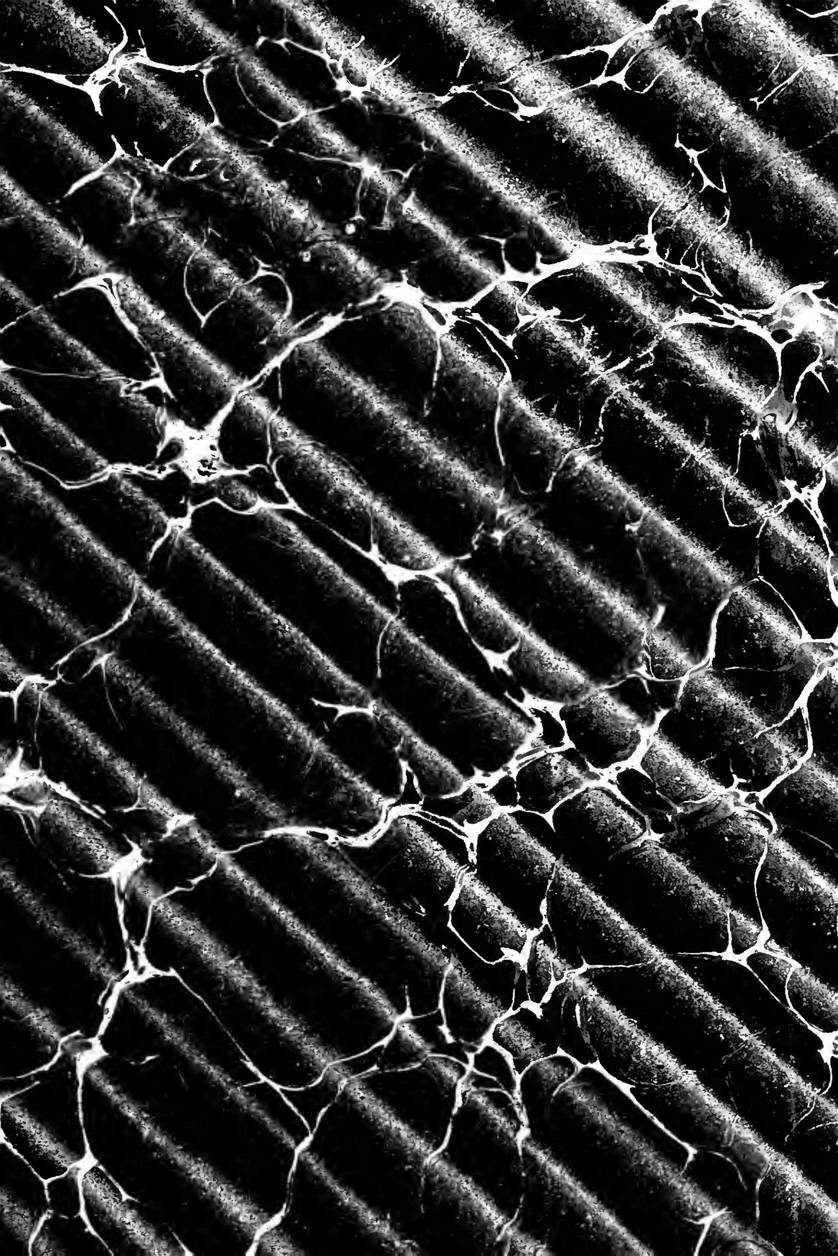

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1891

VOL. XXIV.

(Seventh of New Series)

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

BY

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

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CONTENTS.

TRANSACTIONS.

I.—Zoology.

NEW ZEALAND INSTITUTE.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OTAGO INSTITUTE.

WESTLAND INSTITUTE.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

NELSON PHILOSOPHICAL SOCIETY.

APPENDIX.

LIST OF PLATES.

NEW ZEALAND INSTITUTE.

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

Board of Governors.

(EX OFFICIO.)

His Excellency the Governor.
The Hon. the Colonial Secretary.

(NOMINATED.)

The Hon. W. B. D. Mantell, F.G.S.; W. T. L. Travers, F.L.S.; Sir James Hector, K.C.M.G., M.D., F.R.S.; W. M. Maskell, F.R.M.S.; Thomas Mason; the Hon. Robert Pharazyn, M.L.C., F.R.G.S.

(ELECTED.)

1890.—James McKerrow, F.R.A.S.; S. Percy Smith, F.R.G.S.; E. Tregear, F.R.G.S.

Manager: Sir James Hector.

Honorary Treasurer: W. T. L. Travers, F.L.S.

Secretary: R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

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

Section I.

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

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

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

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

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

Regulations regarding Publications.

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

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

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

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

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

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

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

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

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

Section II.

For the Management of the Property of the Institute.

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

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

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions:—

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

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

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

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

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

Section III.

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

Section IV.

(Of Date 23rd September, 1870.)

Honorary Members.

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

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.
2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

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

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1892.—*President*—Sir Walter Buller, K.C.M.G., F.R.S. ; *Vice-presidents* — A. McKay, F.G.S., G. V. Hudson, F.E.S. ; *Council*—A. de B. Brandon, B.A. W. T. L. Travers, F.L.S., C. Hulke, F.C.S., W. M. Maskell, F.R.M.S., Sir James Hector, K.C.M.G., F.R.S., W. P. Evans, M.A., Ph.D., E. Tregear, F.R.G.S. ; *Secretary and Treasurer* —R. B. Gore ; *Auditor*—T. King.

Extracts from the Rules of the Wellington Philosophical Society.

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

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

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

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

AUCKLAND INSTITUTE.

Office-bearers for 1892.—*President*—Professor F. D Brown ; *Vice-presidents*—James Stewart, C.E., and J. Martin, F.G.S. ; *Council*—Rev. J. Bates, W. Berry, Rev. J. Campbell,

C. Cooper, T. Peacock, Professor Pond, J. A. Pond, E. Roberton, M.D., Professor A. P. Thomas, F.L.S., J. H. Upton, E. Withy; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—J. Reid.

Extracts from the Rules of the Auckland Institute.

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

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

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

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1892.—*President*—Professor Bickerton, F.C.S.; *Vice-presidents*—W. H. Symes, M.D., H. R. Webb, F.R.M.S.; *Treasurer*—G. E. Mannering; *Hon. Secretary*—Robert M. Laing, M.A., B.Sc.; *Council*—T. Danks, F. Barkas, B. Bull, S. Page, R. Speight, Dr. Thomas; *Auditor*—C. R. Blakiston.

Extracts from the Rules of the Philosophical Institute of Canterbury.

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

35. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the first of November in every year.

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

OTAGO INSTITUTE.

Office-bearers for 1892.—*President*—C. W. Adams; *Vice-presidents*—Dr. T. M. Hocken and Professor F. B. de M. Gibbons; *Council*—Messrs. F. R. Chapman, D. Wilkinson, G. M. Thomson, Alexander Purdie, Dr. Belcher, and Professors Scott and Parker; *Treasurer*—E. Melland; *Secretary*—A. Hamilton; *Auditor*—D. Brent.

Extracts from the Constitution and Rules of the Otago Institute.

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

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

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

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

WESTLAND INSTITUTE.

Office-bearers for 1892.—*President*—Captain Bignell; *Vice-president*—W. C. Fendall; *Hon. Treasurer*—T. O. W. Croft; *Council*—Messrs. Joseph Churches, Robert Cross, W. L. Fowler, W. G. Johnston, A. H. King, John Nicholson, Robert Ross, M. Scanlan, J. N. Smythe, J. P. Will.

Extracts from the Rules of the Westland Institute.

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

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

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1892.—*President*—H. Hill; *Vice-president*—Dr. Moore; *Treasurer*—J. S. Large; *Secretary*—George White; *Auditor*—T. K. Newton; *Council*—Dr. Spencer, J. W. Craig, — Humphries, L. Lessong, H. H. Pinckney, J. Ringland.

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

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

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

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

SOUTHLAND INSTITUTE.

Office-bearers for 1892.—*Trustees*—Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1892.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. Boor; *Hon. Secretary*—Sidney Black; *Hon. Curator*—R. I. Kingsley; *Hon. Treasurer*—Dr. Hudson; *Council*—J. Holloway, Dr. Mackie, Dr. Cressy, Rev. W. Evans, Rev. F. W. Isitt.

Extracts from the Rules of the Nelson Philosophical Society.

4. That members shall be elected by ballot.

6. That the annual subscription shall be one guinea.

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

16. That the meetings be held monthly.

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

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE, 1891.

I.—ZOOLOGY.

Art. I.—*Further Coccid Notes: with Descriptions of New Species, and Remarks on Coccids from New Zealand, Australia, and elsewhere.*

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

[*Read before the Wellington Philosophical Society, 21st October, 1891.*]

Plates I.-XIII.

The following pages contain notes and descriptions of a large number of Coccids, including thirty-nine new species from New Zealand, Australia, and India. I make no apology for publishing in our Transactions descriptions of exotic species, for independently of their own special interest there is no certainty that any of them may not at any time make their appearance in this country, as so many others have done before them.

The majority of my Australian species have been furnished to me by Mr. French. One—*Carteria acaciæ*—comes from Mr. Tepper, of Adelaide, as collected by the entomologist attached to the Elder Expedition which, as I understand, is or has been lately exploring the central regions of the continent. The remainder, until a few months ago, formed part of the collection of my late friend Mr. Frazer S. Crawford, of Adelaide. These include, amongst others, two very interesting forms named in this paper *Lecanium baccatum* and *Cœlostoma immane*. I was always in hopes that Mr. Crawford would himself describe these species; but I suppose time did not permit him to do so. He was not greatly inclined to systematize: his chief work lay more in the direction of the economical part of science—entomological or fungological. In his treatment of that lies his principal claim to the remembrance of the world, and it would be difficult to exaggerate the importance of his labours and the debt of gratitude which agriculturists in every country really owe to him. If Crawford had not persistently and eagerly followed out the study of parasitic entomology, if he had not discovered and made known the existence and value of the fly *Lestophonus iceryæ*, the United States Government would not have despatched Mr. Koebele to collect the parasites of *Icerya* in Australia, and the clearance of California from that pest by means of *Vedalia cardinalis* would not have been effected. Whether, later on, the work of *Vedalia* in New Zealand would have been noticed and made use of, is uncertain. But the introduction of that splendid enemy to *Icerya* into America in 1889 was due primarily to the work of F. S. Crawford, and I think there is no harm in emphasizing here this fact, because it is a natural tendency of people nowadays to forget their benefactors unless pointedly reminded of them. For my own part, I am glad to express here, as a systematist who has not been greatly devoted to the purely "economic" side of entomology, preferring rather the scientific side, my admiration for one who dedicated himself so thoroughly to studies more near to the immediate needs of the agriculturists than my own may have been.

The species herein recorded from India have been sent to me at various times by Mr. Cotes, of the Indian Museum, Calcutta, and by the late Mr. T. W. Atkinson, Accountant-General of Bengal, who was an enthusiastic student of the *Rhynchota*, and whose loss last year is much to be deplored. The descriptions and figures which I have sent in return to these gentlemen are, as I understand, awaiting publication in the "Indian Museum Notes." I have included the species in this paper because I am not at all able to feel certain of my power to publish any more of these systematic notes on Coccids, which have now appeared, either in New Zealand or Australia, pretty constantly during the last fourteen years; and it seemed desirable to gather up, so to speak, all *disjecta membra*.

My New Zealand species are again mostly due to Messrs. Raithby and Cavell, and I think that they are not deficient in interest. The curious species *Ripersia formicicola* I owe to the kindness of Mr. W. W. Smith, of Ashburton.

The notes which are herein included, as to "parthenogenesis" and to the power of "gall-"making, will not, it is hoped, be considered either trivial or unnecessary. In both cases remarks of a vague and general character may be found in various works dealing with Coccids: but my intention has been to bring the subjects forward more particularly and definitely. It is to be hoped that in time the problems connected with these matters may be attacked systematically; and that European entomologists, when they get tired of the already dreadfully-worn grooves of the Lepidoptera and Coleoptera, will find the Coccids worthy of their best attention.

It has occurred to me that a few words may usefully be said about the mode of investigating systematically the species and varieties of Coccids. In common with everything else, of course, the outward appearance and habits of these insects, their position on bark or leaves, their colour and size and general form, must be carefully noted. But this exterior study, of itself, would be of extremely little use to the student, and indeed would lead him to utter confusion in a very short time: not only could he seldom distinguish between species and genera, but he would frequently confound Coccids with Lecanids, and I have seen species of Australian Psyllids which in outward appearance in the pupal stage very closely indeed resemble Diaspids. Close examination of the anatomical characters of the insects is therefore necessary: but here again the student will find himself in a difficulty unless proceeding in the proper way. The female insects, which are in most cases the most important, are frequently so covered with cotton or meal that the organs cannot be made out without treatment with reagents: moreover, at gestation they almost always shrivel up into such small, shapeless masses that their true form is often entirely lost. A student must therefore examine them, and preserve them for comparison, in two ways:—the specimen cabinet should contain as many, in their natural position if possible on portions of their food-plant, as form a typical collection; and, besides, others should be mounted for microscopical study, either whole or as dissected parts. The plan which I have found best adapted for these mounted specimens is as follows: it involves several operations, which, however, do not occupy as much time as might be thought from their description.

First, after thoroughly investigating the natural exterior form, colour, position, &c., of the insect, select as many individuals as may be required for dissection and mounting, and, if they are encased in thick cottony sacs, or in thick wax, or under puparia, carefully extract them therefrom—a proceeding which will become less difficult with practice. Secondly, boil them in *strong liquor potassæ.* For this purpose I use a small shallow dish placed on a flat tin plate over a spirit-lamp. The duration of this boiling should vary with the size of the insect: a small *Aspidiotus* or a moderate *Eriococcus* will require much less time than one of the large *Cœlostomas.* Practice again will show when to remove the lamp. The action of the potash is exercised mostly on the soft internal organs. If the boiling were continued long enough, the chitinous epidermis and the feet and antennæ would be destroyed also, but it will soon be ascertained when the internal portion is sufficiently softened, leaving the epidermis unharmed. In the case of a large insect it is usually better to prick it with a needle in two or three places so as to allow the internal substance to wash out. Thirdly, pour away the superfluous liquid, and replace by cold water. One thing is specially to be avoided—namely, any touching of the insect which can possibly be done without, as long as any potash remains to soften it. Fourthly, *float* the insect carefully from the dish on a glass slide, with plenty of water; place a thin cover-glass on it, and very gently press it down: this very slight pressure will usually suffice to expel the greater part of the internal substance without materially injuring the specimen. If now the insect be looked at with a lens it will be found that the boiling in potash has not only rendered it sufficiently transparent to show all the organs, but has at least nearly restored it to its proper shape—taken out, as it were, all the creases. Fifthly, *float* the specimen from the glass slide, cover and all, into a wine-glass of clean water: the cover will float away, the specimen will leave the slide; and now wash it thoroughly in the water, taking care not to touch it with anything hard. Sixthly, when well washed, with all the potash out of it, *float* it again on a slide, pour off the water, and replace it with strong alcohol: let the insect soak thoroughly in the spirit, and after a few minutes it will be found sufficiently hard to be gently moved with a camel's-hair brush into the centre of the slide where it is to remain permanently. Seventhly, put on the required thin cover-glass properly centred; run in more alcohol so as to keep the specimen well soaked; and now it can be examined under the microscope, the various organs noted, and its characters thoroughly ascertained. In general, it is best to place the specimens on the slide with the ventral surface uppermost, as most of the organs are on that surface; but sometimes the reverse is required. Now put away the slide to dry; and it will be well to leave it for several hours with this object, so that every particle of the alcohol may evaporate. The cover-glass will prevent the specimen from shrivelling up or becoming dusty. Lastly, and preferably next day, when it is quite dry, *run in* under the cover-glass a drop or two of

Canada balsam dissolved in benzine. Put it away again to dry (any length of time required), and except the final cleaning and ornamenting of the slide it is complete, and the specimen ought to show every organ necessary for examination with full clearness.

The foregoing process may at first sight seem to be long and complicated. It is not so in reality. I have frequently gone through the whole (except, of course, the final dryings) in a quarter of an hour, and mounted several specimens in an afternoon. The two things which must not be neglected, at the risk of entirely spoiling the specimen, are—first, carefully avoid touching the insect with a needle or a brush, as far as is possible, all through the process, at least until it has been well hardened by the alcohol: secondly, take every care that all the potash is washed out and that all the alcohol has evaporated before the balsam is run in. Mr. Raithby has sent me some very fine specimens which, in addition to the above treatment, he has stained with carmine. I have not practised any staining.

It must be noted that the foregoing applies only to the female insects. The males of most species are so small and so delicate that it is best to mount them untouched. I have many specimens quite sufficiently clear which have simply been first placed in position in a drop of alcohol, covered with thin glass, left to soak in alcohol for some time, and when dry had the balsam run in as usual. I have even treated in this way large males such as *Leachia* or *Icerya*: successfully enough for purposes of study, but of course not "show" slides. The larvæ, again, will not require the potash. But the adult females in almost all cases will require the process just given.

It will usually be found advisable to mount, in addition to the slides showing the entire insect, various portions—antennæ, or feet, or spiracles, &c., separately dissected. When it is considered that a Coccid which attains a length of $\frac{1}{2}$in. is almost a monster, one of $\frac{1}{5}$in. a large one, and one of $\frac{1}{15}$in. probably above the average, the necessity for clear microscopic preparations for any thorough study will be apparent.

It will perhaps have been observed that in this and in all my former papers I have continued to speak of the grouped organs noticeable in the abdominal segment of the Diaspidinæ as "spinnerets." The word has been so used by writers on Coccids for a long time. Targioni-Tozzetti, in his elaborate essay on the anatomy of Coccids ("Studii sulle Coccineglie," 1867), speaks of them as "filiere agglomerate." Signoret terms them "groupes de filières agglomérées." Other authors have used similar phrases. Mr. Morgan (Ent. Mo. Mag., Jan., 1889, p. 190) draws attention to the fact that these groups are at least nearer to the ventral surface of the segment than to the dorsal; that several species of Diaspids are without them altogether, and yet form scales or puparia; and that somewhat similar organs are found in certain insects close to the oral setæ: he concludes therefore that they are not "spinnerets," but "salivary glands." I am not prepared to deny altogether the force of these reasons. Yet it should be noted that at least these little organs, whilst they differ to some extent from the dorsal "spinnerets" of Diaspids, resemble very closely the dorsal organs which have been by common consent considered as "spinnerets" in the other groups. On the dorsal surface of, say, *Aspidiotus*, the tubular organs noticeable are different from those in the "groups;" and in several Lecanid or Coccid insects there are also more or less tubular organs. But there are also in these nearly always a number of circular ones which are quite similar to the "grouped orifices" of *Aspidiotus*. For example, they are very numerous in *Cœlostoma;* and again in *Planchonia*, where their double form is merely a variation. Close examination of a "group of orifices" in a Diaspid will show that they are "multilocular"—that is, composed of several openings all enclosed in an outer circle; and Targioni, in plate ii., fig. 23, of his "Studii," correctly delineates them as such. In this character they exactly resemble the dorsal organs of *Cœlostoma:* it would seem therefore probable that they fulfil the same function. The figure-of-eight orifices of *Planchonia* exhibit only one small circle within each outer one: this appears to be an unimportant variation: but undoubtedly these double organs lie at the base of the double long tubes forming the fringe of the insect, and must be taken as the orifices of excretion of the tubes. On the whole, therefore, it would seem to be clear that the "grouped orifices" of a Diaspid are similar to the "spinnerets" of a Coccid or a Monophlebid; and as, so far, no actual *proof* has been adduced that these organs are not engaged in the excretion of some substance, I have thought it best to retain the word "spinnerets" for the Diaspidinæ.*

It may happen that I may be unable to continue in future years these "Notes on Coccids:" I therefore take this opportunity of giving here a short list of the works which will probably be most useful to anybody who may take up the study of these insects.

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* I find that "grouped orifices" are present, close to the thoracic spiracles, in *Aspidiotus aurantii* (very small), *Diaspis rosæ* (very large and conspicuous), *Mytilaspis pomorum*, *Myt. leptospermi*, *Myt. intermedia*, *Myt. metrosideri*. In all probability they occur in every species of the Diaspidinæ.

BIBLIOGRAPHY.

The following list contains only a fraction of the large number of authors who, in the last two centuries, have written on the subject of Coccids: any one curious to know all their names may consult Signoret's first paper in the Annals of the Entomological Society of France, 1867–68. But, with rare exceptions, these writings contain little of practical importance nowadays, and the student will probably find in the list here given nearly all that is required for complete investigation of this family of insects. As most of the works included are in the form of papers extending over several years, I have thought it best to make the list alphabetical.

Atkinson, T. W.:

Insect Pests belonging to the Homopterous Family Coccidæ (in the Journ. of the Asiatic Society of Bengal, 1886).

Notes on Rhynchota (same Journal, 1889–90).

A New Species and Genus of Coccidæ (same Journal, 1889).

Carter, H.:

On the Lac Insect (Ann. and Mag. of Nat. Hist., 1861).

