the one which appears to me altogether fatal to it of leaving the detail survey utterly unchecked and uncontrolled; but, if the introduction of such a system were seriously contemplated in the face of this objection, others of a smaller magnitude could no doubt also be got over, and it will be unnecessary for me to occupy your time with a consideration of these. Unless, therefore, all settlement is to be brought to a standstill, or the detail surveys to be conducted, as unfortunately they have already been conducted in many of the Provinces, without proper and efficient check, we must adopt a system of triangulation other than that recommended by Major Palmer.

The system of survey introduced into this Province by Mr. J. T. Thomson is one which I consider with very slight modification suitable for adoption by the entire Colony.

This system is very fairly described in pages 18, 19, and 20 of Major Palmer's report, who, whilst admitting the general reliability of the work performed under it, points out that the great advantage of a triangulation such as he advocates being carried out, will be to gather up and bring the whole together with the various triangulations in such Provinces as Wellington within the grasp of one comprehensive system, referring everything to a single standard of length and a single starting point.

I quite agree with Major Palmer as to the very great advantages which would follow the work of a Standard Triangulation, thus gathering up the various minor triangulations into one consistent whole, and if the Colony can afford to spend the money, no one would more heartily rejoice than myself to see the work initiated; but let us be clear about one thing—viz., *that, until it is completed*, such a triangulation cannot replace or do away with the necessity for Minor Triangulation or independent bases. Such triangulation must go on if the detail surveys are not to be left utterly unchecked and unreliable.

If the execution of Minor Triangulation is carefully attended to, a means is *at once* furnished for checking detail surveys, and the work can readily be incorporated with and form a part of a Standard Triangulation, whenever it is deemed advisable that such a work should be undertaken.

I turn now to the consideration of the practical question. To what an extent is the extreme accuracy, which we might obtain as the result of a Standard Triangulation, in which instruments of large diameter were used. affected by the prosecution of a more imperfect, but an immediately available system, viz., Minor Triangulation, on independent bases, and carried on with portable instruments of five or six inches diameter.

In order that I may appear to speak about a matter with which I am thoroughly conversant, I will take as a sample of Minor Triangulation in this Province a portion of work executed by myself and assistants over the country between Ohau and Hawea Lakes. This country was exceedingly mountainous, the stations varying in elevation above sea-level from 1,100 to 5,286 feet. The instruments used were five-inch plain theodolites.

Twelve vernier readings in azimuth were taken at six different parts of the lower plate of the instrument. A base was measured three times with standard welded chain, and due corrections made for temperature near the foot of the Ohau Lake, and a base of verification was measured at the south end of the Hawea Lake about fifty miles distant from the initial base.

The result of the angular work was that, taking all the triangles, in number above fifty, the average error uncorrected for the minute spherical excess on each angle was only three and two-tenths (3·2) seconds, or upon the whole triangle, nine and seven-tenths (9·7) seconds. That not more than four (4) out of the entire number of triangles, contained in the sum of its three angles, a greater error than twenty seconds.

The length of base of verification was, prior to actual measurement, calculated from the triangulation and found to be 37,383·7 links, and the result of actual measurement 37,386·2 links, or about four inches and one-fifth per mile difference.

The measurement of this base of verification was completed in the presence of the present Chief Surveyor, Mr. McKerrow, who himself made the requisite corrections for difference of base and hypothenuse on two steep terrace slopes at each end of the line, and worked out the result.

In a large Minor Triangulation I have now in course of execution for the Provincial Government on ninety-four triangles already observed, the average error in closing each triangle on the sum of its three angles is only eight and seven-tenths seconds, or a little under three seconds to each angle. This shows an improvement on the average of one second to each triangle upon the Lake triangulation, which may be partly attributed to the use of a six-inch instrument over part of the work.