Comstock, Prof. J. H.:

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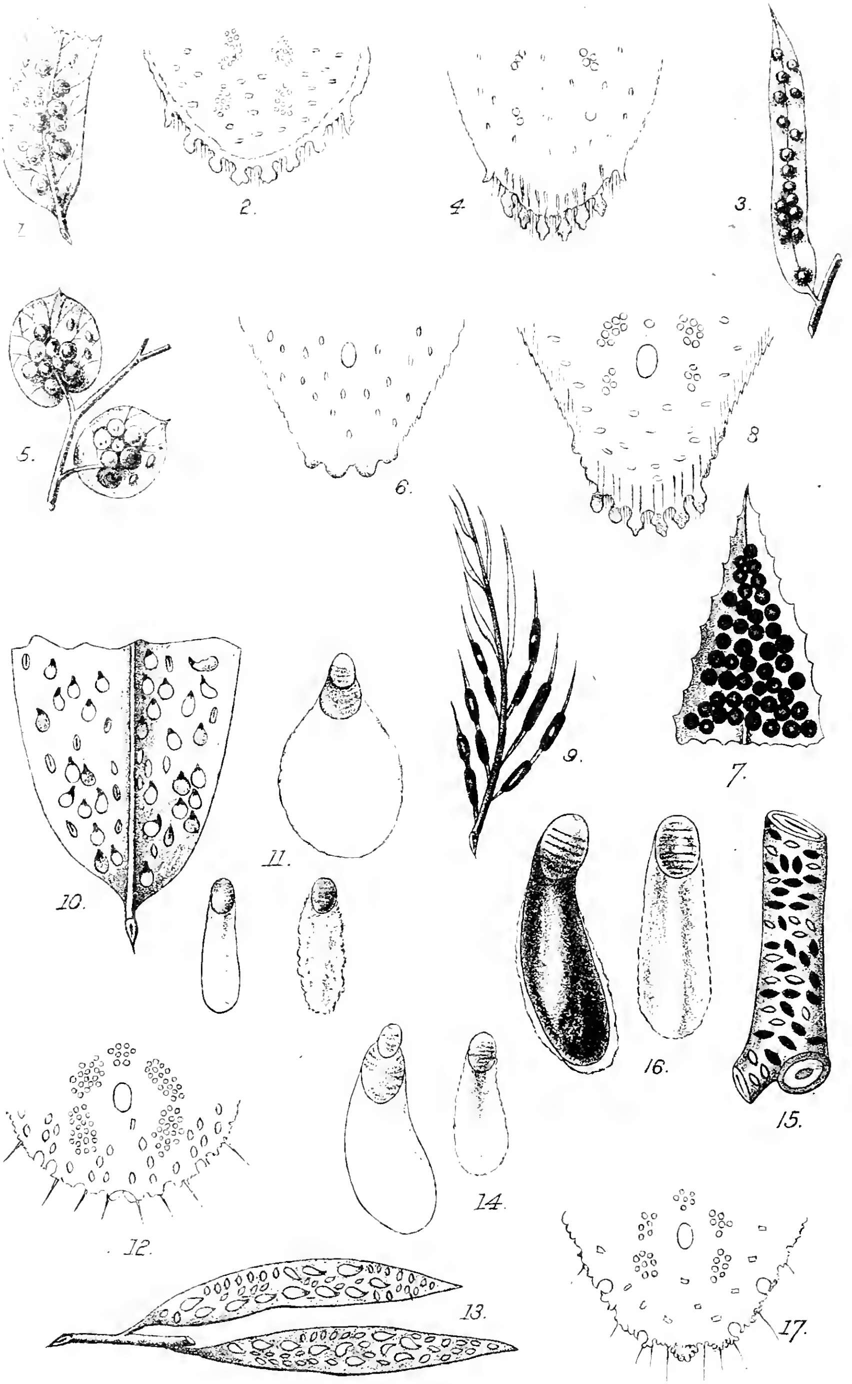

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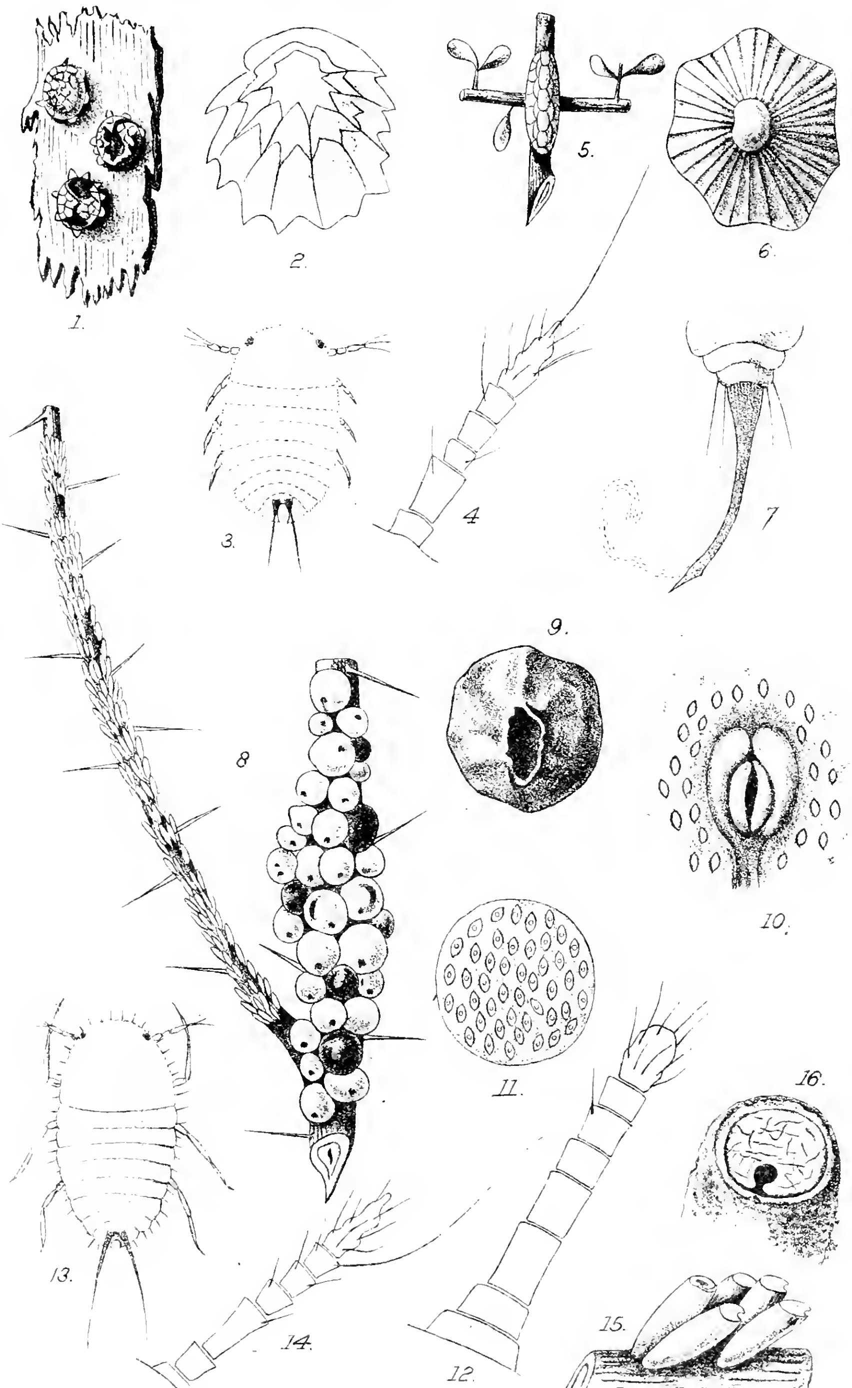

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The foregoing list contains the greater part of *modern* Coccid literature. Earlier writers, such as Réaumur, Geoffroy, Curtis, Bouché, Westwood, Fitch, Nietner, &c., may be sometimes consulted.

Finally, I think it advisable to say just a word or two as to the nomenclature which I have adopted regarding this family of the Homoptera. A few writers have taken exception to my use of such terms as "groups" and "subdivisions": they tell me I ought to say "sub-family," "tribe," and such-like. Again, I am taken to task for my words "Coccididæ," "Lecanidinæ," and so on. They say that the declension of Greek and Latin words should be strictly observed, and that the reduplication of syllables adopted by me in such words as those just given is a grave scientific error. It is to be feared that I am an incorrigible offender. Fully admitting the excellence of grammar and its rules, I cannot help thinking that in the matter of systematic nomenclature clearness and convenience are still more excellent. Huxley, I think, somewhere says the same thing. The classification which I have used is, to me, the simplest, the best, and the most convenient. Others are perfectly free to adopt it or not, as they please: I claim that it puts the family Coccididæ before the student in the clearest and completest way, and, so thinking, I propose to adhere to it.

NOTE.—All the insects originally collected by the late Mr. Crawford, whether determined by me or not, are marked in this paper "Crawford Coll."

Group DIASPIDINÆ.

Genus ASPIDIOTUS, Bouché.

Aspidiotus subrubescens, sp. nov. Plate I., figs. 1, 2.

Female puparium reddish-brown, sub-circular, flat, and smooth; the pellicles in the centre, small, forming a small slightly elevated boss, which is rather yellower than the rest. Diameter of puparium variable: specimens reach from $\frac{1}{23}$in. to $\frac{1}{8}$in.

Male puparium white, slightly elongated, not carinated. Length, about $\frac{1}{20}$in.

Adult female of the usual peg-top form of the genus, the terminal segment shrinking up at gestation: colour, brown. Abdomen ending in six rounded lobes with a number of scaly serrated hairs between them: these hairs extend also a short way along the margin, and where they end is another lobe, which is denticulate and pointed. Spinneret-groups four: the upper pair with 16 to 18 orifices, the lower pair with 10 to 12. Many single spinnerets.

Adult male unknown.

Hab. In Australia, on *Eucalyptus*, var. sp. My specimens are from Mr. French.

This insect seems to be not far removed from *A. ficûs*, Riley, the "Red Scale of Florida;" but, apart from its lighter colour, the puparium is flatter, and the spinneret orifices in the groups are much less numerous. In *A. ficûs* also there appears to be no denticulate lobule on the abdominal margin.

Aspidiotus fodiens, sp. nov. Plate I., figs. 3, 4.

Female puparium circular, slightly convex, greyish or reddish-brown; the pellicles in the centre rather more convex, forming a slight boss and bright orange, but often covered with a thin, greyish, scaly coating. Diameter of puparium averaging about $\frac{1}{25}$in. The puparia occupy depressions in the leaf which have the appearance of being caused by the insect.

Male puparium slightly elongated, similar in colour to that of the female, but smaller; not carinated.

Adult female of the normal pegtop form, orange-coloured, the abdomen somewhat acuminate. Abdomen ending in six rather narrow floriated lobes, set rather close together, with many scaly serrated hairs between them: at a little distance away on the margin is another lobule on each side, which is denticulate as in the last species. Spinnerets in four groups: upper groups with 3 to 5 orifices, lower groups with 1 or 2. Many single spinnerets.

Adult male unknown.

Hab. In Australia, on *Acacia* sp. Specimens from Mr. French.

This species, in the form and colours of the puparium, approaches to *A. uvæ*, Comstock, an insect infesting vines in Indiana, U.S.; but in *A. uvæ* the abdomen ends in only two lobes, and there is no denticulate lobule on the margin. *A. cladii*, mihi (Trans., vol. xxiii., p. 3), is much nearer, and is also Australian. The colours of the puparia in that species are indeed darker and richer, but that is not of great importance; and perhaps, considering the very small number of spinneret orifices in *A. fodiens*, the two insects may be only varieties of the same. *A. cladii* is indeed a good deal larger; but size, again, is not very important.

Aspidiotus bossieæ, sp. nov. Plate I., figs. 5, 6.

Female puparium circular, convex; colour varying from dirty-white to yellow, and sometimes to dark-brown; texture soft and woolly-looking: pellicles central, very small and inconspicuous, yellow. Diameter of puparium averaging about $\frac{1}{18}$in.

Male puparium whitish, slightly elongated, smaller than that of the female; not carinated.

Adult female dark-brown, of normal peg-top form. Abdomen ending in two not large rounded lobes, and perhaps after a small interval another inconspicuous lobule on each side. Margin slightly serratulate. No groups of spinnerets.

Adult male unknown.

Hab. In Australia, on *Bossiea procumbens*: sent by Mr. French.

It is possible that *A. caldesii*, Targioni, may be very near to this species; but the description of it is very vague, and I see nothing in it indicating a soft woolly puparium such as the Australian insect exhibits.

Aspidiotus theæ, Maskell, sp. nov.

The late Mr. Atkinson, of Calcutta, sent me in 1889 a packet of specimens of a Diaspid on the tea-plant in the Kangra Valley, Assam, India. I returned to him a description and figures early in 1890, under the name *A. theæ*, sp. nov. I suppose that his lamented death, which took place in that year, prevented him from publishing this paper: I understand that it will appear shortly in "Indian Museum Notes." The insect has a convex puparium, and its most striking character is the presence on the dorsal abdominal region of the adult female of a large and distinct patch of lattice-work pattern, similar to that exhibited in *Ischnaspis filiformis*, Douglas (Ent. Mo. Mag., 1887, p. 21).

Aspidiotus eucalypti, Maskell. Trans. Roy. Soc. South Australia, 1887–88, p. 102.

I have had specimens of this insect from New South Wales, also on various species of *Eucalyptus*. I regret that the figure 1*d*, of plate xii. in the South Australian Transactions, does not sufficiently exhibit the deep transverse groove in the adult female, which is so marked a feature of it.

Aspidiotus rossi, sp. nov. Crawford Coll. Plate I., figs. 7–9.

Female puparium normally circular, very slightly convex; colour a dull deep brown, almost black, sometimes fading into a lighter shade at the edge: pellicles central, small, forming a little boss which is sometimes yellowish. Diameter of puparium averaging about $\frac{1}{16}$in., but varying a good deal. When on narrow leaves the form is sometimes irregular, oblong or elliptical.

Male puparium slightly elongate, smaller and lighter in colour than that of the female.

Adult female of the normal peg-top form, dark-orange or often dark-brown in colour. Abdomen somewhat acuminate, the margin having a rather deeply serrate appearance, with six floriated terminal lobes, beyond which are three very small denticulate lobules: a few serrated scaly hairs. Four groups of spinnerets: upper groups with 8 orifices, lower groups with 4. Several single spinnerets.

Adult male unknown.

Hab. In Australia, on a large number of plants. It appears to be very common about Melbourne, Sydney, and Adelaide on *Nerium oleander*, but I have seen it on various *Eucalypti*, on *Ricinocarpus*, and on several other plants.

This is one of the insects in the collection of my lamented friend Mr. F. S. Crawford, and I have adopted the name which he attached without description to it: I do not know the origin of the specific designation. The species does not seem to resemble any of those known hitherto. Mr. Crawford, in his early letters to me, named it *Asp. niger*, but I pointed out to him that this name was already appropriated by Signoret for a species living on willows in Europe, and differing from the Australian form in several particulars. In outward appearance *A. rossi* might be mistaken for *A. ficûs*, Riley; but the colour of the puparium and of the female is much darker, and the abdominal extremity of the female differs considerably from that species.

Aspidiotus destructor, Signoret. Signoret, Essai sur les Cochenilles, p. 94.

Specimens of cocoanut leaves (*Cocos nucifera*) were sent to me some time ago by Mr. Cotes, of the Indian Museum, Calcutta. They came from the Laccadive Islands, and were thickly covered with very small Diaspid scales, which I have identified certainly as *A. destructor*. The characteristic feature of the species is the presence of six terminal abdominal lobes, of which the two median are plainly shorter than the others. This insect is very destructive to cocoanuts, and has done great damage in various parts of the Indian Ocean. In the present instance it was accompanied by a variety of *Dactylopius cocotis*, Mask., which I described from Fiji in 1889. I understand that my description and figures of *A. destructor* are to appear in the "Indian Museum Notes."

Aspidiotus aurantii, Maskell. N.Z. Trans., vol. xi., 1878, p. 199; Scale-Ins. of N.Z., p. 42.

On the authority of Dr. Signoret, in a letter from him received in 1883, I referred this insect to *A. coccineus*, a species which appears to have been originally described in Greece: and in my "Scale-Insects of New Zealand," 1887, I definitely placed my name for it as only a synonym. Since then, in a letter from Professor Riley, I have been informed that Dr. Targioni-Tozzetti considered that, after all, my species was distinct from *A. coccineus*. I should be always very loth to depart from the authority of Signoret, whose work on the Homoptera is incontestably the best hitherto produced. At the same time, in every report, book, paper, or newspaper paragraph which happens to mention the insect it is invariably under the name of *A. aurantii*. Custom, right or wrong, must be to some extent obeyed; and, though I am by no means satisfied as to its correctness, the name of *A. aurantii* may now be best adhered to for the future. There is confusion enough, in all conscience, in the nomenclature of Coccids; and, if that confusion can be at all lessened by conforming to the general custom, a little evil may be done to secure a greater good.

In the number of "Insect Life" for June, 1891, p. 417, there is a notice of this insect as occurring in Syria, and I find it referred to therein as "*Aonidia aurantii*, Mask." I have no idea when, why, or by whom this somewhat important change has been made: whoever referred the insect to the genus *Aonidia* did not communicate with me. However, I am unable to accept this correction. *Aonidia* stands, in relation to those species of Diaspids which have circular puparia, in a similar position to that of *Fiorinia* as regards the elongated species: it is characterized by the excessive proportionate size of the second pellicle. In both these genera the second pellicle forms almost the whole puparium, and the adult female is therefore much smaller than the second, or pupal, stage. This very definite character is not found in *A. aurantii*. I have re-examined a large number of specimens, some mounted, many *in situ*, and the second pellicle is quite clearly visible in all, and is considerably smaller than the adult female insect. Moreover, in Dr. Signoret's original description of *Aonidia* he distinctly states that it presents the appearance of two puparia, one superimposed on the other: no such appearance is noticeable in *A. aurantii*. I am thus unable to accept the suggested generic change, and prefer to leave the species in the genus *Aspidiotus*.

Aspidiotus cydoniæ. Comstock, U.S. Dep. of Agric. Report, 1880, p. 295.

While this paper is in the press my friend Mr. A. Koebele, who is on his second journey to Australia in search of Coccid parasites, has brought to me a scale on oranges which he collected on his way at Samoa, in the South Pacific. After careful examination I conclude that this insect is identical with *A. cydoniæ*, a species recently reported as on quinces in Florida. The occurrence of it on citrus in the Pacific is an interesting fact. I received about the same time a letter from Mr. D. W.

Coquillett, of Los Angeles, in which that gentleman tells me that in California there are two *Aspidioti* on citrus: the one is *A. aurantii*, the other is different in a few respects. After seeing the Samoan insect I incline to the belief that *A. cydoniæ* may be this other species, and in consequence that the orange may be as much its food-plant as the quince, if not indeed the principal one.

Genus Chionaspis, Signoret.

Chionaspis eugeniæ, sp. nov. Plate I., figs. 10–12.

Female puparium white, or sometimes yellow, elongated, pyriform, flattish; length about $\frac{1}{10}$in. Pellicles terminal, yellow, not large.

Male puparium white, elongated, soft and cottony; often appearing like a small irregular mass of cotton, but in individuals of normal form a distinct carination is visible.

Adult female elongated, yellow or brown: abdomen ending with a shallow median depression, the two median terminal lobes being represented by thickenings of the margin at the depression with serrulated edges: four very small lobes can be in most cases detected at each side, but this depends on the position of the specimen: a short spiny hair at each side of the depression; one, longer, between the four small lobes, and two others at equal distances on each margin: four altogether on each side: and on each of the anterior abdominal segments of the body three or four spines. Spinneret-groups five; upper group, 6–8 orifices; upper laterals, 10–18; lower laterals, 18–20. Several large single spinnerets.

Adult male unknown.

Hab. In Australia, on *Eugenia elliptica*, *Viburnum* sp., *Leptospermum lævigatum*, *Melaleuca ericifolia*, &c. Specimens sent by Mr. French. The female puparia seem identical on all these plants, excepting a slight variation in colour: the male puparia on *Melaleuca* are frequently very loose and fluffy, and Mr. French tells me that the plants look "as if covered with snow."

In the abdominal margin this species approaches to *C. nyssæ*, Comstock; but differs in other characters.

Chionaspis theæ, Maskell.

On tea-plants in the Kangra Valley, Assam, occurs an insect of which specimens have been sent to me by Mr. Cotes, of the Indian Museum: their description is to appear in the "Indian Museum Notes." The female puparium is pyriform, flat, light-brown: the female insect shows no very striking characters, but the abdominal segments are somewhat conspicuous. The male puparium is very small, white, and so markedly carinated that it has quite a *fluffy* appearance, as if formed of loose parallel threads. On the twigs and leaves sent to me the male puparia far outnumbered those of the females.

Chionaspis aspidistræ, Signoret (Essai, p. 125).

This insect occurs on *Areca catechu* in India, and has been sent to me by Mr. Cotes, who states that it has been doing much damage to those trees. The species is a little peculiar, firstly from the thin yellow puparium (rather unusual in the genus), and secondly from the excessive prominence of the segments in the adult female. Signoret, indeed, speaks of this last feature as giving an extraordinarily quaint appearance to the insect; but I have seen a similar peculiarity (though less strongly accentuated) in some specimens of *Mytilaspis pyriformis.*

Chionaspis nitida, sp. nov. Plate I., figs. 13, 14.

Female puparium silvery-white and shining, elongated, smooth, slightly convex, the sides in a normal specimen somewhat parallel, the puparium being thus not as pyriform as is usual in the genus; pellicles terminal, the larval pellicle bright-yellow, the second greyish. Length of puparium about $\frac{1}{11}$in.

Male puparium silvery-white, elongated, with parallel sides, slightly convex, with an inconspicuous longitudinal median groove. Pellicle bright-yellow. Length of puparium about $\frac{1}{20}$in.

The pellicles and the white secretion in the puparia of both the male and the female are particularly clean and bright-looking.

Adult female golden-brown, elongated, of the normal shape of the genus, the abdominal segments not prominent; abdomen ending in two small floriated lobes with a median depression, the margin crenulated, with a few small spines. Spinneret-groups five: upper group with 4 to 6 orifices; upper laterals 12 to 14, lower laterals 20. Many single spinnerets. On each of the thoracic and the anterior abdominal segments, near the margins, is at each side a group of small spiny hairs. Length of insect about $\frac{1}{18}$in.

Adult male unknown.

Hab. In Australia, on *Daviesia corymbosa.* Sent by Mr. French from Melbourne, and by Mr. Tepper from Adelaide.

The very clean bright puparia of this insect readily distinguish it in outward appearance. In the abdominal extremity it is somewhat near to *C. eugeniæ* and *C. nyssæ*, but it wants the strong spines visible on the segments of those species, and differs also in the spinneret-groups. The snowy-white puparia and golden pellicles are pretty objects under a low power or a lens. The male puparia are frequently placed transversely, not, as usual, longitudinally, on the leaf.

Genus Fiorinia, Targioni-Tozzetti.

Fiorinia acaciæ, sp. nov. Plate I., figs. 15–17.

Female puparium really yellowish and thin, but seeming thick and intensely black from the black second pellicle, which, as is usual in the genus, almost entirely occupies it, and is larger than the enclosed female; elongated, narrow, convex, the sides roughly parallel. The larval pellicle is terminal and dark-brown, and as it is apparently the only one visible the puparium might be mistaken for that of some male Coccid until the large black second pellicle is noted. Length of puparium about $\frac{1}{22}$in.

Male puparium white, cottony, elongated, narrow, with parallel sides, and with a distinct median longitudinal carination. Pellicle terminal, brown. Length of puparium averaging $\frac{1}{25}$in.

Adult female dark-brown, elongated; abdominal extremity truncate, with a single median floriated lobe; margin crenulated, and having on each side two deepish curvilinear incisions; four or five longish fine spiny hairs on the lateral margin. Spinneret-groups five; upper group with 3 to 6 orifices, laterals with 6 to 8. A few single spinnerets.

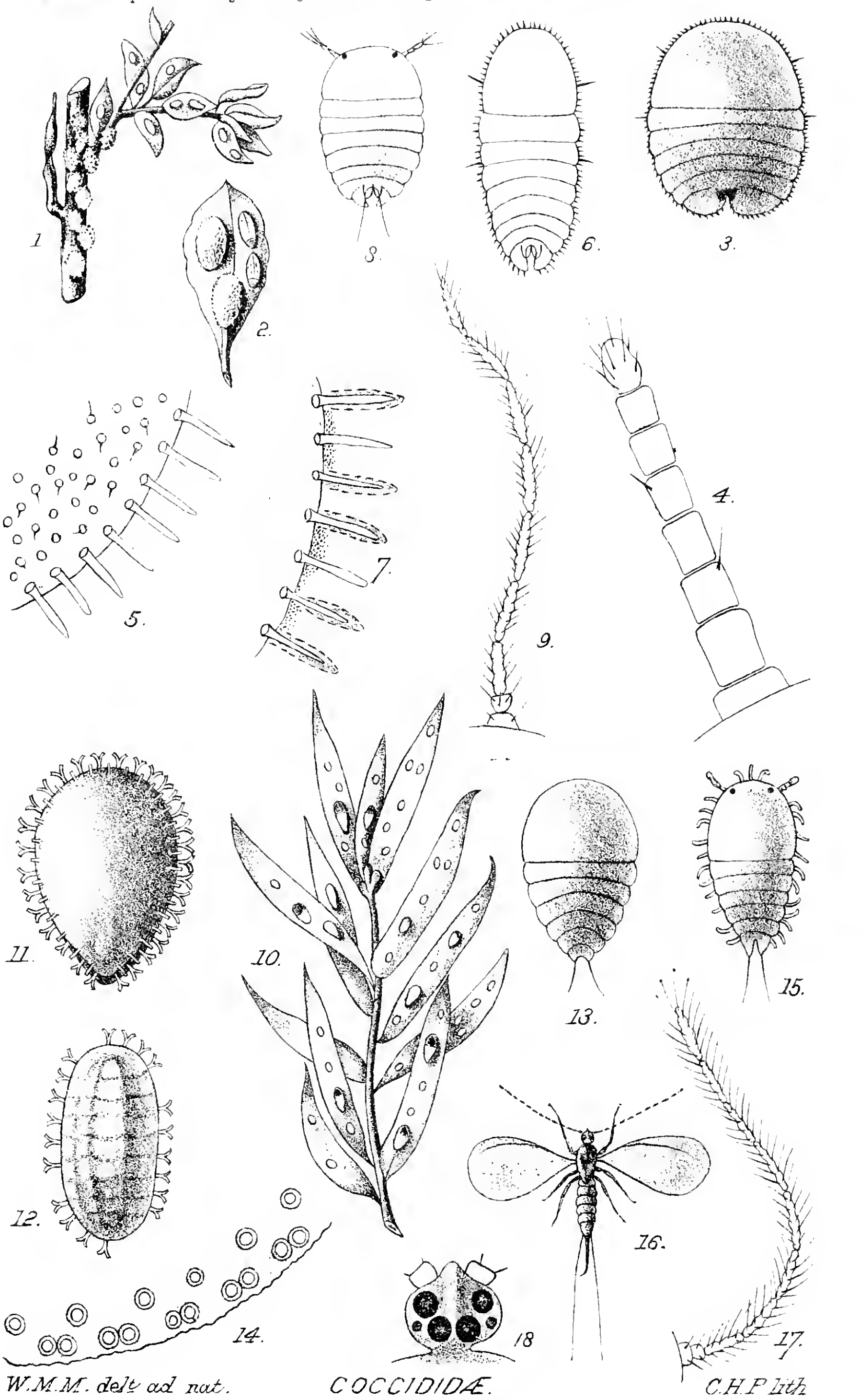
Adult male unknown. In a large number of puparia examined there were dead pupæ which appeared to offer no special characters.