The work of many other surveyors who have taken part in the Minor Triangulation survey of this Province is, I believe, of an equally reliable, and possibly even more correct character than that of the sample I have referred to, but the time at my disposal has not enabled me to examine and refer specifically to it. I have noticed particularly that the angular work of Mr. William Arthur and Mr. C. W. Adams, which I have frequently had to refer to, is exceptionally good.

Work of this character, I think it may be agreed, is sufficiently good for all practical purposes, and nearly the whole Otago Minor Triangulation, extending over 4,200,000 acres is executed within a fair limit of error, a large portion of it being exceptionally good.

All the Minor Triangulation being based upon the true meridian of the initial station of each meridional circuit (of survey districts) is consistent, and refers to one standard of direction within the entire circuit, the whole Province being divided for this purpose into six circuits. For detail concerning meridional circuits, see Major Palmer's report, page 19.

As soon, therefore, as a standard triangulation is initiated, whether now or twenty years hence, the whole of the work executed in the Otago system is ready for absorption by it, and in the meantime furnishes a complete means, and that available for immediate use, for checking and controlling the detail survey.

The only improvements I would suggest in the practical working of the system of triangulation now in use in this Province are—

1st, That the measurement of bases should either be entrusted to one officer only, who may have displayed a special aptitude for the work, or at least that such officer should invariably be present and responsible for the result,

2nd, That the distances between the various bases should in future be increased. (This has, however, in several recent instances been done.)

3rd, That the limit of error permitted in the observation of azimuth angles should be considerably curtailed, and that the errors of observation should be eliminated from the triangles.

4th, That not less than twelve readings at twelve different parts of the lower plate be taken, if 5-inch instruments are used for azimuth angles.

These, however, are mere details, calculated to insure a further improvement in the character of the Minor triangulation, which the greater experience and efficiency of the surveyors available make it now possible to carry out.

I think it may now be taken for granted that, with due care, the measurement of bases and angular work, of the character I have shown, may readily be obtained by the careful use of instruments of good quality though small diameter, and that without in any way departing from the system of survey now known as the "Otago System," in use in this Province, a satisfactory knowledge of the true relative distance and directions of the stations, which it is proposed to use to check the detail surveys by, and that without waiting the eight or ten years spoken of by Major Palmer, or, as I should be inclined to estimate it, the fifteen or twenty years necessary for the completion of the standard triangulation.

Before leaving the subject of the triangulation, and taking up the one which I conceive is really of more pressing importance viz., the detail survey of the Colony, I would say a few words in connection with the subject of topographical maps.

I have no hesitation in saying that no system of triangulation will either be economical (in the vulgar sense of the term) or suitable for this Colony, unless it makes provision for a topographical survey, to be carried on simultaneously with the observation of the smaller triangles.

It is imperatively necessary that, for a considerable time before land is really wanted for sale, the Government should be in possession of a good deal of information about the land, such as its quality, adaptability for settlement, general altitude above sea level, and that the chief topographical features should be mapped out, enabling the Government, with a tolerable amount of accuracy, to determine the areas of large tracts which it is proposed to open for settlement. And inasmuch as the land laws of several parts of the Colony—our own Province amongst the number—admit of and provide for selection of lands prior to actual detail survey, it is evidently advisable further, that maps should be available, showing the position of natural features, such as rivers, creeks, forest, &c., &c., to enable selectors to identify, and the Land Department to understand, which particular portion of land it is proposed to apply for.

When the present Otago system was initiated by Mr. J. T. Thomson, this want was felt and at once met, the surveyors who conduct the triangulation being required to carry on with their observation of the triangles a topographical survey of the country by means of the use of the theodolite alone.

This survey includes the determination of the altitude of all trigonometrical points, chief mountains, passes, junctions of rivers, etc.

I do not gather from Major Palmer's report that he makes any provision for such a survey. It is of course unknown to the English Ordnance Survey, as there was no necessity for it in an old country; but without it, in the Colony, everything beyond the actually surveyed sections would be practically unknown, and the satisfactory disposition of the waste lands would be an impossibility.