Hab. In Australia, on *Acacia pycnantha.* My specimens were sent to me in 1890 by the late Mr. Crawford, of Adelaide. The pieces of bark forwarded were covered with numerous male and female puparia. Specimens also lately from Mr. French, on the same plant.

This species seems to be clearly and markedly distinct. The very black second female puparium and the form of the female abdominal region are differentiating characters, especially (in regard to the last) the single median lobe. The puparia, as in *C. nitida*, are frequently placed transversely on the twig.

Fiorinia camelliæ, Comstock.

I have specimens which I believe to be certainly of this species from Australia, on *Livistonia* and other palms, sent to me by Mr. French. The puparia are dark-yellow, with a longitudinal ridge sloping on each side to the margin, and the abdominal extremity agrees nearly with Comstock's description. The type of the species occurred, as Professor Comstock states, not only on camellias but also on palms in the conservatories at Washington.



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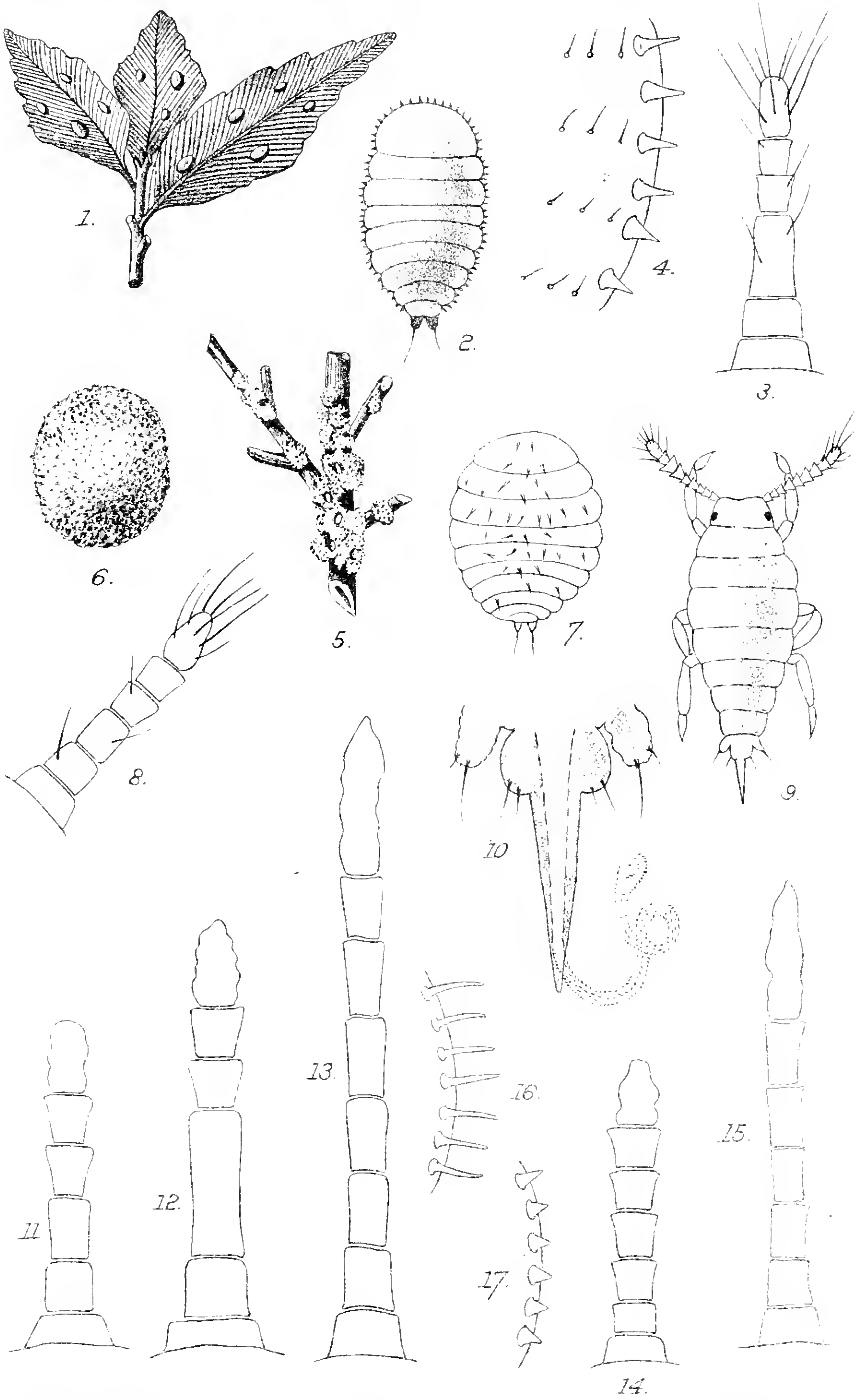

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Genus Poliaspis, Maskell.

In my paper of last year I offered certain reasons for the retention of this as a separate genus, and I see no reason now to alter the opinion therein expressed. At that time only two species were known—*P. media*, in New Zealand, and *P. cycadis*, in America. I have now to record an Australian insect so clearly belonging to this genus that at least one of the objections brought against my classification can exist no longer.

Poliaspis exocarpi, sp. nov.

Female puparium white, elongated, usually nearly straight, slightly dilated posteriorly: pellicles yellow. Length about $\frac{1}{12}$in.

Male puparium white, similar to that of the female but smaller; very obscurely carinated, if at all. Length about $\frac{1}{25}$in.

Adult female brown, darkening with age: elongated, segmented: length about $\frac{1}{16}$in. Abdomen ending in two very minute and scarcely perceptible median lobes; the margin irregular and bearing at each side only four or five spiny hairs set rather far apart. Pygidium exhibiting a double set of spinneret-groups: the lower set composed of five groups, the median having one orifice, upper laterals 18–21, lower laterals 25–35: the upper set forms an arch over the other, sometimes almost continuous, but usually separated into four groups, of which the two outer ones have 8–12 orifices, the two inner ones one or two. Many single dorsal spinnerets.

Adult male unknown.

Hab. In Australia, on *Exocarpus cupressiformis*: sent by Mr. French, who informs me that he has only found it in one locality—Mordialloc, near Melbourne—and that the plant seems usually to be free from scale.

I am unable to add more plates to my paper of this year, and defer a figure of this insect to a future occasion.

Group LECANIDINÆ.

Subdivision LECANODIASPIDÆ.

Genus Ctenochiton, Maskell.

Ctenochiton elæocarpi, Maskell. N.Z. Trans., vol. xvii., p. 26; Scale-Ins. of N.Z., p. 67.

The test of the male pupa of this insect is white and glassy. It resembles somewhat that of the second stage female, but is rather larger and has a longer fringe, and the dorsal portion is more solid, with the waxy plates almost agglomerated. There is a good deal of difficulty in distinguishing between the two.

The adult male has the thorax and abdomen brownish-yellow, the feet and antennæ lighter in colour: the wings iridescent with a red nervure, which in some specimens is rather conspicuous. The abdominal spike seems to vary in length, but is usually about half as long as the abdomen: from the two small tubercles at its base spring two setæ, which bear rather long cottony "tails." Antennæ of ten joints, nearly all long and subequal, the three last and the second rather shorter than the rest, the first very short: on the last joint three slender knobbed hairs, and numerous fine hairs on each joint. Feet normal. Dorsal eyes, four; ventral eyes, four: ocelli, two. Length of insect about $\frac{1}{23}$in.

The colours of the body of this male and the red nervures of the wings render it rather a pretty little object.

Ctenochiton dacrydii, sp. nov. Plate II., figs. 1–4.

Test of adult female white, or with a slight yellowish tinge, moderately thick, formed of a number of subcircular segments, which seem to be very brittle, and apt to break off: the edge of each segment is irregular, and the surface marked with irregular subconcentrical lines, and also radiating lines, so that it has somewhat the appearance of a fish-scale: the circular lines are rather deeply indented. Fringe in the specimens seen fragmentary. The segments of the test are sometimes convex, sometimes flattish.

Test of male unknown.

Adult female dark-brown or reddish-brown, very convex or semi-globular, hollow beneath; diameter about $\frac{1}{4}$in. Antennæ of (probably) seven joints. Feet normal. Abdominal cleft inconspicuous and short; anogenital ring with numerous hairs. Mentum dimerous. The female fills the test, and does not shrivel at gestation, and the dark body showing through the test gives the whole a brownish appearance.

Female of second stage brown, elongated, flattish, but becoming more convex latterly. Average length about $\frac{1}{17}$in. Antennæ of six rather confused joints, the last bearing some hairs. Feet slender; digitules fine hairs. Abdominal cleft and lobes normal, The margin of the body, all round, is minutely crenulated.

Larva yellow, elongated, flattish. Length about $\frac{1}{60}$in. Antennæ of six joints. Feet normal. Mentum dimerous. Abdominal cleft and lobes distinctly Lecanid. The margin of the body, all round, is minutely crenulated.

Hab. In New Zealand, under the bark of *Dacrydium cupressinum* (rimu) in the Reefton district.

This is a fine species, and, although I am departing from my usual rule in describing it from only three specimens of the adult female, I believe that I have correctly assigned it to the genus *Ctenochiton*, from the character of the test and its segments. It appears to be by no means common. Mr. Raithby found the first specimens under thick moss on the roots just above the ground; later finds were under the bark of the trunk; and he thinks that the species may sometimes be subterranean.

Ctenochiton depressus, Maskell. N.Z. Trans., vol. xvi., 1883, p. 132; Scale-Ins. of N.Z., p. 66.

An insect occurs in the Reefton district which I believe, after very careful examination, to be a small form of this species. It is found on a very small-leaved *Coprosma*, and the slight differences observable are, I think, due to the character of the food-plant. These differences are: a somewhat smaller size, averaging about $\frac{1}{11}$in. as against $\frac{1}{7}$in. for the type; a more convex and elongated form of test, and a generally very smooth appearance: none of these things is sufficient to require specific distinction. The antennæ might be considered as having six or seven joints according as one attaches importance to the division in the third, which I have called a "false joint": a similar character is noticeable in most species of the genus. The smooth segments of the test remove the insect from *C. hymenantheræ*, the only other resembling it; and on the whole I leave it as a small form of *C. depressus*.

Genus INGLISIA, Maskell.

Inglisia inconspicua, sp. nov. Plate II., figs. 5–7.

Test of adult female white, elongated, narrow, convex, not conical, with fringe either absent or very small; texture glassy, very thin and delicate and brittle: segments polygonal, marked with very delicate radiating striæ of air cells, and still finer concentric lines. Length of test averaging about $\frac{1}{5}$in.; height about $\frac{1}{30}$in. Although the test itself is white, the general appearance of the insect on a twig is brown, the colour of the insect showing through the translucent segments.

Test of male white, elongated, slightly convex, segmented, with a posterior hinged portion for egress of the insect. Length about $\frac{1}{15}$in.

Adult female brown or reddish-brown, filling the test but shrivelling at gestation. Margin bearing conical spines. Antennæ of six joints. Feet normal.

Female of second stage light-brown or yellowish, flat, covered with a thin test and with a short fringe. Length about $\frac{1}{20}$in.

Larva yellowish, flat, elliptical, active; length about $\frac{1}{50}$in. Form Lecanid; abdominal cleft and lobes conspicuous. Margin minutely serrulate. Antennæ rather large, with six subequal joints. Mentum large, dimerous.

Adult male yellowish-brown; wings iridescent. Length of body about $\frac{1}{30}$in. Antennæ of ten joints, all long and slender except the first two, and all bearing several hairs, of which some on the last joint are knobbed. Abdominal spike long, slightly curved, and a little dilated near the end. Dorsal eyes, four; ventral eyes, four: ocelli, two. Feet normal.

Hab. In New Zealand, on *Corokia cotoneaster*, in the Reefton district. It seems to be rather uncommon.

I think that this insect must be separated from those of the genus hitherto described. It is quite distinct from the conical *I. patella*, *I. ornata*, or *I. fagi*, and the delicately-marked and very thin translucent segments of the test differ from those of *I. leptospermi*. The specific name has been adopted on account of the difficulty there is in detecting the female on the twig, owing to the similarity of its general colouring to that of the bark: in fact, even with a lens it is not always easy to make out the contours with clearness.

Subdivision LECANIDÆ.

Genus Lecanium, Illiger.

Lecanium baccatum, sp. nov. Crawford Coll. Plate II., figs. 8–16.

Adult female dull-yellow, with sometimes a few brown patches, often wholly dark-brown; globular, with only a small orifice beneath for attachment to the plant; average diameter about $\frac{1}{5}$in, but some specimens are larger. Epidermis almost smooth, not speckled with black, but after treatment with potash a great number of small, oval, light marks are visible, each with a central clear spot. On the dorsum, near one side, is visible a black spot, and on close examination this is found to contain a small orifice and two very minute tubercular lobules: the spot contains therefore the anogenital ring, which appears to be quite hairless, and the abdominal cleft is represented by an exceedingly shallow and often quite indistinct depression between the spot and the opening on the twig. The interior of the globular mass is hollow, and the organs are only to be made out by maceration and dissection. Rostrum rather large: mentum short, monomerous. Antennæ of eight joints, of which the third is the longest, the fourth next, the rest shorter and subequal; the last is subglobular, and bears some short hairs. Feet rather slender (of what use are they?): upper digitules fine hairs; lower pair slightly dilated.

Female of the second stage dull-yellow, convex or sub-globular, slightly elongated. Length about $\frac{1}{11}$in.

Larva yellowish, flat, active; length about $\frac{1}{45}$in. Form distinctly Lecanid, the abdominal cleft clearly noticeable, and the lobes not extending beyond it: the lobes bear long setæ. Margin of body minutely serrulate, and bearing several fine hairs. Antennæ of seven joints, of which the third is the longest. Feet normal; digitules fine hairs. The anal ring bears several hairs.

Male pupa enclosed in a small greyish-white subcylindrical very closely felted sac, one end of which is closed by a thin glassy plate or operculum in which there is a small orifice simulating the abdominal cleft of a female; length of sac averaging about $\frac{1}{11}$in. These sacs are frequently clustered in great numbers on a twig quite apart from the females.

Adult male unknown. A single male pupa was observed which had died just on the point of emergence: as far as could be made out the antennæ would have ten joints.

Hab. In Australia, on *Acacia armata* (from the late Mr. Crawford); on *Acacia calamifolia* and *Acacia longifolia* (from Mr. French). The specimens from Melbourne are darker in colour than those from Adelaide. Mr. Crawford, in a memorandum attached to one of his drawings, says that the species is very rare about Adelaide: but I imagine that it must be fairly plentiful elsewhere, from the number of specimens which I have seen.

This is another of the insects in the collection of Mr. Crawford, who, at the time of his finding it, not being then well acquainted with Coccid classification, attached to it the name of *Cryptes baccata.* The females, at first sight, have very much the appearance of *Kermes;* and when I so informed my friend he changed the name to *Kermes maskelli,* under which, I believe, it has since remained in the Adelaide Museum. But the specimens received last year from Mr. French enabled me to examine a large number of larvæ, and these are so evidently Lecanid that it is impossible to include the insect among the *Kermitidæ.* It is therefore here attached to *Lecanium,* and the original specific (and very apt) name given to it by Mr. Crawford has been restored. It will belong to that series of the genus, Signoret's sixth, which includes *L. emerici,* Planchon, and *L. racemosus,* Ratzeburg, from both of which it differs sufficiently.

There is an American insect, *Kermes galliformis,* Riley ("American Naturalist," vol. xv., p. 482) which, to the naked eye, resembles *L. baccatum.* But, apart from the fact that *K. galliformis* is seen under a lens to be speckled with black, and has also usually distinct rows of black spots, it must be assumed (although no description of the larva is given) that in the larval stage it has not the Lecanid form, and therefore cannot belong to the same group as our species: the larva of any *Kermes* has prominent anal tubercles.

Lecanium ribis, Fitch. (New York Agric. Soc. 1856). N.Z. Trans., vol. xxiii., 1890, p. 16.

I reported this insect as occurring in New Zealand, at Ashburton, in my paper of last year. Since then I have received specimens from Oamaru (through Dr. de Lautour) and from various places in Canterbury. The pest is a new arrival in the colony within the last three or four years, and seems to be spreading rapidly. Owners of gardens should take every pains to get rid of it, for, although its proper food-plants are gooseberries and currants, and whilst even on them alone it may cause great loss and expense, yet I doubt if it will strictly confine itself to those plants: the *Lecania* are not at all particular as to their food. Whilst this paper is in the press I have received from Mr. Smith, of Ashburton, insects on grape-vines from that place which seem to me to be only a redder-coloured variety of *L. ribis*: it is possible that they may be the species next about to be mentioned, *L. rosarum*, which as yet I have with certainty only from Australia. But, indeed, the distinctions between several species of *Lecanium*—e.g., *L. ribis*, *L. persicæ*, *L. rosarum*, *L. rugosum*, *L. rotundum*, &c.—are so slight that possibly all of them may be really only varieties of the same, merely somewhat altered by the food-plant. I have no doubt about the insect on the gooseberries—it is clearly *L. ribis*; whether that on the vine is a variety, or is *L. rosarum*, is not yet certain. But in any case fruit-growers should do their best to eradicate both of them. A warning such as this is unfortunately only too likely to be neglected by the careless colonial horticulturist; but it is right to give it, nevertheless.

Lecanium rosarum, Snellen van Vollenhoven.

Adult female dark-red, or reddish-brown; semi-globular; sometimes slightly elongated: diameter from $\frac{1}{10}$in. to $\frac{1}{5}$in. The epidermis is at first smooth, but later exhibits some minute transverse wrinkles.

Hab. In Australia, on gooseberry-twigs at Melbourne: my specimens are from Mr. French.

This is a European insect, of which the original food-plant is the rose, in both England and Holland. But, as I have already stated under the last species, the *Lecania* do not seem to restrict themselves to any one food-plant, and my Australian specimens are so nearly similar to some of *L. rosarum* which were sent to me from England by Mr. Newstead that I cannot well separate them. I have already observed that some insects on grape-vines at Ashburton, New Zealand, may perhaps also be this species, if they are not a variety of *L. ribis*.

Subdivision LECANOCOCCIDÆ.

Insects covering themselves with cottony or felted matter: exhibiting in all stages Lecanid characters.

The genera forming this subsection may be distinguished partly by the character of the sacs which they form. None of them appear solid or waxy; but in some—*e.g.*, *Eriochiton*—they are scarcely visible in the adult stage, while in *Signoretia* the sac is apparent and conspicuous at the time of gestation. More definite characters are in the antennæ and feet—*e.g.*, in *Eriochiton* the former have seven joints, and in the feet the tarsus is usually longer than the tibia.

Genus SIGNORETIA, Targioni-Tozzetti.

Female insects forming a felted sac at gestation. Antennæ of eight joints. Characters Lecanid in all stages.

Only one species of this genus has hitherto been reported—*S. luzulæ*, Dufour, in southern France.

Signoretia atriplicis, sp. nov. Plate III., figs. 1–9.

Sac of female felted; white or with a slight yellowish tinge; elliptical, convex: length about $\frac{1}{9}$in.

Test of male white, thin, waxy, elliptical, convex, with a posterior hinged plate: length about $\frac{1}{16}$in.

Adult female brown, slightly elongated, convex, shrivelling at gestation: length about $\frac{1}{11}$in. Antennæ of eight joints, the second the longest, the rest subequal. Feet normal, the tibia longer than the tarsus, but the digitules seem to be absent. Mentum monomerous. Epidermis bearing a number of small, circular spinneret-orifices; on the margin a row of spines. Abdominal cleft and lobes present; anogenital ring bearing several hairs, of which six are rather large.

Female of the second stage light-brown, flattish, active: length about $\frac{1}{20}$in. Form distinctly Lecanid. It appears to be naked, but there is a very thin and fragmentary waxy test sometimes visible, of which the feather-like fringe corresponds with a row of strong spines all round the margin. Antennæ of six joints. Feet slender; upper digitules fine hairs, lower pair slightly dilated. Abdominal cleft normal; the lobes bear two or three spines; anal ring with numerous hairs.

Larva yellow, flattish, elliptical, active: length about $\frac{1}{45}$in.: form normal of *Lecanidinæ*.

Adult male dark-red: length about $\frac{1}{25}$in. Form Lecanid, with rather long, straight anal spike. Wings rather thick, with conspicuous red nervures. Antennæ of nine joints, all long and subequal except the first two, which are short and thick: numerous hairs on all the joints. Dorsal eyes, four; ventral eyes, four: ocelli, two.

Hab. In Australia, on *Atriplex* sp. (*A. halimus*?): specimens from Mr. French.

This insect differs from *S. luzulæ*, Dufour, in the form of its sac, in its scarcely-elongated form, in the character of the dermal spines, fringe, and spinnerets, and a few other particulars. The male of the European species does not seem to have been observed.

Genus ERIOCHITON, Maskell.

Eriochiton cajani, sp. nov.

This is an insect infesting *Cajanus indicus* (pigeon-pea) in India. The late Mr. Atkinson sent me specimens, of which I returned descriptions and figures not yet published. The species has a more permanent sac than others of the genus, but I placed it therein rather than in the allied genus *Signoretia*, on account of the seven-jointed antenna. An abnormal feature is that in the larva the tibia is longer than the tarsus.

Group COCCIDINÆ.

Subdivision ACANTHOCOCCIDÆ.

Genus PLANCHONIA, Signoret.

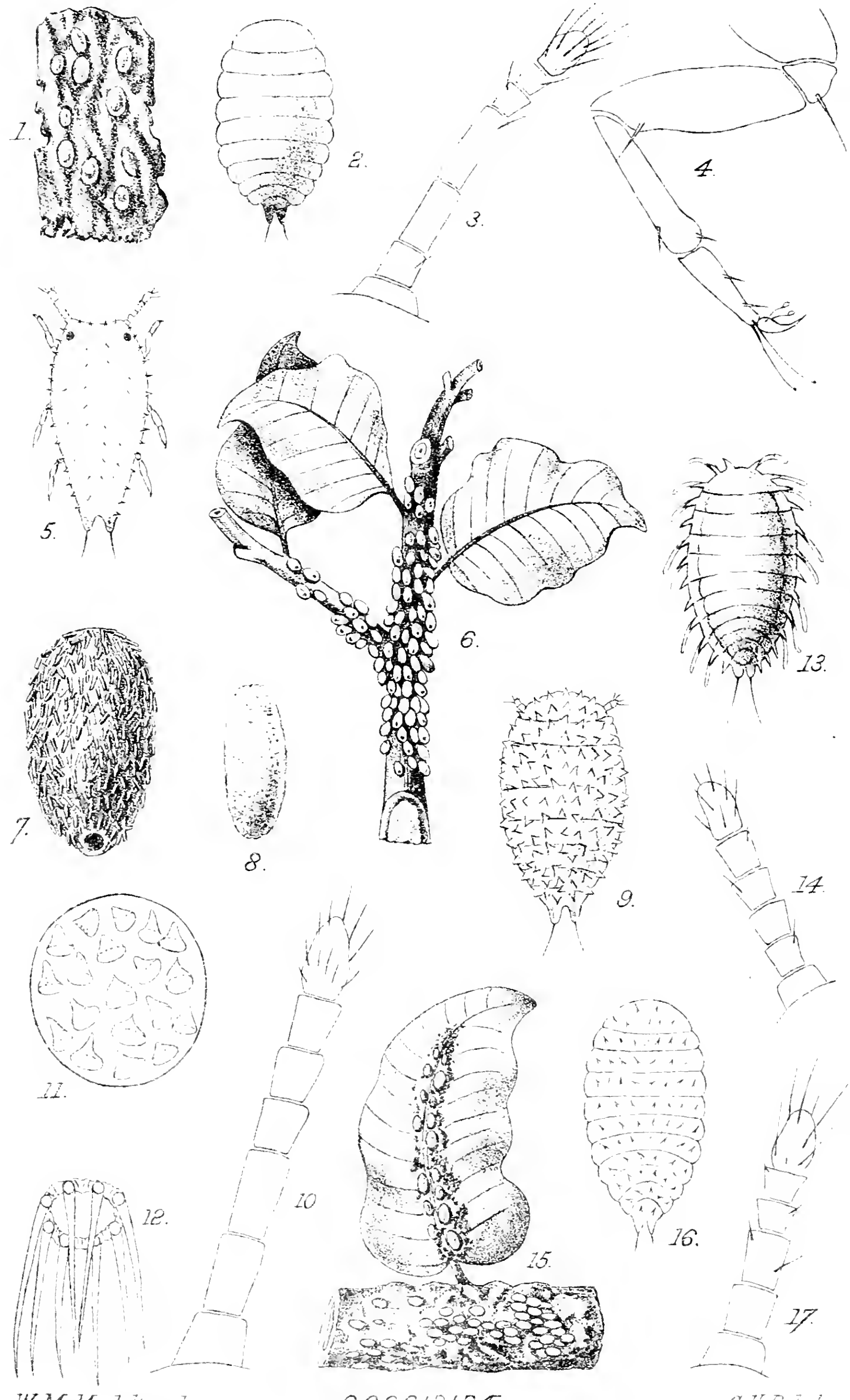
Planchonia styphelisæ, sp. nov. Plate III., figs. 10–18.

Test of adult female very closely felted, so as to appear almost waxy; convex above, flat beneath; elongated oval, slightly tapering posteriorly; colour whitish, or with a very faint greenish tinge: length about $\frac{1}{17}$in. At the posterior extremity the upper portion is slightly elevated, so as to leave a small orifice. All round the margin there is a double fringe of longish, white, glassy, slender tubes, one row above the other, the lower row being rather the longer and in pairs.

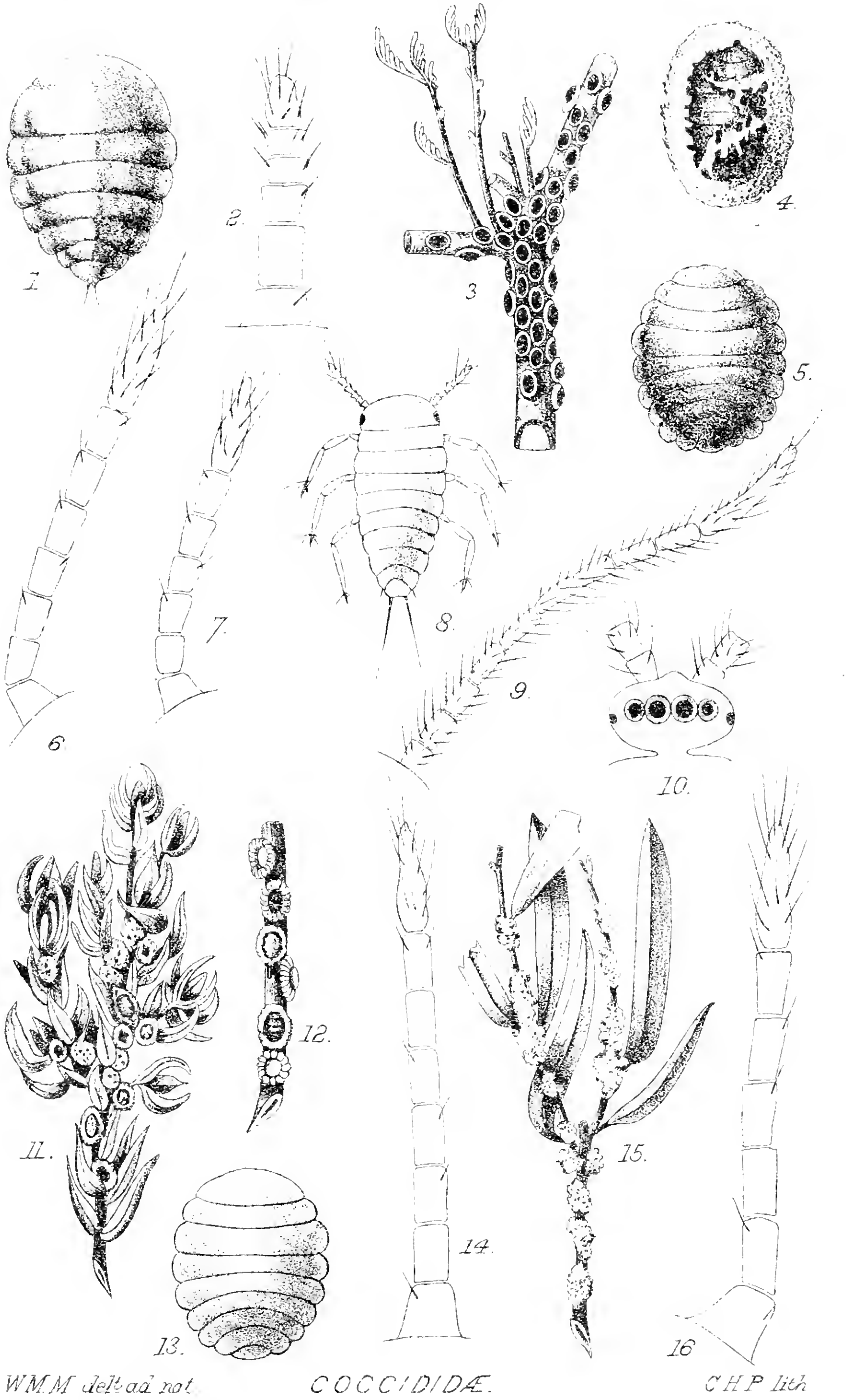
Test of male glassy; colour white, with a faint yellowish or greenish tinge: elongated, slightly convex: length about $\frac{1}{26}$in.: round the margin there is a single fringe of glassy tubes in pairs.

Adult female at first filling the test; elongated, convex; colour brown: shrivelling at gestation towards the cephalic extremity. Antennæ and feet entirely absent. Mentum dimerous. Anal tubercles present, but very small and inconspicuous; anogenital ring small, compound, with apparently six short hairs. All round the margin is a row of figure-of-8 spinnerets, and within it a row of single circular orifices.

Larva yellowish-brown, active, flattish; elongated, tapering slightly posteriorly: length about $\frac{1}{60}$in. Anal tubercles



W.M.M. delt ad nat. COCCIDIDÆ. C.H.P. lith



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COCCIDIDÆ.

C.H.P. lith.

visible, setiferous, very small. Antennæ of six subequal joints: feet normal. On the margin is a row of figure-of-8 spinnerets, from which spring curling, white, glassy tubes.

Adult male very small, yellow: length about $\frac{1}{50}$in. The thorax is rather thick, the abdomen tapering to the spike, which is slightly curved, and about as long as the abdomen. Antennæ of ten joints, of which the first two are short and thick, the rest long, slender, and hairy: on the last joint are four knobbed hairs. Dorsal eyes, four; ventral eyes, two: ocelli, two. Wings delicate, iridescent.

Hab. In Australia, on *Styphelia richei* and *Leptospermum juniperinum:* specimens from Mr. French.

This insect is closely allied to the New Zealand species *P. epacridis*, and it is noticeable that both affect plants of the Epacrid order—*Styphelia* and *Leucopogon*. The differences between them are microscopic; perhaps the most noticeable is the extreme smallness of the anal tubercles in the Australian species. But the dark though translucent test of *P. epacridis* is not likely to be mistaken for that of *P. styphelia*. The male just described is the only one yet observed in the genus: it does not seem to present any very peculiar characters, but is remarkable for its extremely small size.

Genus ERIOCOCCUS, Targioni-Tozzetti.

Eriococcus phyllocladi, sp. nov. Plate IV., figs. 1–4.

Sac of female dark-yellow, elliptical, convex, closely felted: length about $\frac{1}{15}$in.

Sac of male dark-yellow, whitish at the posterior extremity; elongated, very slightly convex, sides parallel; closely felted; length about $\frac{1}{20}$in.

Adult female reddish-brown or with a greenish tinge: filling the sac, but shrivelling at gestation. Antennæ of six joints, of which the third is the longest, the fourth and fifth the shortest. Feet rather strong: the tibia is at least as long as the tarsus; on the trochanter a long hair; digitules fine hairs. Mentum dimerous. All round the margin is a row of strong conical spines, and on each segment is a transverse row of minute spiny hairs.

Female of the second stage greenish, or with a tinge of red; flattish, elliptical, active. Antennæ of six joints. On the margin a fringe of curling, white, glassy tubes springing from conical spines.

Larva presenting no special features.

Adult male unknown.

Hab. In New Zealand, on *Phyllocladus trichomanoides* (tanekaha), in the Reefton district.

This species is allied to *E. raithbyi* (Trans., vol. xxii.,

p. 145), but differs in the six-jointed antennæ and the presence of the marginal row of strong conical spines.

Eriococcus confusus, sp. nov. Plate IV., figs. 5–8.

Sac of adult female dirty-white or grey, aggregated in rough irregular masses on the twigs of the plant; loosely felted: the normal form is globular, slightly elongated: length about $\frac{1}{20}$in.

Sac of male not observed.

Adult female dull brownish-yellow, subglobular, shrivelling at gestation to a shapeless mass. Antennæ of six subequal joints, the fourth and fifth a little the shortest. Feet normal. Epidermis bearing great numbers of simple circular spinneret-orifices and many rather long slender spines, which are most noticeable on the median dorsal region; also some minute spiny hairs. Anogenital ring large, compound, with eight hairs.

Larva and male not observed.

Hab. In Australia, on bark of *Eucalyptus viminalis:* specimens from Mr. French.

Eriococcus hoheriæ, Maskell. N.Z. Trans., vol. xii., p. 298; vol. xxiii., p. 20. Plate IV., figs. 9, 10.

In my paper of last year I was unable to include a figure of the apterous form of the male in this species. I give one now on account of several peculiarities observable. The specimen copied is one of two which emerged in May, 1890, from their sacs. Both were very lively; and, although at first I thought that perhaps they might be only pupæ which somehow managed to escape prematurely and incomplete, yet, as they lived for a couple of days and did not appear to change, this notion was not tenable. It will be observed that the head, thorax, and abdomen show no divisions; that there are only two eyes, which are lateral; and that the antennal joints are compressed: the whole form, indeed, seems to be intermediate. Yet I cannot exactly consider it as equivalent to a half-developed pupa. Dr. Löw, in a paper on *Eriococcus* (*Acanthococcus*) *aceris* (Wiener Ent. Zeit., 1882), refers to an intermediate pupal stage in that species which, he says, probably answers to the "pseudonymph" of *Hymenoptera* (von Siebold); but, as far as I can understand his expressions, this stage occurs altogether within the sac, and is neither active nor procreative. Had only one abnormal form appeared, I should probably not have considered it as anything but a monstrosity; but the occurrence of two similar forms nearly on the same day, and seemingly quite sufficiently apt for generation (as my figure 10 shows), pointed to something more. I have therefore thought it worth while to figure this curious form.

Eriococcus fagicorticis, sp. nov. Plate V., figs. 1–5.

Sac of adult female white, placed in the crevices of the bark of the tree, accompanied by much black fungus; normal form elliptical, convex, but often irregular; rather loosely felted: average length about $\frac{1}{11}$in.

Sac of male white, elongated, narrow, slightly convex: length about $\frac{1}{20}$in.

Adult female red, filling the test but shrivelling at gestation. Anal tubercles conspicuous, setiferous. Antennæ rather long and slender, with seven joints, of which the third and fourth are the longest, the fifth, sixth, and seventh the shortest and subequal: the antenna might seem to have more of a Dactylopid than an Acanthococcid appearance if the last joint were not so short. Feet having the tibia distinctly longer than the tarsus: digitules fine hairs, the lower pair slightly dilated at the tip. Anogenital ring with eight hairs. Mentum dimerous. All round the margin of the body is a row of strong conical spines, and a large number of smaller spines are visible on the dorsum, and are largest on the cephalic and thoracic regions. The epidermis also bears numerous small circular spinnerets.

Larva red, flattish, elongated, active: length about $\frac{1}{60}$in. Anal tubercles conspicuous. Antennæ short, thick, with six subequal joints. Feet normal. On the margin a row of strong conical spines, and four longitudinal dorsal rows of very small spiny hairs.

Adult male unknown.

Hab. In New Zealand, in crevices of the bark of *Fagus fusca*, Reefton district.

This is a clearly distinct species, from the form of the antenna and the length of the tibia in the adult female. The last of these is abnormal in the genus *Eriococcus*, but as all the other characters are normal I have been unable to remove it from that genus: indeed, if that were done, a new genus would have to be established to receive it, and there are scarcely sufficient grounds for such a course. I have seen one or two specimens in which the thinness of the sac on the dorsum might almost relegate the insect to *Gossyparia*, but I think these were exceptional.

Eriococcus eucalypti, sp. nov. Crawford Coll. Plate V., figs. 6–14.

Sac of adult female yellowish- or reddish-brown or brown, but covered with a number of small white glassy tubes, usually directed longitudinally, which give it often a peculiarly clean and bright appearance when viewed under a lens; convex, elliptical: length about $\frac{1}{14}$in. There is usually an orifice at the posterior extremity. The sacs are frequently clustered in great numbers on the twigs.

Sac of male rather lighter in colour than that of the female, more cylindrical and much smaller: length about $\frac{1}{30}$in. The glassy tubes are often not noticeable in this sac.

Adult female dark-purple or almost black, filling the sac but shrivelling at gestation. Antennæ normally of seven joints, of which the second and third are the longest and subequal, the last four short and equal: in some specimens observed the antennæ appeared to have eight joints, the first being very short; but this would probably be quite exceptional. Foot normal, the tibia being a very little shorter than the tarsus; on the trochanter is a long hair; digitules fine hairs. On the dorsum are a very great number of short, thick, conical spines not arranged in any definite order; also many small circular spinnerets with slender cylindrical tubes. Anal tubercles conspicuous, each bearing on the inner side two strong spines; anogenital ring with eight hairs.

Larva red, flattish, elliptical, active: length about $\frac{1}{70}$in. Antennæ of six short subequal joints. Margin bearing a row of strong, thick, conical spines, from which spring curling glassy tubes. Anal tubercles rather small.

Adult male not observed by me. I have a rough sketch by Mr. Crawford which shows two dorsal eyes, two ventral eyes, and two ocelli, a short conical spike, and two very long cottony "tails:" the antennæ and feet are not shown.

Hab. In Australia, on *Eucalyptus diversicolor* (Adelaide, from Mr. Crawford); on *Bursaria spinosa* (Melbourne, from Mr. French). In a memorandum of Mr. Crawford I find it stated that the insect is "very destructive to young gum-trees."

This species, in the late Mr. Crawford's collection, originally received from him the name "*Thekes eucalypti.*" In assigning it to its proper genus I thought at one time of changing the specific name, because it has been frequently sent to me on *Bursaria*, and probably has also other food-plants; but, the insect having been referred to elsewhere (*e.g.*, by Professor Webster, in "Insect Life," vol. i., p. 363) under the name *Eriococcus eucalypti*, it has been thought better to leave it so here. No description of it has hitherto been published.

Eriococcus eucalypti, by the characters of its sac and of its dorsal conical spines, belongs to that section of the genus of which the New Zealand *E. multispinus* may be taken as the type, as mentioned presently.

Eriococcus tepperi, sp. nov. Crawford Coll. Plate V., figs. 15–17.

Sac of female dirty-white or yellowish, elongated, elliptical, often aggregated in masses: length about $\frac{1}{14}$in.

Sac of male similar, but rather smaller.

Adult female dark-red or brown, shrivelling at gestation: length about $\frac{1}{16}$in.: subglobular. Anal tubercles conspicuous. Antennæ of six joints, the first three subequal (the third a little the longest), and each about twice as long as the fourth and fifth, the sixth rather shorter than the third, and bearing some hairs. Feet rather slender: tarsus nearly twice as long as the tibia. Anogenital ring with eight hairs. Mentum dimerous. No marginal spines, but on each segment is a transverse row of rather slender spines. Epidermis bearing numbers of small, simple, circular spinneret-orifices.

Larva red, flattish, elliptical, active: length about $\frac{1}{65}$in. Anal tubercles conspicuous, setiferous. Antennæ as in the adult. On the margin a row of slender spines, and a transverse row of similar spines on each segment.

Adult male dark-red, wings iridescent. Length about $\frac{1}{30}$in. Antennæ and feet normal. Spike short, conical: the cottony "tails" are very long.

Hab. In Australia, on *Eucalyptus globulus* and *Bursaria spinosa.*

This is another of the late Mr. Crawford's species, and was named by him after Mr. J. G. O. Tepper, of Adelaide. The species is allied to the New Zealand *E. pallidus*, but is rather smaller, and differs also in the form of the antenna, the third joint being only very little longer than the second, whereas in *E. pallidus* it is a good deal longer.

Genus RHIZOCOCCUS, Signoret.

Rhizococcus grandis, sp. nov. Plate VI., figs. 1, 2.

Adult female dark-red, naked, subglobular or subelliptical, convex, distinctly segmented: length about $\frac{1}{5}$in. Anal tubercles small, and usually hidden by the convexity of the abdomen. Antennæ of six joints, of which the second is the longest, the first third and sixth shorter and subequal, the fourth and fifth the shortest: on the sixth are several short hairs. Foot rather slender: tarsus longer than the tibia; at the extremity of the tibia a spine; upper digitules fine hairs, lower pair slightly dilated. Mentum dimerous. Anal ring with eight hairs. On the dorsum are some scattered slender spines.

Larva red, flattish, active: length about $\frac{1}{65}$in. Antennæ, foot, and tubercles normal. Round the margin runs a row of rather long and slender spines, and on the dorsum are two longitudinal median rows of smaller spines.

Male unknown.

Hab. In Australia, on roots of *Acacia longifolia:* specimens from Mr. French.

This very large insect has much the appearance to the naked eye of *Coccus cacti* (the cochineal insect), being of very much the same size and colour; but examination shows that the characters just described are distinctly Acanthococcid, and, as no sign of a sac was observed on any of the specimens sent to me, I have attached it to the genus *Rhizococcus*. In this instance I think that the size of the insect may be taken as a distinguishing character, being so much greater than that of any other known species.

Generic and Group Distinctions amongst the Acanthococcidæ and the Dactylopidæ.

Plate IV., figs. 11–17.

It is always useful to find some character which may at once decide the position of an insect in a family, group, or genus, and which will simplify the work of the systematist. Thus, for example, although in general appearance many Aleurodids or Psyllids bear close resemblance to Coccids, these latter may invariably be at once distinguished, whether in the adult or larval stages, by the existence of only a single claw on the foot; and the observer may then with perfect certainty proceed without further trouble as to the family. So, again, the last abdominal segment in an adult female at once decides its position amongst the Diaspids or the Lecanids. I have thought that it might be useful to give here a guide to a feature which will mark, for a student of Coccids, a distinction between the *Acanthococcidæ* and the *Dactylopidæ* noticeable almost at the first glance: I mean the form of the antennal joints. In both subdivisions the *number* of the joints may vary—the normal antenna of *Eriococcus*, for example, has six joints, and that of *Dactylopius* eight joints, but I believe I have not erred in attaching to these genera such species as *Eriococcus fagicorticis* or *Dactylopius hibbertiæ*, which have seven joints. But in almost all the species of both with which I am acquainted there is this distinction: that in the *Acanthococcidæ* the last joint is very little, if at all, longer than the penultimate, whereas in the *Dactylopidæ* it is very considerably longer. I do not know of any exception to this rule as regards the former group; but *Dactylopius eucalypti* (presently described) departs from its type in having a very short last joint, and is indeed abnormal in other respects. The figures 11 and 13 of Plate IV. exhibit the differences mentioned: it will be seen that there is a squatness and "stumpy" appearance about the former, and a comparative slenderness about the latter, to which the shape of the last joint contributes a good deal. I find this long last joint in *Pseudococcus* and *Ripersia* as well as in *Dactylopius*; whilst in *Orthezia* (at least, in my specimens of *O. urticæ*) it is markedly and excessively long. A student may therefore, I think, have no hesitation in assigning at least to its proper subdivision any insect of the Coccid group from inspection of its antenna.

In a good many species of *Dactylopius* I have found the antenna sharply bent between the first and second joints; but I am not prepared as yet to employ this as an important distinction.

Passing now to the genus *Eriococcus*, the figs. 11, 12, and 14 of Plate IV. show that there are three antennal forms, and figs. 16 and 17 that there are two forms of marginal spines in that genus. Fig. 14 (*Erioc. raithbyi*) differs from fig. 11 (*E. multispinus*) only in having seven joints: in both the joints are subequal. But in fig. 12 (*E. pallidus*) the third joint is much longer than any of the others. As regards the spines, those of *E. pallidus* and its allies are shown in fig. 16 to be much longer and more slender than those of *E. multispinus* and its allies, fig. 17. Some species combine the characters of both—*e.g.*, *E. phyllocladi* (as shown in figs. 3, 4 of the same plate) has the long third joint with the short conical spines. I mentioned these points in my paper of last year: the figures now given will illustrate them. In some species the marginal spines are very small, if not absent—*e.g.*, *E. confusus*, or the European *E. buxi*—but in most they are present and conspicuous, whether slender or stout.

Subdivision DACTYLOPIDÆ.

Genus Dactylopius, Costa.

Dactylopius albizziæ, sp. nov. Plate VI., figs. 3–10.

Adult female very dark purple, or perhaps, indeed, deep glossy black, resting on a cushion of snowy-white cotton; form subglobular, segmented: length about $\frac{1}{14}$in. Antennæ of sometimes seven, sometimes eight, joints, subequal except the last, which is rather long and fusiform, bearing several shortish hairs. Feet slender, normal: the tibia is very slightly dilated at the end; upper digitules long fine hairs, lower pair slightly dilated. Mentum rather large, doubtfully trimerous. Anal tubercles very small and inconspicuous, each bearing a seta. Anal ring with six hairs. Epidermis bearing a great number of small circular spinnerets and some slender spiny hairs.

Larva dull dark-red or purple, covered with scattered white meal; elliptical; active: length about $\frac{1}{50}$in. Antennæ of six joints, of which the sixth is much the longest and fusiform. Feet normal, rather thick. Anal tubercles small, setiferous. On the dorsum a number of very fine spiny hairs.

Adult male reddish-brown: length about $\frac{1}{20}$in. Thorax and abdomen rather thick. Spike short, conical. Antennæ of ten joints, all rather short and subequal, except the last, which is twice as long as any of the rest. Wings rather thick and mealy. Dorsal eyes, two; ventral eyes, two: ocelli, two.

Male pupa purple, enclosed in loose white cottony secretion.

Hab. In Australia, on *Albizzia lophantha:* specimens from Mr. French, who informs me that the insect threatens to do much damage to the trees—and, indeed, the twigs sent to me were thickly covered with insects in all stages.

This is rather a striking-looking species, the contrast between the white cotton and the very dark-coloured insect being very noticeable. It is clearly distinct.

Dactylopius hibbertiæ, sp. nov. Plate VI., figs. 11–14.