It is true that Major Palmer proposes to have constructed a topographical map of the Colony, but he does not appear to understand the necessity of pushing this branch of the work ahead of settlement.

He says (page 26)—

"In the preparation of topographical maps the method to be pursued will vary according to the particular circumstances and the means available in different parts of the country. In some parts there are already accurate materials to hand, in others some revision and addition will be needed to work up existing details. All future section surveys should be so made as to *furnish the chief necessary particulars.*

"Lands already occupied should be *first included*, early attention being given to those which are now under lease from rough surveys, and the work could be afterwards pushed beyond these limits to the country at large.

"It might be desirable to station a small staff in each district specially to prosecute this branch."

It appears therefore from this extract—

1st, That *future section surveys* are to furnish the chief necessary particulars.

2nd, That lands already occupied are to receive attention first.

3rd, That a separate staff is to be appointed in each district for this branch.

In my opinion the chief use of topographical maps is to enable us to settle people on the lands and prior to such settlement to afford us the information I have alluded to above.

These maps may at a future time be improved by reductions from section survey, but have them we must, and that before section survey is undertaken.

The appointment of a separate staff for topographical work, whilst in harmony with English system, is altogether against the genius of colonial practice.

In England there are hundreds, I had almost said thousands, available for the work, whilst here we count our numbers by twos and threes.

Here we cannot afford to send a surveyor to the top of a mountain simply to observe the azimuths of the trig lines, which any accomplished observer can do even with twelve readings in about two hours, but we keep him on the same point sometimes for four or five hours more taking observations relating to the topography of the country.

In this manner we obtain the complete work at very much less cost than if we had a number of observers all following one another over the same ground as in England.

It is true that we require men of more varied ability than under the other system, but it is our pride to train them, and it is also true that the amount of work required from the colonial surveyor is greater than it would be under a different system.

I now proceed to say a few words on the uses to which the stations of a triangulation must be put in connection with the detail survey of the Colony, and I think it suitable here again to advert to the distinction between the detail work of such a survey as the Ordnance Survey of England and that of a Colony such as New Zealand.

The end to be attained by the former survey being chiefly correct cadastral maps or plans shewing the relative position and size of objects occupying the earth's surface, a system was adopted of breaking down these triangles, measuring the sides with the chain and multiplying the tie lines; in fact, arriving at the knowledge of the position of the various objects almost entirely by a system of chain measurements and offsets, without employing the theodolite at all. Nor, so far as I can gather, was any more thorough test applied to the detail work than to see that it was kept within such a limit of error as would not be apparent in the construction of the cadastral plans.

Traverse work with theodolite and chain appears to have been occasionally resorted to in road surveying, with no trace of any other test being applied save the one I have referred to.

For the first time for many years, and since the greater portion of the preceding part of this paper was written, I have looked into what may be considered a standard work on surveying.

Lieut.-General Frome's work, "An outline of the method of conducting a Trigonometrical Survey, etc.," revised and enlarged by Captain Warren, fourth edition, published 1873, may, I suppose, be looked upon as one of the best and latest works on the subject now published.

Whilst this work contains much interesting and valuable information connected with trigonometrical survey, and contains a chapter on colonial surveys (General Frome having formerly been Surveyor General of South Australia), I have been a good deal struck by the meagreness of information exhibited when the practical details of survey are under consideration, and the inapplicability of English methods and even General Frome's colonial methods, to the survey of New Zealand.

The rude method of measuring lines by "plumbing the chain" is the only one used and recommended in connection with the Ordnance survey, and the *probable* amount of error *in chaining alone* is stated by General Frome (page 47) to be 1 in 1000, or 8 links per mile, a greater amount being *often allowed* when surveying for small scales, according to the nature of the ground passed over.