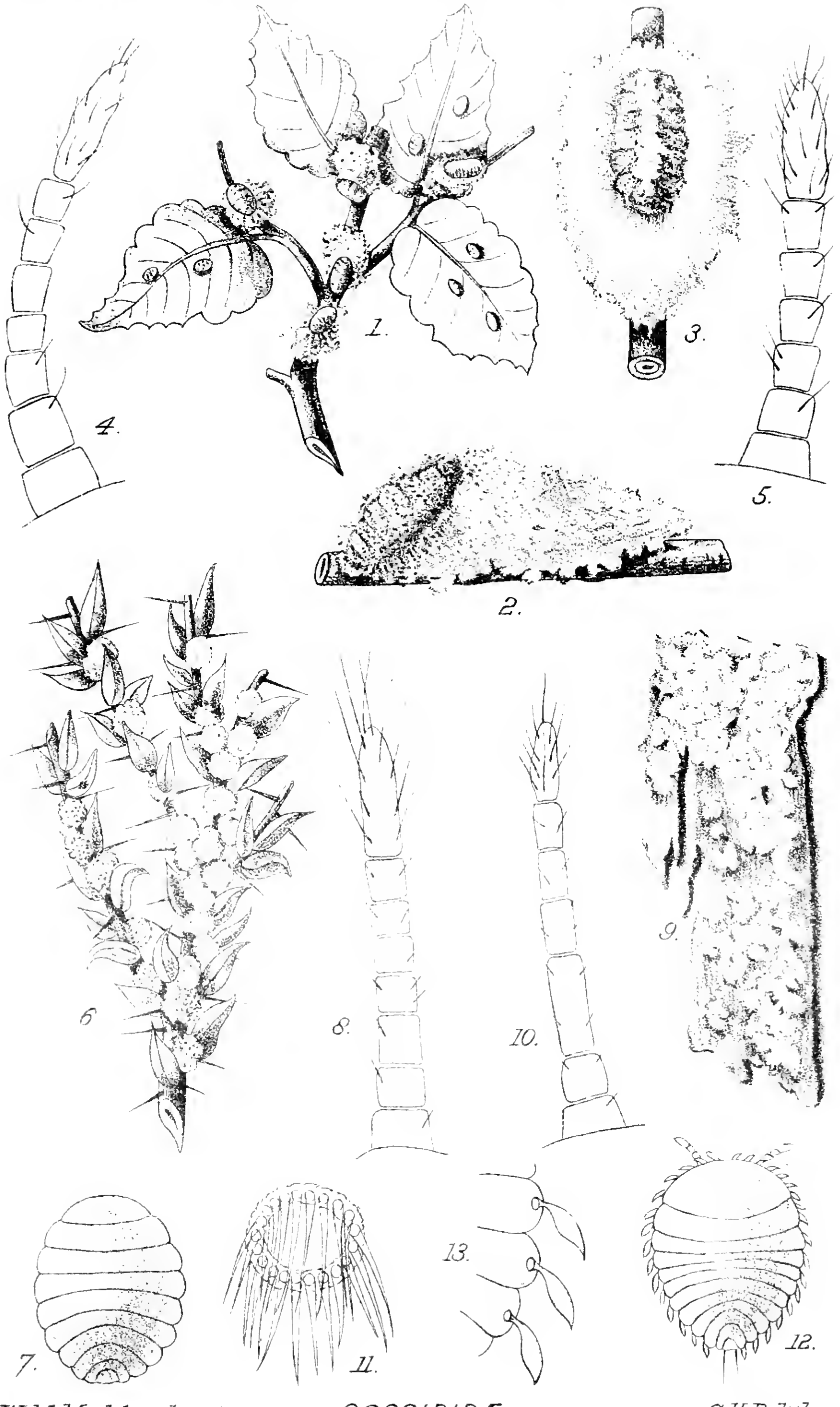
Adult female dark-purple, resting on a cushion of yellow cotton, and frequently covered with a quantity of similar cotton, which, however, does not seem to be joined at the edges to the lower cushion. The margins of the cushion are often turned upwards, and exhibit transverse grooves and foldings. Female subglobular, segmented: length about $\frac{1}{10}$in. Antennæ of eight (rarely seven) joints, subequal except the last, which is somewhat longer than the rest, and cylindrical, bearing some short hairs. Feet rather short and thick; digitules fine hairs. Anal tubercles very small and inconspicuous, each bearing a seta and several spines. Anal ring with six hairs. Mentum dimerous. Margin having some small spines, not set closely together. Epidermis bearing great numbers of small circular spinneret-orifices, interspersed with minute spiny hairs.

Larva brown; elliptical, active: length about $\frac{1}{65}$in. Antennæ of six joints, the last the longest. Feet short and thick. Anal tubercles very small, setiferous. A few small spines on the dorsum and margin.

Adult male unknown.

Hab. In Australia, on *Hibbertia linearis* and *Hibbertia virgata:* specimens were sent to me early in 1890 by the late Mr. Crawford.

This insect differs from *D. albizziæ* in the character of the cottony cushion and upper covering, and also in the form of the feet and antennæ of the adult female, and other minute characters. It would seem that the upper cottony mass falls off at gestation, leaving the insect shrivelling up in the cup formed by the lower cushion.



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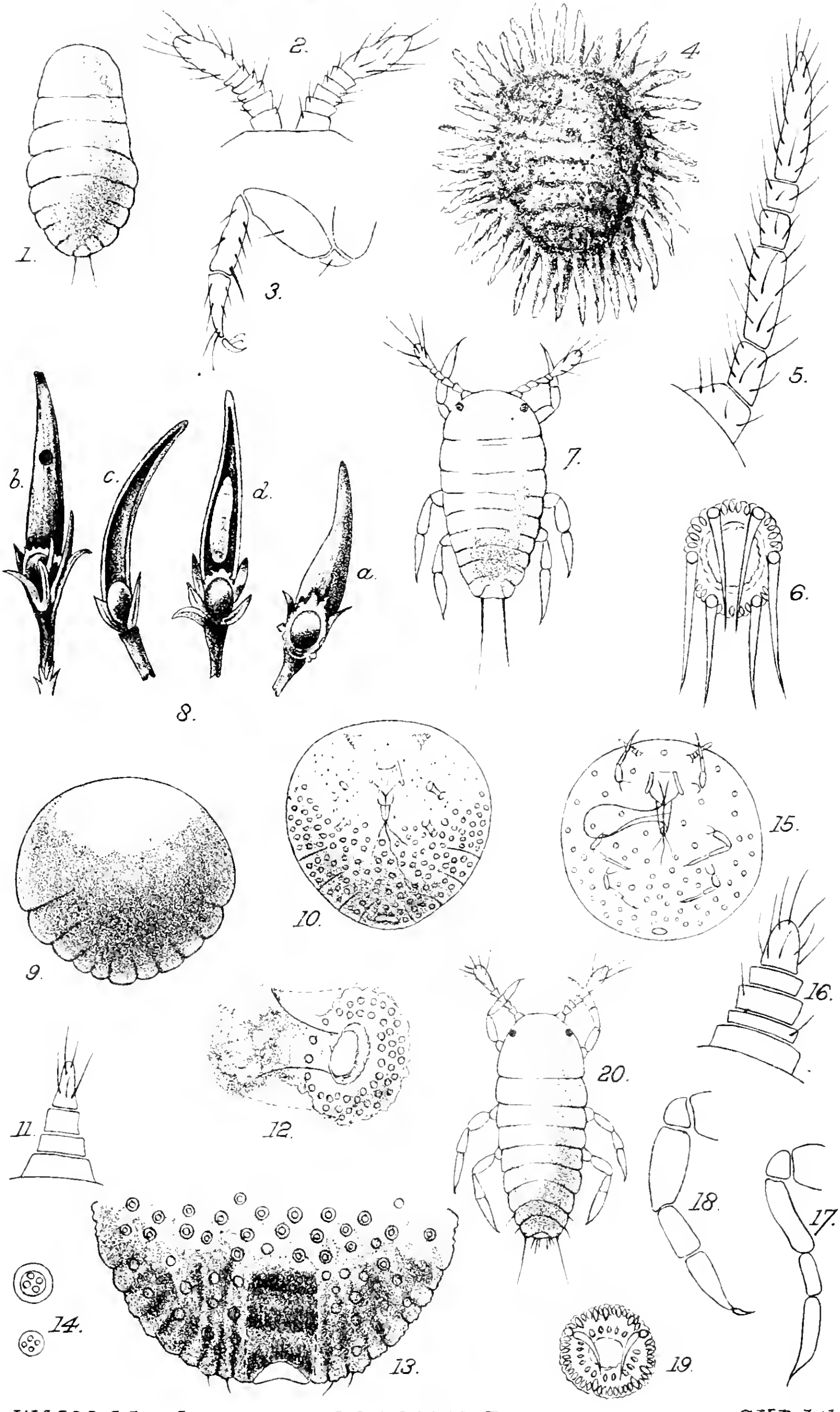

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Dactylopius acaciæ, sp. nov. Plate VI., figs. 15, 16.

Adult female very dark-purple or dull intense black; aggregated frequently in masses on the plant, with small quantities of white cotton: insect subglobular, segmented: length about $\frac{1}{25}$in. Antennæ rather long, with seven joints, subequal except the last, which is large and fusiform, and bears several hairs. Feet rather long and strong: the digitules are all fine hairs. Anal tubercles very short and inconspicuous, with, on each side rather higher up, two smaller lobules: all the six bear a number of short, rather strong spines, and on each of the median tubercles is a longish seta. Epidermis covered with great numbers of circular spinneret-orifices, which are most numerous near the margins; interspersed with spines and some longish fine hairs. Anogenital ring with six hairs. Mentum trimerous.

Larva and male not observed.

Hab. In Australia, on *Acacia linearis* and *Acacia lophantha*: several specimens from Mr. French.

The differences between this species and the two last depend not so much upon its size and the character of the cottony envelope as upon the minute features just described. It might, indeed, at first sight be taken almost for a small form of *D. albizziæ*; but the six abdominal lobules and the antennæ and feet separate it from that species.

Dactylopius iceryoides, sp. nov. Plate VII., figs. 1–5.

Adult female light-brown, with transverse darker streaks, and powdered over with yellow or buff-coloured meal; resting on a thick cushion of yellow cotton, in which it is partly imbedded, and frequently only attached to the plant by the cephalic extremity, the remainder being raised up by the mass of cotton beneath. Form elongate-elliptical, distinctly segmented, very convex; the dorsum frequently elevated in a distinct longitudinal ridge. Length variable: some specimens observed reach nearly $\frac{1}{5}$in., the accompanying mass of cotton being as large as a pea. Antennæ of eight joints, the first two larger and rather longer than the next five, which are subequal; the last fusiform, as long as the first two together, and bearing some hairs at the tip. Feet rather strong, normal. Mentum dimerous. Anal tubercles very small, inconspicuous, setiferous, borne upon small wide lobes, which bear a few spines. Anogenital ring with six hairs. Epidermis bearing numbers of very small circular spinnerets, which are most numerous near the margins, interspersed with fine spiny hairs.

Female of second stage dark-red, with a quantity of white or yellowish cotton round the edge, and also some on the dorsum; form elliptical, slightly convex; very active: length about $\frac{1}{16}$in. Antennæ rather thick, with seven joints, all subequal except the last, which is large and fusiform. Feet thick and strong: tibia and tarsus equal in length. Anal tubercles very small and inconspicuous, setiferous, with a few spines. Epidermis bearing spinnerets and spiny hairs, as in the adult.

Larva and male not observed.

Hab. In New Zealand, on *Fagus fusca*, Reefton district: specimens from Mr. Raithby.

This is a very peculiar species, and in its habit of growth and position departs a good deal from the normal type of *Dactylopius*. In its way of standing on its head and filling the space between its body and the twig with cotton it imitates *Icerya*, and I have therefore given it the specific name above. It might very easily be mistaken, on superficial observation, for *Gossyparia cavellii*, which also lives on *Fagus* and constructs large cushions of yellowish cotton; and the similarity is enhanced by the position of the insect—half embedded in the cotton, with the dorsal region exposed. But, apart from the much greater size of *D. iceryoides*, examination of its organs shows at once that it is not an Acanthococcid. The insect is one of the largest *Dactylopidæ* known to me, and it certainly presents a very striking appearance as viewed in its natural position on a twig.

Dactylopius cocotis, Maskell. N.Z. Trans., vol. xxii., 1889, p. 149.

Amongst the quantity of *Aspidiotus destructor* mentioned above as sent to me by Mr. Cotes, of Calcutta, on leaves of cocoanut from the Laccadive Islands were a few insects which I consider to be only a variety of *D. cocotis*, originally described by me from Fiji. Their colour was yellowish instead of red, and in some cases the antennæ exhibited only seven joints. In other respects, especially in the tufted hairs of the epidermis, they agreed with the type, and neither of the two points just mentioned is sufficient to raise them to specific rank.

Dactylopius globosus, sp. nov. Crawford Coll. Plate VII., figs. 6–8.

Adult female enclosed in a mass of white, or sometimes greyish, rather loose cotton, which, when separate, takes a more or less globular form, but may be aggregated in large masses covering the twigs. Insect subglobular, flat beneath and convex above; colour red, or purple, or brown; distinctly segmented: length sometimes reaching $\frac{1}{8}$in. Antennæ of properly eight joints, but sometimes of seven; the fourth, fifth, sixth, and seventh the shortest, the last the longest and cylindro-fusiform. Mentum rather large, pointed, trimerous. Feet usually normal, sometimes rather short. Anogenital ring with six hairs. Epidermis bearing large numbers of simple circular spinnerets and fine hairs.

Larva not observed.

Male pupa brown, enclosed in a sac of white cotton smaller and more elongated than that of the female. Adult male unknown.

Hab. In Australia, on *Acacia armata* and *Acacia decurrens.*

Another of Mr. Crawford's species, to which he originally attached the name of *Erium globosum.* My specimens on *Acacia decurrens* were sent by Mr. French.

Dactylopius eucalypti, sp. nov. Crawford Coll. Plate VII., figs. 9–13.

Adult females congregated in masses of white cotton between the sheets of bark of the plant; form subglobular, segmented; colour red or yellowish-brown: length about $\frac{1}{11}$in. Antennæ of seven joints, of which the third is the longest, and the seventh is scarcely longer than the sixth. Feet with a rather short tarsus, not more than a third of the length of the tibia, and rather thick; all the digitules are long fine hairs; on the trochanter are two rather strong hairs. Anal tubercles scarcely visible; anogenital ring compound, with many hairs (in some specimens apparently twenty). Mentum doubtfully dimerous. Epidermis bearing many small circular spinnerets, and on the cephalic region a number of rather long spiny hairs.

Larva yellowish-brown, congregated sometimes in very great numbers on the bark, mingled with thin white cotton or meal; form subcircular, slightly elongated and tapering somewhat posteriorly; distinctly segmented, flattish, active: length about $\frac{1}{30}$in. Antennæ of five subequal joints, the third a little the longest; on the last joint there is an excessively long hair. Feet rather thick: the tibia is shorter than the tarsus. All round the margin is a row of conspicuous feather-like pointed processes, forming a fringe. Anal tubercles small, setiferous.

Male pupæ congregated in sacs of white loose cotton, mixed with those of the females and larvæ, or sometimes in masses by themselves.

Adult male reddish-brown; abdomen rather slender: length of body about $\frac{1}{20}$in. Wings hyaline, slightly iridescent. Antennæ of ten joints. Feet long and slender, with a very short tarsus. Abdominal spike short, conical. Dorsal eyes, two; ventral eyes, two: ocelli, two.

Hab. In Australia, on bark of *Eucalyptus amygdalina.*

This is one of the late Mr. Crawford's species. It appears to be clearly distinct, and in some of its characters abnormal.

The seven-jointed female antenna is found also in some other species of *Dactylopius;* but the mentum, which may possibly be monomerous, and the anogenital ring, with its large number of hairs, depart altogether from the generic type. At the same time, I do not consider that, for the present, it is necessary to remove the insect from *Dactylopius* and establish a new genus on these characters. The male seems to present no specially distinguishing features; and the larva, although specifically distinct enough, with its feathery fringe and minute anal tubercles, may yet be considered as generically normal. It has been already remarked that the shortness of the last antennal joint is exceptional. On the whole, I leave the species for the present as a *Dactylopius.*

Dactylopius herbicola, Maskell. *Agricultural Gazette of New South Wales*, June, 1891, p. 352.

I mention this insect here only for a reference to the publication in which its description has appeared, and which may perhaps not be so well known as its excellence and usefulness deserve. The insect is Australian, on grass.

This species may also usefully be compared with the next, which also infests grass.

Dactylopius graminis, sp. nov. Plate X., figs. 9–12.

Adult female enclosed in a sac of white felted secretion, aggregated in masses thickly covering stems of grass: the sacs are of irregularly elliptical form. Insect dark-purple, or almost black, globular, segmented: diameter about $\frac{1}{20}$in. Antennæ of eight joints, the first seven subequal (the sixth perhaps shorter than the rest), the last as long as any two of the others, fusiform, and bearing a few hairs. Mentum trimerous. Feet slender; digitules all fine hairs. Anal tubercles very small and inconspicuous, each with a seta and two or three spines. Anogenital ring with six hairs. Epidermis bearing a number of simple circular and small tubular spinnerets.

Larva and male not observed.

Hab. On grass, Natal, South Africa. My friend Mr. J. W. Douglas, of London, has sent me several specimens, and has allowed me to add the species to this paper.

This insect is not far removed from *D. poæ* and from *D. herbicola*, the former of which infests grass in New Zealand, the latter in New South Wales. It differs from *D. poæ* in its colour, in its aërial habitat (the New Zealand species being subterranean), and in the more solid nature of its sac. The difference from *D. herbicola* is not so clear at first sight, although in the Australian species the dorsal portion of the sac is apparently never quite complete; but the feet differ considerably, and are sufficient to distinguish the two species.

Genus Ripersia, Signoret.

This genus was formed to include the *Dactylopidæ* with antennæ of six joints. I have been frequently asked the meaning of the word; and the only explanation I can give is that it is an anagram of the name of M. Ed. Perris, a friend of Dr. Signoret, to whom he had already dedicated two species—*Westwoodia perrisii* and *Porphyrophora perrisii*—and whose name he preferred on this occasion to twist round as above. I do not know any other derivation.

Ripersia rumicis, sp. nov. Plate VIII., figs. 1–3.

Adult female dull dirty-yellow, or yellowish-white, subterranean, naked or excreting only a very thin white meal; form irregularly elliptical, obscurely segmented: average length about $\frac{1}{24}$in. Antennæ very short, placed very close together at the cephalic extremity; with six joints, of which the first two are equal and moderately large, the next three very short, the sixth the longest and fusiform. Mentum probably trimerous. Feet very short: tibia only slightly longer than the tarsus; the tibia has a spine at the extremity. The feet are somewhat far apart, the anterior pair being placed near the base of the antennæ, the second pair median, the posterior pair at about two-thirds the whole length. Anal tubercles very small, setiferous; anogenital ring with six hairs.

Second stage of female rather smaller than the adult, of similar colour and form, and with antennæ of six joints.

Larva and male not observed.

Hab. In New Zealand, underground, amongst roots of *Rumex acetosella* (garden sorrel): my specimens are from the Reefton district, sent by Mr. Raithby.

This is a very peculiar little insect, which, from its very small size and dull colour, is by no means easy of detection. Mr. Raithby informed me that it was only from the little patches of white meal noticed in the earth while digging that he was led to discover the Coccid; and in dry earth, after having been kept for some time, it is only by some patient search under a lens that the insects can be picked out. I was at first somewhat disposed to look upon this form with six-jointed antennæ as *possibly* the second stage of *Dactylopius poæ*, another subterranean New Zealand Coccid; but the position of the antennæ and feet seemed to forbid this, and the finding of some specimens with enclosed eggs settled the matter entirely. The species is clearly a distinct one, and I know of no other Coccid in which the antennæ are placed so close to each other. It is by no means easy to mount a specimen of this insect for minute examination and preservation on a slide, on account of the excessive softness and thinness of the skin.

From a later letter from Mr. Raithby I gather that this insect is very plentiful in its locality—so much so that on turning over a sod the earth looks as if "stricken with mildew."

Ripersia formicicola, sp. nov. Plate VIII., figs. 4–7.

Adult female flattish, sometimes circular, sometimes slightly elongated; colour yellow, or brown, or red; diameter averaging about $\frac{1}{25}$in. without the processes; segmented; powdered dorsally and ventrally with white meal, and having a number of white cottony tassels all round the margin, forming a kind of fringe which is sometimes more or less equal all round, sometimes longer at the posterior region; the tassels are frequently as long as half the diameter of the insect. Antennæ of six joints, of which the third and sixth are much the longest and subequal, the fourth and fifth the shortest, the sixth is fusiform, and all the joints have hairs. Feet rather long and slender: tarsus a little more than half as long as the tibia; digitules fine hairs. Mentum conical, long, trimerous. Anogenital ring compound, with six hairs; anal tubercles very small, setiferous.

Larva yellowish-pink, covered slightly with white meal; flattish, elongated, active: length about $\frac{1}{50}$in. Antennæ of six joints, of which the last is much the longest. Feet moderate: tibia shorter than the tarsus. Mentum long, conical, trimerous. Anal tubercles small, setiferous, and each bearing two conical spines.

Male unknown.

Hab. In New Zealand, underground, in ants' nests: my specimens are from the Ashburton district, sent to me by Mr. W. W. Smith.

This is a clearly distinct species, its generic position being fixed by the antennæ. In Mr. Smith's letters accompanying the specimens he informs me that the insects are free, and travel about in the galleries of the ants' nests (sp. *Tetramorum striatum* and *T. nitidum*, Smith), and that when the nests are suddenly disturbed the ants may frequently be seen carrying off the *Ripersiæ* with their own eggs for safety to the innermost galleries, but that they seem never to eat or otherwise harm the Coccids. Mingled with all are often specimens of *Dactylopius poæ*, but these are evidently attached to the roots of grass penetrating the nests, and have no connection with either ants or *Ripersiæ*. It would be interesting to know whether in other countries Coccids are found under similar conditions, and, if so, how the ants and they mutually behave to each other. There appears to be a general consensus of opinion that Aphides are made use of by ants for their honey-dew—or, as frequently stated, employed as "milch-cows:" but this is the first instance that I know of where ants and Coccids dwell together; and the quantity of honey-dew excreted by the *Ripersia* cannot be very great. It is to be regretted that naturalists so frequently neglect to enter into any detail about their observations. I think I can recall a number of casual remarks and incidental allusions tending to indicate that Coccids of various species furnish food, through their honey-dew, to ants; but no previous definite statement by any author is known to me.* The point, nevertheless, is not without interest.

SPECIES OF UNCERTAIN POSITION.

On various species of *Casuarina* in Australia there occur some Coccids which I cannot at present assign to any known genus, or even to any definite group. Having examined numerous specimens of adults and larvæ, I confess myself fairly puzzled. No specimen of a male or of a male pupa has come under my notice; males might perhaps clear up the difficulty. It will be seen presently that in treating of the Brachyscelid group I draw attention to the presence therein of an excessively prolonged abdominal region: in the insects about to be described this feature does not appear, and they may therefore not be Brachyscelid. The simple, hairless anogenital orifice points to the *Monophlebidæ*: but I am not prepared as yet to place them there. The larvæ may be either Dactylopid or Monophlebid: the adults do not agree with any known Dactylopid form. On the whole, probably, the balance will be in favour of their Monophlebid relationship; but then the group will have to be somewhat extended to receive them.

SPHÆROCOCCUS. Gen. Nov.

I am not yet prepared to attach definite characters to this genus.

Sphærococcus casuarinæ, sp. nov. Plate VIII., figs. 8–20.

Adult female globular, naked; the cephalic portion greyish, the abdominal region dark-brown; there is usually a small quantity of white cotton under the body; diameter about

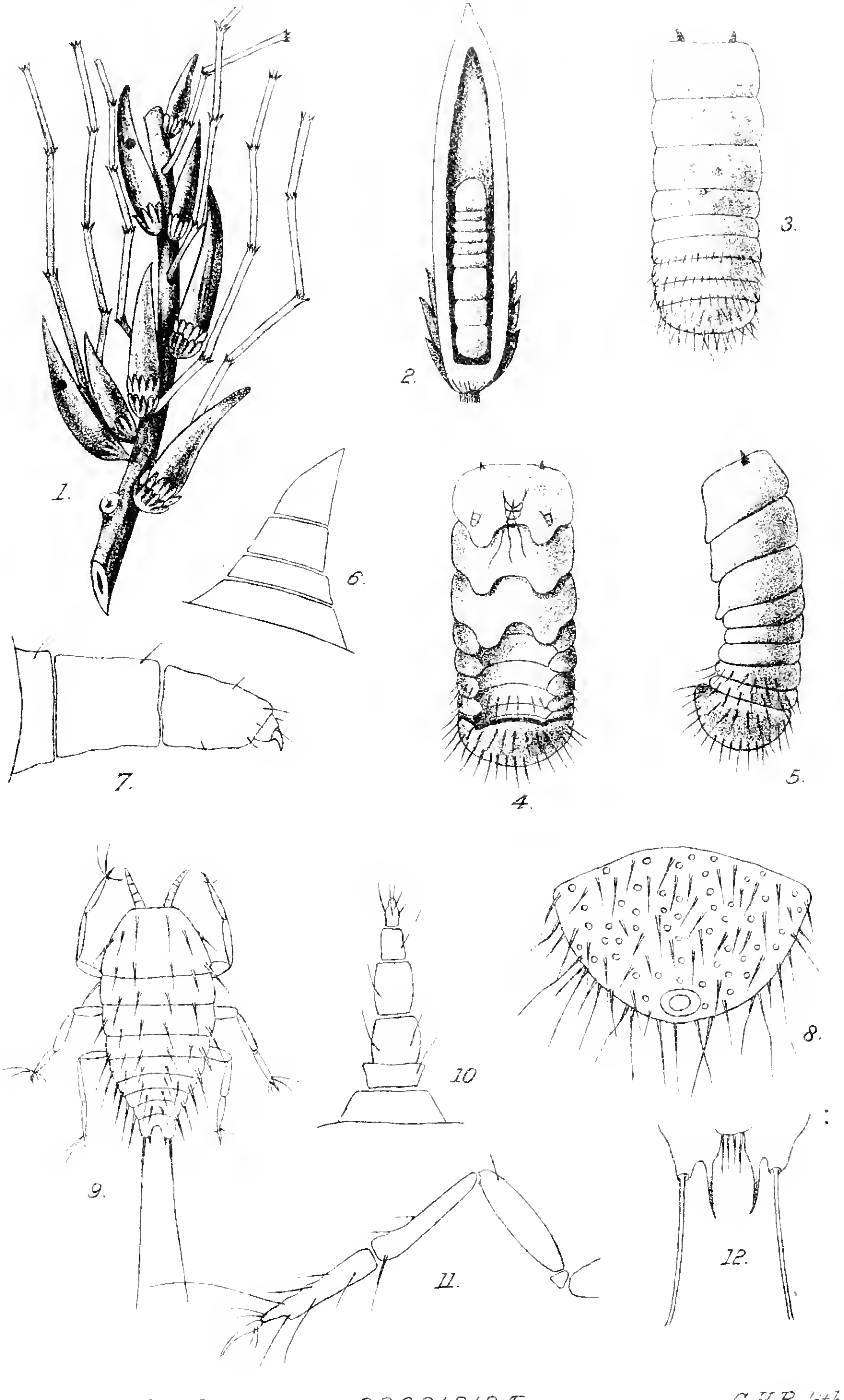
* Whilst this paper is in the press, I find that Mr. J. W. Douglas, in the *Entomological Monthly Magazine* for September, 1891, describes an *Orthezia* found in ants' nests in Colorado; but it is not quite clear whether this *Orthezia* inhabits ordinarily the nests or was taken there accidentally.

$\frac{1}{16}$in., but shrivelling at gestation; the anterior region is smooth, the abdomen indistinctly segmented and roughly wrinkled. Antennæ very small, almost atrophied, sharply conical, the joints indistinct, but apparently four or five in number; on the last joint are a few hairs. Feet entirely absent. Rostrum rather large; mentum conical and dimerous. There are four large spiracles on the anterior region, each bearing at the orifice a ring of small circular glands, and near the posterior pair are two patches containing large numbers of similar but much smaller glands. Anogenital orifice simple and hairless, with a tubular organ leading to it, which appears to bear at its interior end a number of circular glands. Epidermis covered with great numbers of circular multilocular spinnerets, which are small and scattered on the light-coloured anterior region, but larger and much more numerous on the dark abdominal portion; they are interspersed with very minute, short, slender, spiny hairs.

Female of the second stage red in colour, globular, very indistinctly segmented; the abdominal region is rather darker in colour than the rest: diameter about $\frac{1}{30}$in. Antennæ short, conical, of five joints, subequal in length, but varying in thickness. The feet are somewhat peculiar, having usually a soft, slender, weakly appearance, with a very slender femur (as in fig. 17) and an almost setose claw; but the anterior pair are sometimes more normal (as in fig. 18); there seem to be no digitules. Anogenital ring compound, with apparently only two short hairs. Spinnerets as in the adult, but less numerous.

Larva yellow, elongated, active; length about $\frac{1}{50}$in.; elliptical, segmented. Abdomen rounded, with two very small median anal tubercles, each bearing three short hairs, and above them two others equally small, each bearing a long seta. Antennæ of six joints, the first five short and subequal, the sixth fusiform, as long as any three of the others, and bearing some longish hairs. Feet rather thick; digitules fine hairs. Rostrum large; mentum long, conical, and dimerous.

Hab. In Australia, on *Casuarina quadrivalvis*: specimens from Mr. French. All the individuals observed occupied positions amongst the small scales clothing the bases of the long pointed galls formed by the next insect to be described, *Cylindrococcus*. This was the case with more than twenty specimens received, and I have failed to find any on other parts of the plant. This association at first led me to think that there might be some connection between the two, even if this external insect were not somehow an immature form of the other: the suspicion was strengthened by finding, as mentioned below, two specimens of the second stage *inside* the galls. But, later, I obtained a specimen in the act of gesta-



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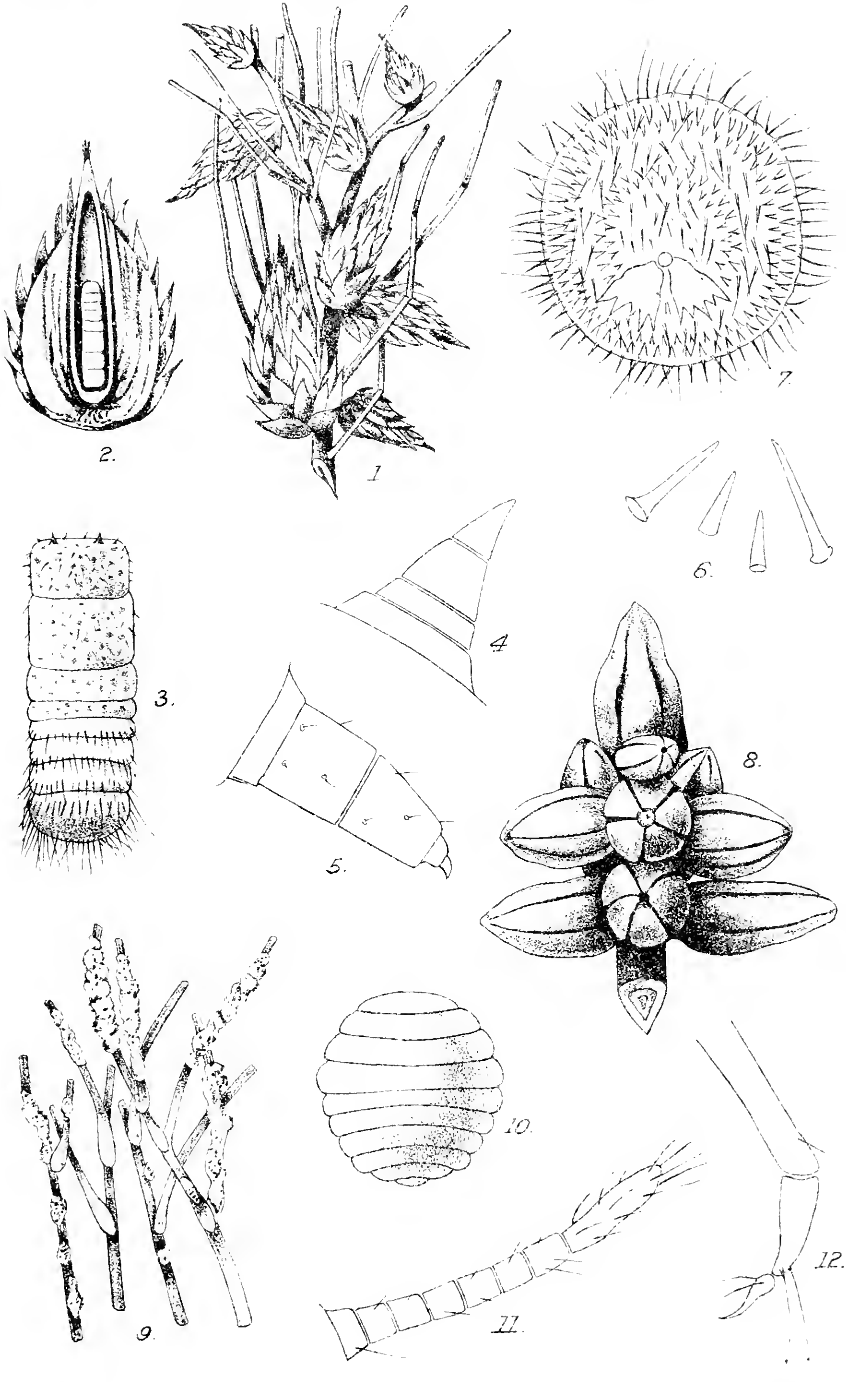

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tion, and the larva just described was one which emerged from the mother. There was consequently no further room for doubt that the two insects are separate and distinct.

CYLINDROCOCCUS. Nov. Gen.

Insects inhabiting galls which appear to be evidently aborted and misshapen forms of the twigs of the plant, as in each case the teeth or small scales seen at the ordinary joints have become a thickish mass clothing the base or the surface of the gall. In the two species about to be described only the anterior pair of feet are present, the others being represented by merely small dark patches on the epidermis. Anal segment circular, slightly convex, not prolonged in a "tail."

The galls formed by the two species differ. That of *C. casuarinæ* is long and slender, varying from nearly 1in. long and $\frac{1}{6}$in. wide at the base to not much more than $\frac{1}{4}$in. long and $\frac{1}{20}$in. wide at the base. The gall is smooth, except for the clothing of small scales round the base. That of *C. spiniferus* is externally much thicker in proportion to its length. Specimens observed vary from $\frac{3}{8}$in. long and $\frac{1}{4}$in. wide at the base to nearly 1in. long and more than $\frac{1}{2}$in. wide. The whole gall is very rough, being covered from base to tip with pointed scales, which are larger than the ordinary scales of the plant. In the interior, however, of this rough gall there appears to be always a central narrow elongated tube in which the insect is found, resembling thus the gall of *C. casuarinæ*.

I am not acquainted with any other genus of Coccids in which the anterior pair of feet only are preserved in the adult female. In the genera *Capulinia*, Signoret, and *Opisthoscelis*, Schrader, the posterior pair are alone visible. *Cylindrococcus* is therefore entirely distinct, if only on this account.

Cylindrococcus casuarinæ, sp. nov. Plate IX.

Insects inhabiting long narrow cylindro-conical galls, which appear to be evidently aborted and misshapen forms of the twigs of the plant, as in each case the small scales seen at the ordinary joints have become a thickish mass clothing the base of the long narrow gall. These galls vary in length and thickness: some are nearly 1in. long and $\frac{1}{8}$in. wide near the base; others not more than $\frac{1}{4}$in., and proportionately slender; but I have found adults, or remains of adults, in both large and small. The extremity of the gall is somewhat sharply pointed; the consistence varies, some being rather solid and hard, others appearing more like several strips pasted together more or less lightly. The interior is always a cylindrical tube; the exterior is smooth above the basal scales.

The adult female occupies the lower end of the tube, her cephalic extremity resting on the base, and the rostrum applied to the termination of the unharmed portion of the twig. Form elongated, cylindrical, with parallel sides; the cephalic end more or less truncate, the abdominal extremity rounded. Length variable: specimens observed from about $\frac{1}{9}$in. to about $\frac{1}{5}$in. Colour red, with frequently many darker spots on the cephalic and thoracic regions, and often powdered with white meal, which on the cephalic region frequently appears rather solid. Viewed dorsally, the body exhibits several segments, of which the three anterior ones are the largest; viewed ventrally, each of the three anterior segments is seen to possess two rounded lobes or processes developed posteriorly, and slightly overlapping the next segment. The median segments are short and concave, and the rounded anal segment is frequently turned upwards (as shown in fig. 5, side view). In the hollow thus formed crowds of larvæ may be frequently seen congregated and crawling about. On all the abdominal segments, especially on the last two, are many longish hairs; the cephalic and thoracic segments are almost, if not quite, hairless. The last abdominal segment forms a circular, slightly convex plate, with the anal orifice (which is simple and hairless) in the centre. On this segment there are no spines, but only the longish fine hairs just mentioned. The antennæ are placed quite at the cephalic extremity: they are very short, conical, with very broad base, and terminating in a sharp point. I can only make out four joints, of which the second is the shortest, and there seem to be no hairs. The anterior pair of feet are very thick and stumpy, and appear to have at first sight only four joints; but on close examination there is seen to be a short thick coxa, with a thick cylindrical femur, and a tibia also thick and slightly tapering. The tarsus is very small and short, and the distinction between it and the small claw is not easily made out. The figure 7 of Plate IX. exhibits the features of this foot. The posterior pairs of feet are only represented by maculæ, which, however, seem to be usually very slightly convex. Rostrum rather large; mentum dimerous. I have not been able to detect any eyes. On the epidermis are several small and simple spinneret-orifices.

The foregoing description applies to the normal, uninjured, adult female. But the great majority of the specimens which I have observed have been attacked by parasites, and probably the student may more often find parasitised females than any others. Insects in this condition may be recognised, first, by being usually of a light-yellow colour, and next by having an almost regularly cylindrical form, in which there is scarcely any trace of segments: in fact, the appearance is bloated and unnatural. The lighter colour is due to the semi-transparency of the skin, and the absence of the ordinary red internal organs; the smooth unsegmented appearance is similar to that exhibited frequently by Aphides attacked by parasites. Indeed, the insect under these conditions is nothing but a bag containing parasitic larvæ. I have found several, not actually dead, containing as many as fifteen large, fat, white grubs closely packed. These are probably hymenopterous, for in a few instances I have seen Hymenoptera inside the Coccids, just on the point of emergence. When mature, the parasite escapes from the gall through a small round hole in the usual way.

Female of the second stage not observed. But in two instances I have found, flattened between the adult female and the base of the gall, exuviæ which at first I took to be those of this stage, though afterwards I recognised them as the second stage of *Sphærococcus*, just described. Their presence inside the galls can only, I suppose, be accidental—they must have entered through some chink and been unable to get out again; but the situation in which they were found only tended to make the diagnosis of the gall-making species more difficult.

Larva dark-red, elongated, elliptical, tapering slightly posteriorly; very active: length about $\frac{1}{50}$in. Antennæ placed close together at the cephalic extremity, which is rather truncate: they are short, tapering, with six joints, of which the first is very thick, the last two small; on the last are several hairs. Feet rather long and slender: tibiæ about equal to the tarsi; claw slender; digitules all long hairs: the tarsus is somewhat sharply narrowed near its tip, and at this spot there are two long hairs. Mentum short, thick, dimerous. There are six dorsal longitudinal rows of spines, which are very long and slender, especially those on the margin of the abdominal segments. Anal tubercles moderate, each bearing a strong spine and a long seta.

Male not observed.

Hab. In Australia, on *Casuarina quadrivalvis:* Mr. French has sent me several specimens.

Cylindrococcus spiniferus, sp. nov. Plate X., figs. 1–7.

Insects inhabiting galls which they form on the twigs of the plant: these galls are sometimes seen in bunches of half a dozen together, sometimes singly. The external form is somewhat like that of a filbert, wide at the base and narrowing rapidly to a point: length varying from $\frac{3}{8}$in. to 1in., the basal width being from $\frac{1}{4}$in. to $\frac{1}{2}$in. The surface is very rough, being covered with large pointed scales, and these are so disproportionate to the size of the ordinary small scales, or teeth, at the joints of the twig that it is not easy to make out how they are collected. There are, indeed, some scattered scales on the bark which more nearly resemble those on the gall; but even these are usually smaller, and always much less closely aggregated. On cutting open a gall longitudinally the interior is found to be more or less solid, with, in the centre, a slender elongated tube, resembling the gall of *C. casuarinæ*, and within this tube will be found the female insect.

Adult female resembling in general appearance *C. casuarinæ*, but generally rather brownish than red in colour, and the spots are darker. The larvæ congregate in the concavity of the ventral region, as in the last species. Antennæ very short, broad at the base and sharply pointed. I have not been able to satisfy myself as to the number of joints, but these are probably four, the second being the shortest. Only the anterior pair of feet are present, and these resemble generally those of *C. casuarinæ*, but may perhaps be more slender. The characteristic features of *C. spiniferus* are found in the spines which it bears. These, on the cephalic and thoracic regions, are scattered in fairly large numbers, some being long and slender, others shorter and thicker. On the anal segment, which is circular, slightly convex, and bearing numerous long fine hairs, the spines are short, rather thick, and arranged in several concentric rows. Moreover, in the middle of the circular disc formed by this segment, close to the anal orifice, there are two adjacent, flattish, broad, protruding lobes or plates, irregularly quadrangular, with deeply-serrated terminal margins, and bearing on the serrations usually five strong thick spines.

Second female stage not observed.

Larva dark-red, elongated, elliptical, tapering slightly posteriorly; very active: length about $\frac{1}{60}$in. Antennæ as in *C. casuarinæ*, of six joints, of which the last two are very small. The feet, marginal and dorsal spines are as in *C. casuarinæ*, but I think the tibiæ and tarsi are rather thicker.

Male not observed.

Hab. In Australia, on *Casuarina quadrivalvis*: Mr. Tepper and Mr. French have sent me several specimens.

The external form of the gall and the numerous spines on the adult female sufficiently distinguish this very interesting insect: the larva is also rather smaller than in the other species. I know of no Coccid in any group or genus which presents similar lobes and spines on the anal segment.

Cylindrococcus, sp. (?) Plate X., fig. 8.

I possess a photograph by the late Mr. Crawford of a curious group of galls on *Casuarina*, of which I have endeavoured to give an accurate representation. Mr. Crawford evidently considered this as the same as *C. spiniferus* just described, for on the same photograph is a twig with galls of that species. Yet I perceive a difference in this respect: that the galls shown in my figure are smooth, and apparently built up of several longitudinal segments meeting at the tip. Mr. Tepper, of Adelaide, sent me some time ago two galls which resembled these. On cutting them open I found them filled with numbers of small cavities in which were larvæ and pupæ of some dipterous insect, and I conjectured this to be some species of *Cecidomyia*. On that occasion I could not detect any Coccid in the interior, and so informed Mr. Tepper; but in a subsequent letter he told me that the boys about Adelaide used to be rather fond of eating these galls, on account of their sweet taste, until somebody drew their attention to "the red insect inside." Supposing, then, that this "red insect" will turn out to be a Coccid after all, I think I may venture to predict that it will be a third species of *Cylindrococcus;* and perhaps by next year I may be able to identify it. Meanwhile the figure which I give will serve very well to show the differences in external form of the galls of this curious genus.

I suppose that there may have been twenty or thirty dipterous larvæ in the cavities of the substance of each gall which I cut open. No similar case has hitherto come under my notice. Parasites attacking the insects themselves are of course common enough amongst Coccids; but in this instance the Diptera were living in the gall, and not in the female Coccid.

Subdivision MONOPHLEBIDÆ.

Genus Cœlostoma, Maskell.

Cœlostoma compressum, sp. nov. Plate XI., figs. 1–8.

Adult female red, elongated, convex, segmented, active; excreting at gestation a quantity of white or pinkish cotton, covering the dorsum, and forming an ovisac behind it; this cotton frequently takes the form of curly laminations: length of insect about $\frac{1}{5}$in. as a rule, but specimens reach $\frac{1}{3}$in. Antennæ of ten joints, slightly tapering as far as the eighth, the two last increasing a little in thickness; the first nine joints are subequal, the second being a little the longest; the last joint is as wide at the base as the end of the ninth, so that the two almost look as if joined in one; all the joints bear several hairs. Feet rather strong and thick: tarsus more than half as long as the tibia; the tarsus is curved; both tibia and tarsus bear on the inner edges a row of spines: there are two digitules, one tarsal, the other on the claw; both are long fine hairs: the trochanter bears several setæ. Rostrum and mentum absent. Anogenital ring simple; anal tubercles very small, setiferous. The epidermis bears great numbers of circular compound spinnerets, intermixed with some longish fine hairs which are not very numerous.

Female of second stage red, darkening with age; elongated; segmented: average length $\frac{1}{4}$in., but some specimens observed exceeded $\frac{1}{3}$in.: occupying a groove in a mass of white, or greyish, or yellowish wax, which leaves the dorsal region usually exposed; this waxy mass would doubtless be more or less globular if it were not squeezed nearly flat by pressure between the laminæ of the tree-bark, the consequence of the pressure being that the wax spreads out round the insect, sometimes with a diameter of more than an inch. Antennæ atrophied, reduced to a single small joint bearing several short hairs. Feet entirely absent. Rostrum large; mentum conical, trimerous. The anal tube seems to be simple. Epidermis covered with great numbers of circular compound spinnerets, which are most numerous near the margins.

Larva red, elongated, somewhat slender, active: length about $\frac{1}{24}$in. Antennæ of seven joints, the first and last the longest, second and sixth shorter and equal, the rest still shorter and equal; the third, fourth, and fifth are also the narrowest, so that the antenna is rather irregular. Feet moderate: tarsus longer than the tibia; there are no tarsal digitules, the lower pair being fine hairs. Anal tubercles very small, setiferous. Mentum trimerous.

Male unknown.

The adult female of this species is sometimes "parthenogenetic," as will be noticed presently.

Hab. In New Zealand. The second stage of the female is found between the layers of bark on *Podocarpus totara*, in the Reefton district. My specimens are from Mr. Raithby.

I have included this insect in the genus *Cœlostoma*, on account of the absence of the rostrum and mentum in the adult stage, and other generally normal characters; but it departs from the type in the ten-jointed antenna of the adult, and the seven-jointed antenna of the larva. Both of these antennæ, also, are abnormal in not being conical or tapering from base to tip in the adult, and as far as the penultimate joint in the larva. These points serve readily to distinguish the species, apart from the crushed condition of the waxy mass in the second stage, which indeed may be only accidental.

I have stated that this insect is "parthenogenetic." Whether there is really any such thing as true parthenogenesis amongst insects is a question which I need not discuss. Mr. Buckton (Monogr. of British Aphides, vol. i., p. 61) remarks that there are "interesting forms in which we might almost believe, though the evidence be but negative, that no male occurs;" and he goes on to say that Leuckart and von Siebold "distinctly assert that such anomalies exist in nature." At the same time, other observers consider that there are among

Aphides species which are truly hermaphrodite. I believe, however, that, as far as any thorough investigations have yet been made, the so-called parthenogenesis is but the continuous action of an original sexual act between a true male and a female, acting through a certain number of generations, after which the race would be extinguished without a repetition of the sexual act.* This form of generation (which undoubtedly is itself sufficiently wonderful) appears to have been satisfactorily observed in Aphides and in certain species of *Diptera;* while, as regards Coccids, something analogous has already been announced in the case of *Lecanium hesperidum,* by M. Moniez (Comptes Rendus de l'Acad. des Sci., 1887), where the male is stated to remain in the body of its female parent, and, *itself in the larval stage, to impregnate the female larvæ* before they emerge. As far as the females are concerned, Sir R. Owen has accounted for the facts observed (Disc. on Parthenogenesis, 1849), by a theory of the retention of the power of reproduction in some of the "nucleated cells" of the first female of the series. Of course, the explanation would not touch the point of the generative power in the male of *L. hesperidum* existing only in its earliest and quite incomplete stage.

However, although, in the case of Aphides, the attention of entomologists has, ever since the days of Réaumur, been directed to this phenomenon of unisexual generation, very little has been known or written about it in connection with Coccids. Incidental remarks may be found in various entomological and other works to the effect that the *Homoptera* as an order are endowed with this special power; but it would seem that these are simply generalisations from the particular case of Aphides; and I am not aware of any writer on Coccids who has mentioned an actual instance for any species of that family. It will therefore be not uninteresting to note here a case under my own observation, and undoubtedly clear.