In this Province the total error, including both the angular and linear work, *must not exceed* eight links per mile, as tested by the direct length between the trig stations to which the work is tied, the traverse being usually one-half and sometimes twice as long as the direct distance between these points. And whilst this error is admitted as an extreme, several of our surveyors do not average more than from one to three links per mile when subjected to the severe test of traverse reduction hereafter referred to.

In Otago the detail work is all founded upon long and sometimes intricate traverses, which it is absolutely necessary to have executed within a small limit of error, and subjected to the severest tests to ensure accuracy.

Nearly all the distances of boundaries of properties, opposite sides of road lines, areas, etc., are calculated from, and depend upon the accuracy, both angular and linear, of the traverse work, and the whole of the more minute topographical details which accompany the plans of section and traverse work, are obtained chiefly by observation with the theodolite alone from the stations of the traverses, and from points fixed by observation with the theodolite along the various section lines.

The surveyor is required to refer the direction of each of the traverse lines as well as all section boundaries, and, indeed, every line of the detail survey to the standard of a single meridian—viz., that of the initial station of the meridional circuit, and one of the chief uses of the triangulation is that it furnishes a means by which this can readily be done. He is further required to furnish tables (called traverse tables), showing the position of each of his pegs (the mark put into the ground at every angle throughout the detail survey) on the meridian and perpendicular of the trig station at which his traverse starts, and further to close every traverse at another trig station.

This necessarily involves a large amount of computation; but it enables the Inspector to ascertain the amount of error in the surveyors' work, even without inspection in the field, unless the tables are wilfully falsified. In such a case field inspection alone can discover the errors.

Field inspection may be considered an indispensable part of every sound system of survey, and experience has proved that it is only in very exceptional cases that it can be safely dispensed with.

As the relative position of the trig stations, at which any traverse starts and closes, is known, the sum of the reductions of his traverse lines can be at once compared with the single reduction of the trig line, and if absolutely correct, the two will exactly correspond. In so far as it departs from this result, we discover the amount of error in the traverse.

The traverses, if of considerable length, should also be checked at intermediate points by using the trig lines as bases, and throwing smaller triangles on to any portion of the work at intermediate points which it is desired to test.

It is also exceedingly desirable that frequent observations should be taken from the stations of the traverse to any trig points in view, and to other stations of the traverse, as if this is done it enables a skilful surveyor in a few minutes to discover any mistake in the chain-work, such as ten or twenty links or a chain dropped in any traverse line, and that without going over the work again in the field, though it is always necessary to verify by a re-measurement any line upon which an error is thus discovered.

This, then, is, in my opinion, the chief practical use of the triangulation, viz., to furnish a means by which this system of check can be applied to the detail survey; and yet the system recommended by Major Palmer renders, as I have already shewn, the application of such a check impossible in many parts of the Colony for a number of years. No such crucial test of the correctness of the detail work of the English Ordnance Survey was ever, so far as I can learn, applied, as we are in the daily habit of applying to the surveyor's work in this Province, at least, of the Colony by the above method of traverse reduction, and I believe this system is also used in the Province of Wellington.

I have met gentlemen in this Colony apparently familiar with methods in use in England, who were palpably ignorant of the way to measure a line correctly on the earth's surface, and who opened their eyes on being informed that there was any other way of checking a detail survey save by seeing whether it would "come in" in the plotting.

So far as I can read Major Palmer's report, he does not see the necessity for any more thorough test being applied to detail work in the Colony than that applied in England.

Referring to revision of old surveys (Report, page 27), he says, if old surveys are connected to the trigonometrical points and *re-plotted* in new maps, "It is not unlikely that a good deal will be *found to fit in such a manner* *as to leave no doubt of its accuracy.*" And again, "But nothing must be *humoured*, and nothing admitted in the new record maps which does not *plot correctly*."

However sufficiently such a check by construction may have satisfied the requirements of the English Ordnance Survey, it is quite insufficient as a check in the detail work of this Colony, and has long been thrown aside in this Province as of not the slightest value, dependence being alone placed on the calculated traverse reductions, without which it is impossible to verify the accuracy of colonial surveys satisfactorily.