The first examples of *C. compressum* which I received (in 1890) from Mr. Raithby were females of the second stage on pieces of bark, each resting in its mass of excreted wax. Some of these I dissected or mounted; others I placed in my cabinet in the usual way—with a pin through the bark. My experience of insects in this stage is that in the great majority of cases they remain *in situ*, and in a few days die: adults I

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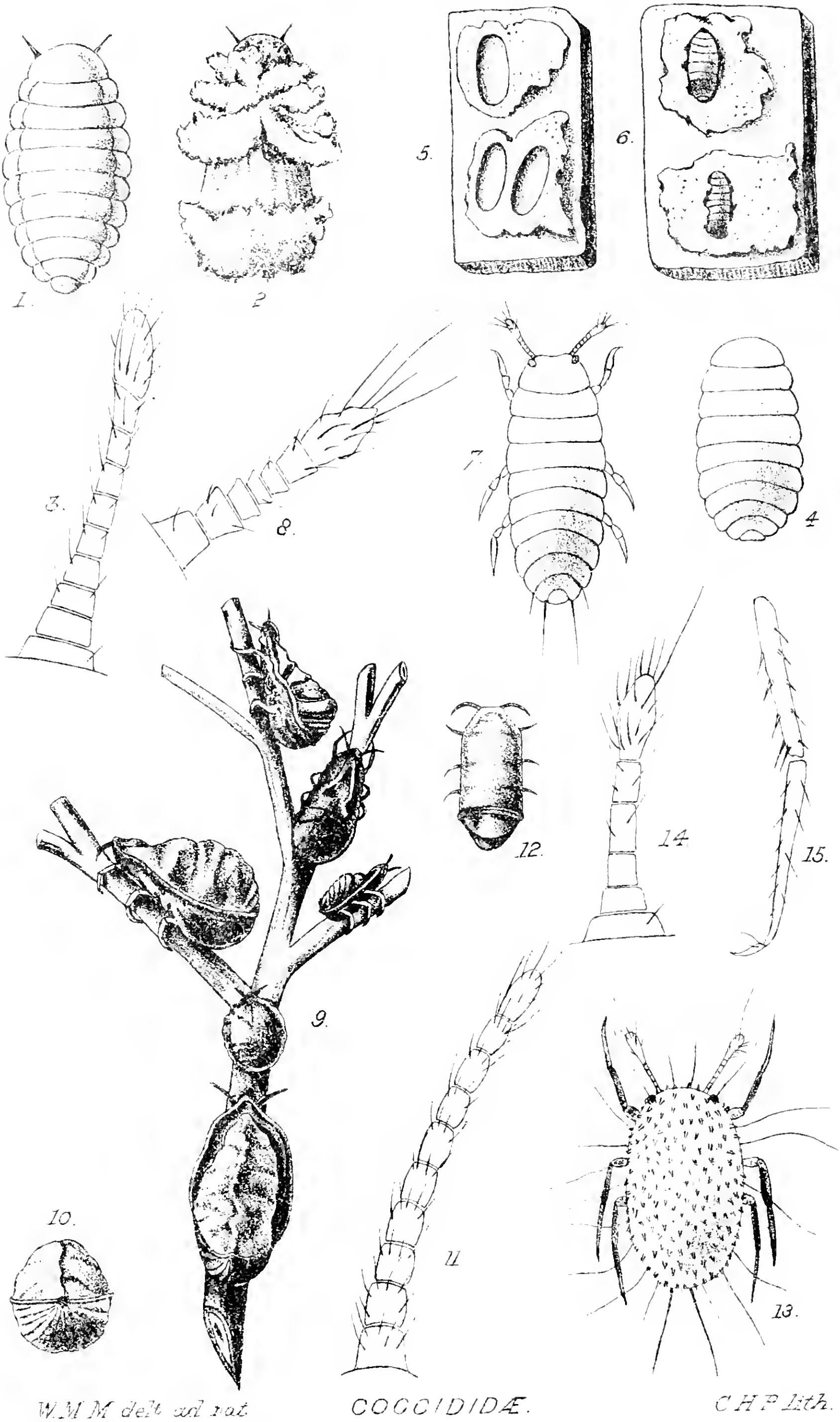
* In *Psyche* for September, 1891, p. 150, I find it stated that "to a description of a hermaphroditic spider Bertkau appends a catalogue of recent cases, and states that 361 hermaphroditic *Arthropoda* are now known, of which . . . . 349 insects." I do not know where the paper referred to is to be found; but in the list given in *Psyche* no mention is made of *Homoptera*.

find (as in the case of *M. crawfordi*, below) to live longer. Sometimes I have had adult females which emerged in confinement, but not often. This was the case in the present instance, for about a week afterwards I found an adult *C. compressum* crawling about the drawer, the exuviæ of the second stage being left in the wax. I transferred her to a glass-covered box, and forgot her until, some ten days later, I found that she had covered herself with cotton and was beginning to form an ovisac. In perhaps a month afterwards this ovisac was plainly being filled with red eggs, which I could detect through the cotton. This female could not possibly have had access to any male since her metamorphosis, being shut up in a cabinet-drawer. The power of oviposition under such circumstances being thus established, it remained to ascertain whether the eggs were fertile or sterile. I therefore left the insect undisturbed for some months, until in December I found three larvæ which had emerged from the eggs and were crawling about. There was thus no further room for doubt that the female of *C. compressum* can produce fertile eggs without the access of a male in her adult stage.

Earlier in the year I had received the specimen of *Monophlebus crawfordi* of which I shall say something presently, and this also in confinement produced many eggs from which emerged larvæ. But I am unable to say whether, before being captured in Australia, this insect might not possibly have been visited by a male. There is, however, this difference between the two cases: that every egg of *M. crawfordi* seems to have been fertile, the larvæ emerging in swarms, whereas only three or four larvæ of *C. compressum* came out; the rest of the eggs (perhaps many scores) still remain in the ovisac, and are apparently dead. This difference seems to point to at least more powerful action in the case of direct sexual impregnation. But, at all events, we have here a positive instance of propagation by a female which, if ever impregnated by a male, must have been impregnated at an early and incomplete stage of her existence.

I have already stated that I am not aware of any *definite* cases of a similar character adduced by previous writers on Coccids. It is necessary to guard this statement by the acknowledgment that I have not been able to procure von Siebold's essay on "Parthenogenesis in the *Arthropoda*" (Leipzig, 1871): at the same time, it is probable that this author would not enter into many details regarding *Coccidæ*.

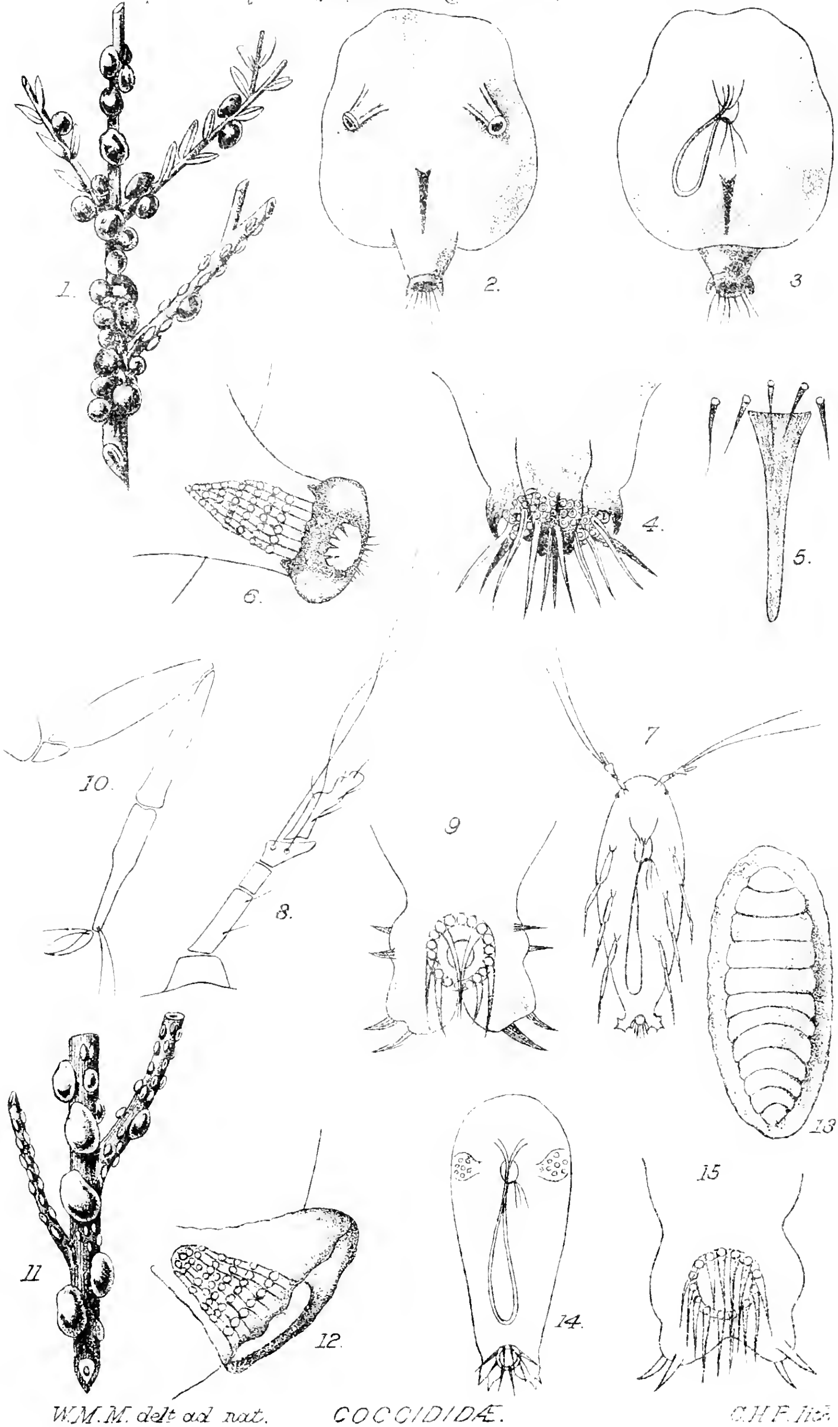
There is a capriciousness, so to speak, in the occurrence of male Coccids in different species which is worthy of further inquiry. Sometimes males are excessively numerous—*e.g.*, *Cœlostoma wairoense* in New Zealand, or *Ericerus Pé-La* in



W.M.M. delt ad nat.

COCCIDIDÆ.

C.H.P. lith.



W.M.M. delt ad nat. COCCIDIDÆ. C.H.F. lith.

China, where they are far out of proportion to the number of females. Sometimes there is a fair equality in the sexes, or a few more females than males: this may be taken as the normal condition. Sometimes the males are excessively rare, even undiscovered after many years' search—*e.g.*, *Lecanium hesperidum* or *Mytilaspis pomorum*. Sometimes the sexes are intermingled, sometimes separate: I have seen a branch of *Acacia* with one long twig covered thickly with females alone of *Lecanium baccatum*, and another long twig covered still more thickly with males alone; and a tree of *Pittosporum tenuifolium* has been for two or three years in succession white with males of *Fiorinia asteliæ*, only a few females appearing here and there.* The student of Coccids is constantly meeting with phenomena and problems such as have been discussed in these paragraphs, which tend to strengthen his conviction that few, if any, families of the great insect class of the animal kingdom equal them in complexity and interest.

Cœlostoma pilosum, Maskell. N.Z. Trans., vol. xxiii., p. 29.

Since last year I have obtained specimens of the male of this species. The insect is darkish-red or brown in colour, but covered with hairs and with a good deal of whitish meal on the body and legs: length of body about $\frac{1}{10}$in., expanse of wings about $\frac{3}{8}$in. Wings rather thick, with a strong red nervure. Antennæ long and slender, with ten joints, the first two short and thick, the rest long and subequal; on all the joints are many hairs. Feet long and slender, very hairy, and the hairs on the inner edges of the tarsus and tibia are spinous; no tarsal digitules, the pair on the claw being long fine hairs. Abdominal spike short, subcylindrical. Eyes large, facetted.

There is little difference between this insect and the male of *C. zealandicum*: it is rather smaller and rather more hairy, and has a larger quantity of meal, the male of *C. zealandicum* being usually almost, if not quite, clean; but in the anatomical characters the two seem to be very similar.

Cœlostoma immane, sp. nov. Crawford Coll. Plate XI., figs. 9–12.

Adult female of a dull dark-red or reddish-brown colour, sometimes nearly black; elongated and, if viewed from above, more or less elliptical: length in the specimens observed varying from $\frac{1}{3}$in. to 1in. Viewed sideways the cephalic extremity appears thin and flattish, the thoracic and abdominal regions considerably inflated both dorsally and ventrally, so that in a large specimen the head is only about $\frac{1}{7}$in. thick, while the

* This tree has since been killed by the Coccids.

thickness of the abdomen is more than ½in. The insect has thus much the appearance of an old leather bag or bottle, with one end flattened and a seam running round the middle of it. The skin is much wrinkled, but it is not easy to make out regular segments. The antennæ are short and tapering, and seem to have only ten subequal joints, but possibly the last joint may be broken off in all the specimens seen. The feet are rather long and, for the size of the insect, slender: on the trochanter is a longish seta; there seem to be no digitules, or at least only a short one on the claw. In all the specimens observed the feet are clasped round the twig, as if the insects were afraid of falling off. Rostrum and mentum wanting. At the posterior extremity there is a rather large simple anal orifice, the skin round it being much wrinkled. The epidermis is closely marked with great numbers of minute pits, and there are some short hairs.

Amongst the specimens observed is one which resembles the rest in colour and in general form when viewed from above, but it has not an inflated abdomen, and the general appearance is smoother. I have been inclined to consider it as the second stage of the female, but it is destitute of a rostrum, and probably, therefore, is an adult female in its earlier state, before gestation. In this specimen there is a very small quantity of whitish cotton under the anal region; and along the margin, just below what I have called a seam on the edge, are ten small circular specks of white (five on each side), which may mark the position of spiracles.

Hab. In Australia, on *Acacia aneura*. My specimens were sent by the late Mr. Crawford in 1887: he informed me that they were forwarded some years earlier to the Museum at Adelaide by a shepherd from the interior, but the exact locality was unknown: I gathered, however, that it was somewhere in the direction of Cooper's Creek. The original discoverer having died soon afterwards, the insect could not again be traced. Mr. Crawford also stated that the largest specimen sent to me (1in. long) was "a Lilliputian compared with some that our Museum authorities have in spirits." If this is so the species must indeed be a gigantic one, far surpassing anything hitherto known.

I have been obliged to attach this insect to *Cœlostoma*; yet I do so in some doubt, having as yet had only a few specimens, and some of those not entirely perfect. I look upon the practice of erecting species (and sometimes even genera) upon insufficient, or single, or perhaps mutilated specimens, as reprehensible in the highest degree, and, indeed, very little less than an insult to readers and students. In the present case the specific name here adopted, which simply expresses the huge bulk of the insect, will be applicable to it under whatever genus it may hereafter be found to belong to. I think I have placed it correctly in *Cœlostoma*, on account of the absence of a rostrum and the tapering form of the antennæ. There is no doubt of its being a Monophlebid; but further examination, especially of the earlier stages and of the male, is required for absolute certainty.

My specimens do not exhibit any signs of a cottony envelope or of an ovisac, except in the very small quantities mentioned above; but I should not like to say that in the natural state they may not excrete a good deal.

Genus MONOPHLEBUS, Leach.

Monophlebus crawfordi, Maskell. Trans. Roy. Soc. South Australia, 1887, p. 108; N.Z. Trans., vol. xxiii., p. 28. Plate XI., figs. 13–15.

In my paper of last year I expressed doubts whether the "long white setous anal hairs" spoken of by Mr. Koebele belonged really to the adult stage of this insect. Since then I have had opportunities of examining three more adult females, and, although each of them lived for several weeks, no signs of such setæ appeared. The very fine female mentioned last year as being sent to me in April remained alive, but seemingly unchanged in condition, until September, when it began to excrete some long thin curling yellowish threads from various portions of the dorsum; and towards the end of the month indications of a posterior cottony sac became noticeable. These were only slight until the 20th October, when she began to excrete a much larger number of dorsal threads, and also to increase the sac, which grew in size until near the end of November: the sac was not of any definite form and was loose in texture, and as its growth progressed the insect became gradually raised up *a tergo*, as in *Icerya*. On the 2nd November I noticed the first eggs deposited in the sac, and thence to the 25th November the eggs came forth in great numbers, of the usual elliptical form and red colour: as oviposition continued the female shrivelled up, until at the end of November its formerly large red body was scarcely to be made out in the loose cottony mass.

I was anxious to watch the proceedings of this insect with some care, because I supposed it possible that before capture in Sydney she might perhaps have been visited by a male; and I wanted to compare her with *Cœlostoma compressum*, also ovipositing (certainly without any male) about the same time. I saw no change in the eggs of the *Monophlebus* until the 15th February of this year, when one larva was found crawling on the glass top of the box: by the 17th several scores had emerged, and by the 20th probably some hundreds, all very lively, and changing the appearance of the white ovisac with red eggs into a seething mass of brown crawling insects mixed with whitish egg-shells. From the immense number of these larvæ, which left scarcely any unfertile eggs, I concluded that in all probability direct connection with the male had been effected in the adult stage of this female.

The larva of *M. crawfordi* is reddish-brown, elongated oval, active, segmented: length about $\frac{1}{24}$in.: there is a slight whitish meal on the dorsum. In a live specimen there are usually some long, very slender, hyaline marginal hairs, which, however, seem to be very brittle. Antennæ of six joints, of which the first and sixth are thick, the rest slender; the first five are subequal in length, the sixth much larger, as long as any two others, club-shaped, and bearing several hairs, of which one, not at the extremity, is very long. Feet long and slender: the tibia and tarsus thin, and the tibia is scarcely longer than the tarsus; claw slender, with two short fine digitules springing from small tubercular bases. Mentum apparently dimerous. Body covered with great numbers of cylindrical tubular spinnerets, interspersed with circular compound spinnerets and with spiny hairs: from these tubular spinnerets on the margin spring the long hyaline hairs mentioned above. Anal tubercles small, each bearing a long, rather strong, seta.

The general appearance of this larva and the forms of the feet and antennæ approach much more nearly to *Icerya* than to either *Cœlostoma* or *Leachia*. I regret very much that the want of appliances rendered it impossible to keep the larvæ alive and to watch their metamorphosis, as observation of the second stage of *Monophlebus* is very desirable for comparison with the other genera.

Group BRACHYSCELIDÆ, Schrader.

In the Journal of the Entomological Society of New South Wales, 1863, Mr. H. L. Schrader published a description of some new species of Coccids, seemingly all found on various *Eucalypti*, and differing a good deal from known genera, principally in their habit of forming large and strangely-shaped galls on the food-plant. A subsequent, and apparently nearly identical, notice by the same author appeared in the same year in the Transactions of the Zoolog.-Botanische Gesellschaft, of Vienna. Dr. Signoret included these species briefly in his "Essai." I have been able to procure Schrader's German paper, but not his Sydney one; and I regret that in the synopsis of groups and genera of Coccids given in my "Scale-Insects of New Zealand" a page containing this abnormal group dropped out in the printing.

Schrader's descriptions are exceedingly imperfect, and are by no means satisfactory guides for a student. In fact, while it is convenient enough to use his generic names as forming a group of the *Brachyscelidæ*, and while the group-name (absurd as it is, for shortness in the feet would not even be a proper *generic* character) can be retained, it would be necessary to begin the systematic study of these curious forms quite afresh in order to obtain clearness. I understood some time ago that Mr. A. S. Olliff, of Sydney, had collected the material for such a study, but I suppose that press of other duties has prevented him from publication.

Of Schrader's species I possess fine examples of *Brachyscelis ovicola*, *B. munita*, and two others, which may be perhaps *B. pilcata* and *B. pharetrata*. All of these came to me from South Australia.

As far as I can make out, the distinguishing character of the group *Brachyscelidæ* has been taken to be the formation of hard woody galls. In some species the females and males appear to occupy the same gall; in others they inhabit separate galls. In my specimens of *B. ovicola* the female gall is as large as a pigeon's egg, the separate male galls being very small and tubular; in the species which I suppose to be *B. pileata* the little tubes of the male are stuck in numbers on the round female gall, which is as large as a filbert. Coccids, however, are so capricious in their ways that it would not be in the least surprising to me to find some day a Lecanid or a Dactylopid gall-maker; and, indeed, I have in this paper hesitated to attach to *Brachyscelidæ* the insect which I have named *Cylindrococcus*. A more satisfactory course (I speak subject to correction by any student of this group) might be to take also into consideration the form of the female abdomen. This, in at least the specimens of *B. ovicola* and *B. munita* which I have examined, and in *Carteria* and *Frenchia*, described presently, is noticeably prolonged somewhat like a tail, more or less slender. The resinous mass in which *Carteria* lives is not at all like the gall of *Brachyscelis*, yet I agree with Signoret in thinking that *Carteria* may better be placed amongst the *Brachyscelidæ* than in any other group, and probably the abdominal prolongation (which exists in the American and the Indian as well as in the Australian species) may usefully be employed as a connecting character. I am aware that this suggestion involves an extension of the original group-characters as more or less defined by Schrader, but this is at least convenient, if not necessary.

It will be understood that the presence of a "tail" would not denote a Brachyscelid unless other characters were present. For example: I have lately received from Australia a peculiar insect with a particularly-pronounced "tail," and I find that the characters of the adult (all that I have yet seen) are distinctly Lecanid. But if, in the *Crustacea*, it is deemed right to separate those with sessile eyes from those with stalked eyes, a similar grouping based partly on the presence or absence of a "tail" might be allowed amongst Coccids.

Genus Carteria, Signoret.

This genus may be characterized by the prolongation of the abdominal segments of the female in a more or less distinct but not very long "tail," by the presence on the thoracic or on the abdominal dorsal region of two protruding tubes (probably the organs for excreting the resinous matter surrounding the insects), by the absence of feet in the adult, and by the presence of a large strong spine just above the abdominal prolongation.

The genus has hitherto been represented by the Asiatic and African species, *C. lacca*—producing the article commercially known as "shellac"—and by two American species, *C. mexicana* and *C. larreæ*, Comstock, which also produce much resin, though seemingly not in commercial quantities. I am unable to say from the specimens submitted to me whether the two Australian species herein described can be made useful in this way: their resin is not superabundant as far as I can tell, but it might be worth while to make further inquiry on the point.

Signoret at first ("Essai," 1874, p. 293) placed *Carteria* amongst the Lecanids, on account of the monomerous mentum, the presence of two very minute lobules close to the anal ring (which he considered analogous to the "squames anales" of *Lecanium*), and the very long anal spike of the male. In 1876, however (p. 429), he changed his view, and indicated that the genus might be placed amongst the *Brachyscelidæ*. I agree with this opinion, and have here adopted it, not on account of the formation of any gall, which *Carteria* does not effect, but partly because of the prolongation of the abdomen above mentioned. The characters of the larvæ are distinctly not Lecanid. Comstock, in his description of the two American species (Rep. on Insects, 1881), does not mention any larvæ, nor does he discuss the affinities of the genus. I prefer to make use of existing means of classification wherever it is possible, even if the boundaries must be very slightly enlarged, to proposing an additional group, which might require much revision hereafter.

Carteria melaleucæ, sp. nov. Plate XII., figs. 1–10.

Female insects producing a quantity of very dark-red or purple resinous matter, which may be aggregated in masses on the twigs, or in detached semi-globular pieces each of which contains an insect. On the outside of these resinous masses may be frequently seen small quantities of white cottony fibres.

Adult female dark-red, globular: diameter about $\frac{1}{16}$in. Feet and antennæ entirely absent. Rostrum moderate; mentum short, thick, monomerous. Abdomen prolonged in a thick cylindro-conical process, which frequently appears as if formed of three segments, the basal one short and broad, the next cylindrical, the terminal one more or less conical, and bearing at the end the anogenital ring surrounded by small lobules and many strong hairs; two of these lobules are rather larger than the rest, and may answer for the anal tubercles. A little above the base of the abdominal process is one very large strong spine. On the thoracic region, nearly as high up as the rostrum, are two rather thick protruding cylindrical tubes, each ending in an orifice fringed with short hairs; the central tube leading to this orifice appears to bear a number of excretory glands, and the whole organ is probably employed in the production of the resinous matter or lac. A large compound spiracle is situated near the base of each tube. Epidermis bearing a good many, but not crowded, small circular spinnerets with minute spiny hairs; and in various parts of the cephalic region are little groups of small subcylindrical tubes: probably from all of these are produced the cottony fibres mentioned above.

Second female stage not observed.