The introduction of this complete system of check for detail work over the whole Colony, in connection with a carefully executed Minor Triangulation is, I conceive, the reform which we require.

Improvement of Detail Surveys.

I would venture to suggest also, that it is desirable to improve the character of the detail survey even in this Province, and to state my opinion that it is quite possible to diminish the allowed error in amount, without affecting the rapidity of execution, or cost of survey.

So long as the system of chain measurements is permitted, known as "plumbing the chain," a comparatively large error may almost with certainty be looked for. Fourteen years ago, I ceased the "plumbing system," and have ever since persevered in observing the inclination of the surface for each chain in ordinary undulating ground, with the best results.

As regards accuracy, I find no difficulty in keeping the average error of traverse work, both chain and theodolite, under two links per mile; and I think, out of some four or five hundred miles of traverse now in the Otago Survey Office, the average error does not exceed from one to one and a half links per mile—the greater portion of the chain measurements having been taken by skilled assistants, trained on this system.

I may say also that I find it possible to get through the work more rapidly by following this system than I could ever do before.

I would therefore suggest, for the improvement of detail survey, that the limit of error be reduced to four links per mile, and that surveyors be required to observe the surface slopes, and make the necessary reductions. Also, that either the surveyor himself, or an educated and trained cadet, should make all the chain measurements.

Particular attention should also be given to the condition and character of all theodolites permitted to be used in the survey of the Colony. It is not infrequent, in some parts of the Colony, to observe instruments in use which should have been for some time put on the shelf.

Any theodolite constructed in the usual manner, after about twelve months' work, begins to shew signs of "shakiness," and is really unfit to render correct work. Lately I have adopted the principle of doing away with the lower tangent screw altogether, and bolting the clamping collar direct to the upper levelling plate. This I find to answer admirably; the perfect rigidity of the lower plate thus obtained being invaluable, especially in trigonometrical work.

This alteration in the construction of the instrument renders a system of notation slightly different from that in common use, necessary, but one not in the least inconvenient.

I shall be very happy to exhibit and explain this improvement in the theodolite to any practical surveyor, and also to explain the system of notation.

An instrument constructed on this principle will last about four times as long in good observing condition as one with a lower tangent screw; and instruments now useless may easily be converted and rendered again workable.

In any case, I would attach considerable importance to a thorough periodical inspection of every instrument allowed to be used on the survey of the Colony. Instruments used by the Otago staff are, I am informed, periodically inspected, and every contract surveyor is, by the survey specifications, required to produce and exhibit the instruments to be used in carrying out his contract.

Plotting Detail and other work.

The methods of construction of maps, where the plotting of traverse work is concerned, pursued in connection with the English survey, I venture to say are very rude and inaccurate; and even in laying down the points of a triangulation, the method used in England, and described by General Frome (pages 131 and 132, "scoring triangulations" and "plotting triangulations,") are, in my opinion, very far behind those in use in this part of the Colony. Where the scale is not a very large one, and the triangles are at all numerous, the methods recommended will give rise to a constantly increasing and intricate series of errors.

By the system in use here of reducing all stations of the triangulation to the meridian and perpendicular of the initial station, the position of each station is laid down independently of every other, and thus the perpetuation of error rendered impossible—the only really difficult problem of the plot being practically to raise the perpendicular accurately to the meridian. The results of the ordinary method of doing so by beam compasses I have found it useful to check and test by measuring with standard brass straight-edge for the proportional lengths of sides and hypothenuse of the two right angled triangles, which may be formed by the perpendicular on each side of the meridian.

To obtain as speedily as possible a correct diagram of the triangulation has evidently been felt highly desirable in England as well as here, but the method recommended by General Frome (page 132) can only give a very rough approximation—one indeed so rough that I should be inclined to call it useless. In order to keep the plot of topographical work well forward, I suppose every surveyor engaged in trigonometrical work has felt the necessity for this diagram.

The method pursued by myself is to keep a series of separate calculations, which I term "rough solutions and reductions," some of which I exhibit in connection with a triangulation now in progress. These solutions are made as the triangulation proceeds, most frequently from two observed angles, only no attempt being made to eliminate errors of observation or to obtain mean results. These reductions, however, enable the stations to be accurately laid down on paper *at once*, leaving the ultimate calculations, with all corrections, mean results, etc., applied, to follow in the rear.

In this manner the plot of topographical work is kept almost as far on as the triangulation itself, and that in a manner which, I think, all surveyors will agree, is very far in advance of the methods apparently sanctioned in England.

As regards the plotting of detail work, the best method apparently known in England, and recommended by General Frome (note page 50) for plotting traverses is by using a card-board protractor, with the centre cut out; or, for surveys on a large scale, the circular brass protractor, with vernier, is recommended, as being more minutely accurate, *each* line being added from the plotting of the preceding one. Both these methods have been tried here, and thrown aside many years ago as unsatisfactory, inexpeditious, and incorrect in practice.

Sometimes on a detail, or particularly a large topographical survey, there are not less than several thousand bearings to be protracted, and it is of the greatest importance that a method should be used, combining accuracy and expedition.

The following is the method in use by myself and most other colonial surveyors, I believe:—

The meridian and perpendicular of the initial station being first laid down on the sheet, lines parallel to these are carefully transferred, cutting each other about the centre of the sheet, and a large protraction is laid with a fine needle point on the sheet itself.

This may be done with great accuracy by means of a heavy brass ruler, with cylinders of large diameter, and a boxwood scale from the table of natural sines and cosines, using parts of each of the four lines in the direction of the cardinal points alternately as sines and cosines for each arc, differing one degree of the circle.

Taking a radius of ten inches, we have thus a protractor twenty inches in diameter, divided accurately to each degree of the circle, and the degrees may then with the scale be subdivided to thirty or even fifteen minutes, leaving intermediate proportions to be estimated by the eye on applying the brass ruler for the purpose of protracting a bearing.

As a fine needle only is used to mark the points, the protraction is scarcely visible, except on close inspection, on the completion of the map, after pencil marks have been rubbed out, and yet it may at any time be resuscitated for the purpose of testing the plotting, if necessary. I exhibit a plot sheet of topographical work in progress, with protraction twenty inches in diameter thus constructed.*

Whilst the use of protractors of large diameter, carefully laid down in the plot sheet itself, enables us to lay down bearings, however numerous, correctly, it must be borne in mind that all traverse points of the detail survey are, under the Otago system, plotted altogether independently of any protraction whatever, directly from the traverse tables, and furnish reliable points from which the various bearings may be accurately protracted by the method I have referred to.

I venture to say that it is quite impossible to construct a large map with a good deal of traverse work in it, correctly, by either of the methods recommended by General Frome in the note referred to.

Before bringing this paper to a close, by referring shortly to the subject of the revision of old surveys, I think it will be appropriate that I should say a few words as to the reasons which have induced me, in referring to the Otago system, to say little or nothing about the work which had to be done ere it was possible to institute the Minor Triangulation on the satisfactory basis upon which that work was begun in this Province. My reason for so doing has been because I conceive we have to-night amongst us gentlemen who can handle that branch of the subject very much more ably than I could hope to do, gentlemen who initiated and carried on the astronomical and, as we call it, the standard part of the work.

I trust these gentlemen will supplement my dry and somewhat commonplace paper on the immediately practical branches of colonial survey, by some account of their more interesting and more scientific labours.

I proceed, in conclusion, to consider shortly the subject of proposed revision of surveys already in existence, but pervaded confessedly in some parts of the Colony with many and considerable blunders.

* For the suggestion of the above method of constructing a protraction, which I find superior to every other I had previously tried, I was indebted to my late assistant, Mr. Begg, who gave promise of being an ornament to the profession, but who is now unfortunately no more.

In devising or attempting to devise any remedy, we cannot lose sight of the fact that we have not only to be sound in our principles of measurement, but that we must also be sound in our principles of law. When these two sciences come into positive collision, as they will sometimes be found to do, it is very clear that the law must relax somewhat of its demands. A law can be made or altered, but we cannot alter the properties of a mathematical figure. I feel that, to go at all exhaustively into the subject, would occupy a much greater portion of time than we have at our disposal this evening, but, after a good deal of reflection, I cannot see any practical way out of the difficulty save by the introduction of a special measure into the Legislature dealing with the whole subject.

This measure might provide that in any district within which serious errors existed, a majority of the holders of land might, on application to the Surveyor-General, have a re-survey of their properties made and their titles corrected, the expense of the re-survey being defrayed either entirely or partly by the imposition of a special rate.

The details of such a measure would require the most careful consideration, and the best authorities in the Colony, both in law and mensuration, ought to be consulted as to its provisions, otherwise it might prove a curse rather than a blessing.

I would also, whilst upon the question of old and incorrect surveys, desire to record my opinion that the present system of trying suits involving questions of disputed boundaries by ordinary common or special juries is a very great mistake.

In the matter of disputed boundaries, a very wise provision was included in "The Crown Lands Act, 1862," which reads as follows :—

"Section XIV. If in any action, suit, or proceeding, touching or concerning any Crown Lands, or any Grant, Lease, or License relating thereto, any question shall arise as to the limits or extent, or as to the boundary of any land comprised in any Grant, Lease, or License, it shall be competent for the Court before which such action, suit, or proceeding may be pending, to order and direct that such question shall be referred to any person or persons whom the Court shall think fit, subject to such terms and conditions as the Court shall think fit, and the award, order, and determination of such person or persons shall be conclusive in such action, suit, or proceeding as to the matter so referred, and shall be binding on the parties, and may be enforced as a rule of the Court, and the Court may make such rule or order as to it shall seem fit touching such reference or the costs thereof."

So far as I am aware the course of procedure contemplated by this provision has never yet been followed by any of our Courts, and yet I venture to say it would be very much more satisfactory than the opinion of twelve persons possessing no special training which would lend to their opinion any weight when given as to the boundaries of land, and the provision remains practically a dead letter of the law. Whether this may arise from insufficiency in the wording of the clause, from ignorance of its existence, or from disinclination to act upon it, I am not aware. It is owing, no doubt, very much to errors in survey operations that litigation has been unfortunately so much induced of late, but, until a change is made in the description of land in the Crown Grants, we cannot, I think, expect that even correctness of survey will altogether remove the cause of litigation.

Two years ago, I was induced to write on this subject owing to a decision of the Court of Appeal in the celebrated Blue Spur case. As the dispute in that case was concerning the boundaries of auriferous lands of great value, the question was tried at great length and at enormous cost; and as the views I then expressed affect directly the subject of errors in survey, and the best mode of correction of the same, I append to this paper two letters which I addressed to the *Daily Times*, July 23 and 26, 1873, which any one interested in this phase of the subject may peruse.

In conclusion, I would say that I quite agree with Major Palmer as to the necessity for placing the survey of the Colony under the direction of an able Surveyor-General, and removing as far as possible the conduct of his operations from political interference and influence.

In no other way, so far as I can see, can that uniformity of system which is so much to be desired, be obtained, and steady prosecution of the work of survey be ensured; but I venture to think, that a uniform system of Minor Triangulation properly carried out, the application of traverse reductions as a check in all cases to detailed surveys, and a steady endeavour to improve the detail survey by every means likely to keep allowed error within the smallest possible limits, is what is really so urgently required at the present time, and that the initiation of a great Standard Triangulation, however desirable on geographical and scientific grounds, is no cure whatever for the evils under which many of the Provinces appear to be now suffering.

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