Larva red, flattish, active; length about $\frac{1}{50}$in. Body ending in two short, but thick and conspicuous, divergent anal tubercles, each bearing about four strong short spines; and between the pair is a large compound anal ring, which appears to have six hairs. Antennæ slender, irregular, with five joints, of which the second is cylindrical; the third and fourth about half as long as the second; the fifth slender, irregular, as long as the second, and bearing some short hairs; the fourth joint, which is very widely dilated, bears two excessively long hairs. Feet long and very slender: tibia slightly longer than the tarsus; digitules four long fine hairs. Mentum monomerous.

Male unknown.

Hab. In Australia, on *Melaleuca uncinata* and *Eucalyptus* sp. (sent by Mr. French), and on *Melaleuca pustulata* and *Aster axillaris* (sent by the late Mr. Crawford).

All the species of *Carteria* are peculiar. The present insect differs from *C. lacca* in its globular form, and from the two American species in the position of the two lac-tubes and the structure of the abdominal process. It is perhaps nearest to *C. mexicana;* but I find no mention of the larva of that species for comparison. The resin or "lac" of *C. melaleucæ* is readily soluble in alcohol.

Carteria acaciæ, sp. nov. Plate XII., figs. 11–15.

Insects excreting a quantity of light-red or pinkish resinous matter, aggregated in masses or in detached irregular pieces.

Adult female red in colour, globular: diameter about $\frac{1}{25}$in. Feet and antennæ absent. Abdomen ending in a thick cylindro-conical process as in the last species, but in the specimens observed the extremity was very much less hairy. The usual large strong spine is placed above the base of the process. The two lac-tubes are on the thoracic region: they are shorter than those of *C. melaleucæ*, and more widely dilated at the end. The small circular spinnerets and the little groups of tubular ones seem to be distributed over the whole thoracic as well as on the cephalic region.

Female of the second stage covered with a light-red elliptical convex waxy test, the segments of the insect appearing through the wax: length about $\frac{1}{30}$in.: these tests are often very numerous on a twig. The enclosed insect is sub-elliptical, tapering slightly posteriorly; the abdomen ends in two short divergent anal tubercles, each bearing two spines; the compound anal ring between them bears several hairs. Antennæ and feet absent. Rudiments of lac-tubes may be seen on the thoracic region, about as high up as the rostrum. Rostrum rather small; mentum monomerous.

Larva not observed.

Male unknown.

Hab. In Australia, on *Acacia* sp. My specimens were sent by Mr. J. G. O. Tepper, of Adelaide, with a note: "Collected by Mr. Helms, of the Elder Exploration, in central Australia."

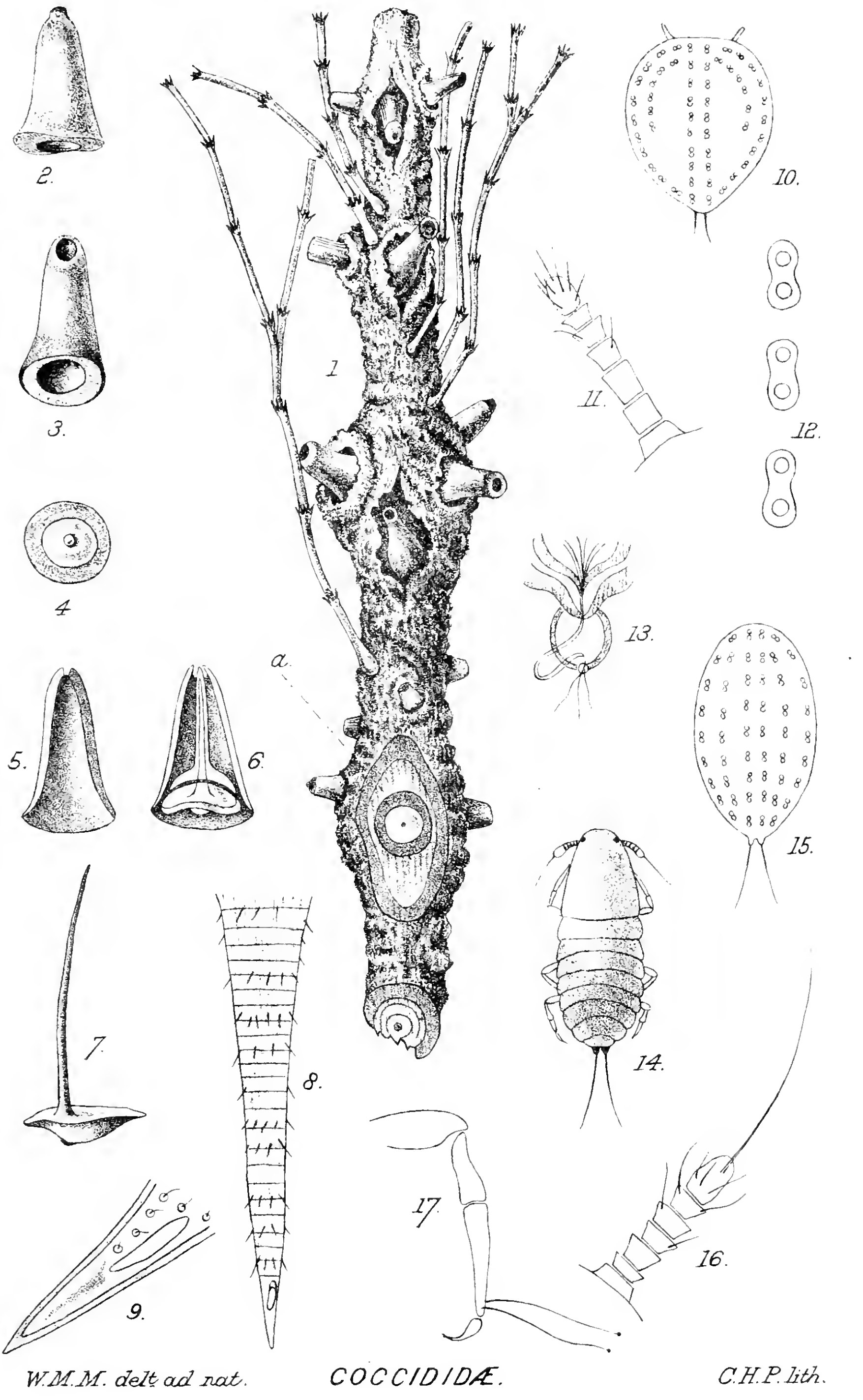
This species, in the colour of its lac, resembles closely *C. larreæ*, Comstock, an American species. I note that J. M. Stillman, in the "American Naturalist," vol. xiv., p. 783, says that *C. larreæ* is also found on *Acacia greggi*. Our Australian species differs, however, in the form and the position of the lac-tubes. Comstock does not describe either larva or second stage of his species.

Genus Frenchia. Gen. Nov.

Females excreting a tubular, smooth, woody test, which entirely covers them; also at gestation forming an inner waxy indusium closely attached to the insect; also producing gall-like swellings or excrescences in the twigs of the food-plant. Abdomen distinctly prolonged.

The only species yet known is apodous and without antennæ in the adult stage: pending discovery of other species I refrain from including these as generic characters.

I have included this genus amongst the *Brachyscelidæ*, as it seems impossible to place it elsewhere, and it accords with



W.M.M. delt ad nat. COCCIDIDÆ. C.H.P. lith.

that group in the formation of galls in the food-plant. It was, however, at first doubtful whether the insect should not be attached to Schrader's genus *Ascelis*, which likewise loses feet and antennæ. But, as no mention seems to be made by Schrader of any test in *Ascelis*, his genus apparently being covered only by the gall produced by it (as, indeed, are also *Brachyscelis* and *Opisthoscelis*), there seemed to be quite sufficient reason for its separation. I possess specimens of *Brachyscelis ovicola*, Schrader, and also of other species of the same group, and in none of these is the female covered with anything but a single gall-like, seemingly vegetable domicile. In *Frenchia* the female in its very latest stage has three coverings—the inner waxy indusium, the hard woody tubular test, and the plant-gall.

I have pleasure in attaching to this very peculiar insect the name of Mr. C. French, who appears to have first discovered it.

Frenchia casuarinæ, sp. nov. Plate XIII.

Adult female covered with a cylindro-conical, hard, tubular test, woody, of very close texture: the wide base of this tube is open; the other end being at least partially closed until gestation, after which it remains open: the length of the tube varies with the age of the insect, attaining at full growth an average length of rather over $\frac{1}{2}$in., the base being sometimes $\frac{1}{3}$in. in diameter: the colour at first is yellow, deepening with age to reddish-brown or nearly black: the outside is quite smooth; the inside is likewise smooth, and powdered with white meal. The tube is set deep in the bark, the open base closely attached to the wood of the tree; the cylindrical portion protruding through the bark, sometimes for half its length or more; and in old specimens the adjacent bark is much cracked, exposing almost the whole tube. A single tube is commonly surrounded by more or less swelling of the plant, but often several tubes are placed close together, and in such cases the galls attain considerable size: some specimens observed reach more than 2in. in diameter, the unharmed portion of the twig not being more than $\frac{1}{2}$in.

Within this woody tube, for the greater portion of the insect's life, is only a coating of powdery meal; but in the latest stage much of the meal appears to become coagulated into a waxy white or yellowish indusium, which becomes attached to the insect, the lower part wide and circular, the upper portion tapering away in a slender tube to a point.

The adult female is at first reddish-yellow, then bright-red, and after gestation dark-brown. The form is peculiar, the cephalic portion circular and disc-like, rather thick in the middle and thinner at the edges, and from the upper side of this the abdominal region proceeds in the form of a slender tapering tube passing up the woody test and terminating in a single point: in fact, the insect has something of the appearance of a tadpole. The cephalic region occupies the whole base of the woody tube; and its lower surface is at first slightly convex, applied to the wood of the tree by a small central protuberance in which is situated the rostrum, which has a short tubercular monomerous mentum and very short setæ. Antennæ and feet absent. I have failed to find an anogenital ring; but in the abdominal tube, a little above the point, there seems to be an orifice which may answer for it. There are four large spiracular orifices, and seemingly some others smaller: the tracheæ of the former are very large. The abdominal tube is obscurely segmented, the transverse corrugations being very numerous; and it is also longitudinally striated, having the appearance of being composed of strong muscular tissue: at intervals along it there are transverse rows of very small circular spinneret-orifices and of slender hairs. The dorsal cephalic epidermis bears great numbers of circular and also of tubular spinnerets. At gestation the under-side of the cephalic region becomes concave, and frequently covers the larvæ: no larvæ or eggs have been observed in the abdominal tube; but possibly they may emerge through the orifice in it, and make their way down to the cephalic disc, so as to escape under the edges of the waxy indusium and thence up the woody tube.

Female of the second stage reddish-yellow, elliptical, tapering slightly posteriorly: length about $\frac{1}{35}$in. Antennæ short, of seven joints, of which the three first are the longest, the sixth very short. Feet absent. Mentum tubercular, monomerous. Abdomen terminating in a small simple anal ring with two moderately long setæ. Epidermis bearing two median longitudinal rows of figure-of-8 spinnerets and two marginal rows of the same, the innermost of which last rows is only on the cephalic and thoracic regions. This second stage is found in very inconspicuous and minute brown papillæ on the bark, which are often scarcely to be detected except by their comparative smoothness: they are not deep in the bark, nor does the insect appear to reach the wood: there is sometimes noticeable a commencement of the woody tube; but I think that this second stage is not of long duration, for the insects in tubes, however short, are nearly always of the adult form and character.

Larva yellow, darkening as it grows, flattish, elongated, active: length about $\frac{1}{80}$in. Form subelliptical, the abdominal region rather dilated, the posterior extremity somewhat acuminate. Abdomen ending in two very small anal tubercles, each bearing a long seta. Antennæ of apparently six or seven short joints, but the joints are somewhat confused; on the last is a long hair. Feet slender: tibia shorter than the tarsus; tarsus slightly dilated; upper digitules very long knobbed hairs, lower pair apparently wanting. On the dorsum are two marginal, two median, and two intermediate rows of figure-of-8 spinnerets.

Male unknown.

Hab. In Australia, on *Casuarina equisetifolia* and *C. quadrivalvis:* Mr. French has sent me several specimens.

This remarkable insect, as observed above, does not seem to fit into any known genus. It is not clear by what process the burrowing into the bark is effected. The larva does not seem to do it, at least to any great depth, because the female of the second stage is, as stated just now, found scarcely buried. As for the gall-like swellings of the plant, they may be accounted for in the usual way as the result of "irritation caused by the suction of the insects;" yet I see nothing to indicate that *Frenchia* has any organs of irritation not possessed by other Coccids. This question of gall-formation merits attention. Another Brachyscelid—*B. ovicola*, Schrader—forms great egg-shaped domiciles, which are only attached to the plant by their extreme tips. I possess specimens of these nearly 2in. long, on twigs scarcely $\frac{1}{10}$in. thick: there must be something more than "irritation" here. But, if there exist in certain species special organs with which they so act on a plant as to produce galls, it would be interesting to discover it. After several years' minute investigation of many (perhaps three hundred) different Coccids, no organ of the kind is known to me. Yet, as I have observed elsewhere (Entom. Monthly Mag., November, 1890), some Coccids produce galls, some make cavities, others exercise no influence on the *form* of a plant. As between, say, *Aspidiotus nerii, Lecanium hesperidum, Xylococcus filiferus, Rhizococcus fossor, Frenchia casuarinæ, Brachyscelis ovicola*, what is the difference of organs in each which results in the different action of each on the food-plant? Long ago Réaumur and Bonnet attempted to explain plant-galls on the theory that the softer portions of the structure would tend to growth on the lines of least resistance, and consequently would flow towards a puncture by an insect. The explanation, however, fails to show why in the great majority of cases neither galls, cavities, nor distortions occur, whilst a minority of Coccids bring about one or other of the three. In *Insect Life*, vol. iii., No. 7, p. 343, Professor Riley, commenting upon my paper in the *Entomological Monthly Magazine* just mentioned, expresses the opinion that "a poisonous principle must exist, however difficult to detect." Just so; but it would be interesting to have the subject worked out. Time will not permit of my entering upon this investigation, and, indeed, I am not sure whether some amount of chemical knowledge might not be required for it. However, I venture once more to draw attention to the point, in the hope that some entomologist may get tired of the butterflies and beetles, and turn to the study of Coccids.

INDEX TO PLATES I.-XIII.

Plate I.

Fig. 1. *Aspidiotus subrubescens*, insects on leaf.
Fig. 2. „ pygidium of female.
Fig. 3. *Aspidiotus fodiens*, insects on leaf.
Fig. 4. „ pygidium of female.
Fig. 5. *Aspidiotus bossieæ*, insects on leaves.
Fig. 6. „ pygidium of female.
Fig. 7. *Aspidiotus rossi*, insects on ordinary leaf.
Fig. 8. „ pygidium of female.
Fig. 9. „ insects on narrow leaves.
Fig. 10. *Chionaspis eugeniæ*, insects on leaf.
Fig. 11. „ male and female puparia.
Fig. 12. „ pygidium of female.
Fig. 13. *Chionaspis nitida*, insects on leaves.
Fig. 14. „ male and female puparia.
Fig. 15. *Fiorinia acaciæ*, insects on twig.
Fig. 16. „ male and female puparia.
Fig. 17. „ pygidium of female.

Plate II.

Fig. 1. *Ctenochiton dacrydii*, insects on bark.
Fig. 2. „ segment of female test.
Fig. 3. „ larva.
Fig. 4. „ antenna of larva.
Fig. 5. *Inglisia inconspicua*, female on twig.
Fig. 6. „ segment of female test.
Fig. 7. „ spike and penis of male.
Fig. 8. *Lecanium baccatum*, females and males on separate twigs.
Fig. 9. „ female, ventral view.
Fig. 10. „ dorsal "black spot" of female, with anal lobes.
Fig. 11. „ portion of epidermis.
Fig. 12. „ antenna of female.
Fig. 13. „ larva.
Fig. 14. „ antenna of larva.
Fig. 15. „ sacs of male pupæ.
Fig. 16. „ extremity of male sac.

Plate III.

Fig. 1. *Signoretia atriplicis*, insects on twig and leaves.
Fig. 2. „ male and female sacs on leaf.
Fig. 3. „ adult female, dorsal view, before gestation.
Fig. 4. „ antenna of female.
Fig. 5. „ marginal spines of adult female.
Fig. 6. „ female of second stage.
Fig. 7. „ marginal spines and fringe of female of second stage.
Fig. 8. „ larva.
Fig. 9. „ antenna of male.

Fig. 10. *Planchonia styphelia*, insects on leaves.
Fig. 11. „ sac of adult female, dorsal view.
Fig. 12. „ sac of male, dorsal view.
Fig. 13. „ adult female, before gestation.
Fig. 14. „ spinnerets of female.
Fig. 15. „ larva.
Fig. 16. „ adult male.
Fig. 17. „ antenna of male.
Fig. 18. „ head of male, dorsal view.

PLATE IV.

Fig. 1. *Eriococcus phyllocladi*, insects on leaves.
Fig. 2. „ adult female, dorsal view, before gestation.
Fig. 3. „ antenna of female.
Fig. 4. „ spines of female.
Fig. 5. *Eriococcus confusus*, insects on twig.
Fig. 6. „ sac of female.
Fig. 7. „ adult female, diagram to show spines.
Fig. 8. „ antenna of female.
Fig. 9. *Eriococcus hoheriæ*, apterous male.
Fig. 10. „ spike and penis of apterous male.
Fig. 11. *Eriococcus multispinus*, type form of female antenna, 6 joints.
Fig. 12. *Eriococcus pallidus*, type form of female antenna, 6 joints.
Fig. 13. *Dactylopius glaucus*, type form of female antenna, 8 joints.
Fig. 14. *Eriococcus raithbyi*, type form of female antenna, 7 joints.
Fig. 15. *Dactylopius acaciæ*, type form of female antenna, 7 joints.
Fig. 16. *Eriococcus pallidus*, type form of spines.
Fig. 17. *Eriococcus multispinus*, type form of spines.

PLATE V.

Fig. 1. *Eriococcus fagicorticis*, insects on bark.
Fig. 2. „ adult female, dorsal view, before gestation.
Fig. 3. „ antenna of female.
Fig. 4. „ foot of female.
Fig. 5. „ larva.
Fig. 6. *Eriococcus eucalypti*, insects on twig.
Fig. 7. „ sac of adult female.
Fig. 8. „ sac of male pupa.
Fig. 9. „ adult female, diagram to show spines.
Fig. 10. „ antenna of female.
Fig. 11. „ dorsal spines of female.
Fig. 12. „ anogenital ring of female.
Fig. 13. „ larva.
Fig. 14. „ antenna of larva.
Fig. 15. *Eriococcus tepperi*, insects on bark and leaf.
Fig. 16. „ adult female, diagram to show spines.
Fig. 17. „ antenna of female.

PLATE VI.

Fig. 1. *Rhizococcus grandis*, adult female, dorsal view.
Fig. 2. „ antenna of female.
Fig. 3. *Dactylopius albizziæ*, insects on twig.
Fig. 4. „ female with cottony cushion.
Fig. 5. „ adult female, dorsal view.
Fig. 6. „ 8-jointed antenna of female.
Fig. 7. „ 7-jointed antenna of female.

Fig. 8. *Dactylopius albizziæ*, larva.
Fig. 9. " antenna of male.
Fig. 10. " head of male (diagram).
Fig. 11. *Dactylopius hibbertiæ*, insects on twig.
Fig. 12. " females and cottony cushions.
Fig. 13. " adult female, dorsal view.
Fig. 14. " antenna of female.
Fig. 15. *Dactylopius acaciæ*, insects on twig.
Fig. 16. " antenna of female.

Plate VII.

Fig. 1. *Dactylopius iceryoides*, insects on twig.
Fig. 2. " adult female and cottony cushion, side view.
Fig. 3. " adult female, dorsal view.
Fig. 4. " antenna of adult female.
Fig. 5. " antenna of female, second stage.
Fig. 6. *Dactylopius globosus*, insects on twig.
Fig. 7. " adult female, dorsal view.
Fig. 8. " antenna of female.
Fig. 9. *Dactylopius eucalypti*, insects on bark.
Fig. 10. " antenna of female.
Fig. 11. " anogenital ring of female.
Fig. 12. " larva.
Fig. 13. " marginal fringe of larva.

Plate VIII.

Fig. 1. *Ripersia rumicis*, adult female, dorsal view.
Fig. 2. " antennæ of female.
Fig. 3. " foot of female.
Fig. 4. *Ripersia formicicola*, adult female, dorsal view.
Fig. 5. " antenna of female.
Fig. 6. " anogenital ring of female.
Fig. 7. " larva.
Fig. 8. *Sphærococcus casuarinæ*, insects at base of galls. *a*, unharmed gall; *b*, gall showing orifice of escape of parasite; *c*, gall cut open, empty; *d*, gall cut open, showing enclosed *Cylindrococcus*.
Fig. 9. " adult female, dorsal view.
Fig. 10. " adult female, diagram to show organs.
Fig. 11. " antenna of female.
Fig. 12. " spiracle of female.
Fig. 13. " abdomen of female.
Fig. 14. " spinnerets of female.
Fig. 15. " female of second stage (diagram).
Fig. 16. " antenna of female, second stage.
Fig. 17. " foot of female, normal form.
Fig. 18. " *anterior* foot as sometimes observed.
Fig. 19. " anogenital ring of female, second stage.
Fig. 20. " larva.

Plate IX.

Fig. 1. *Cylindrococcus casuarinæ*, galls on twig.
Fig. 2. " gall cut open, with enclosed female.
Fig. 3. " adult female, dorsal view.
Fig. 4. " adult female, ventral view.

Fig. 5. *Cylindrococcus casuarinæ*, adult female, side view.
Fig. 6. „ antenna of female.
Fig. 7. „ foot of female.
Fig. 8. „ anal segment of female.
Fig. 9. „ larva.
Fig. 10. „ antenna of larva.
Fig. 11. „ foot of larva.
Fig. 12. „ anal tubercles of larva.

Plate X.

Fig. 1. *Cylindrococcus spiniferus*, galls on twig.
Fig. 2. „ gall cut open, with enclosed female.
Fig. 3. „ adult female, dorsal view.
Fig. 4. „ antenna of female.
Fig. 5. „ foot of female.
Fig. 6. „ spines of female.
Fig. 7. „ anal segment of female.
Fig. 8. *Cylindrococcus* sp., galls on twig (from a photograph).
Fig. 9. *Dactylopius graminis*, insects on stems of grass.
Fig. 10. „ adult female, dorsal view.
Fig. 11. „ antenna of female.
Fig. 12. „ foot of female.

Plate XI.

Fig. 1. *Cœlostoma compressum*, adult female, dorsal view.
Fig. 2. „ adult female in cotton, at gestation.
Fig. 3. „ antenna of adult female.
Fig. 4. „ female of second stage, dorsal view.
Fig. 5. „ empty tests of female, second stage.
Fig. 6. „ females, second stage, in tests.
Fig. 7. „ larva.
Fig. 8. „ antenna of larva.
Fig. 9. *Cœlostoma immane*, insects on twig, natural size.
Fig. 10. „ adult female, posterior view.
Fig. 11. „ antenna of adult female.
Fig. 12. „ female, probably adult before gestation.
Fig. 13. *Monophlebus crawfordi*, larva.
Fig. 14. „ antenna of larva.
Fig. 15. „ foot of larva.

Plate XII.

Fig. 1. *Carteria melaleucæ*, insects in wax on twig.
Fig. 2. „ adult female, dorsal view.
Fig. 3. „ adult female, ventral view.
Fig. 4. „ abdominal extremity of adult female.
Fig. 5. „ large spine of female.
Fig. 6. „ lac-tube of female.
Fig. 7. „ larva.
Fig. 8. „ antenna of larva.
Fig. 9. „ anal tubercles of larva.
Fig. 10. „ foot of larva.
Fig. 11. *Carteria acaciæ*, insects in wax on twig.
Fig. 12. „ lac-tube of adult female.
Fig. 13. „ test of female, second stage, dorsal view.
Fig. 14. „ female of second stage (diagram).
Fig. 15. „ anal tubercles of female, second stage.

PLATE XIII.

Fig. 1. *Frenchia casuarinæ*, insects in tubes on twig: the bark is cut away at *a* to show scar when tube is removed; natural size.
Fig. 2. " tube, showing closed extremity.
Fig. 3. " tube, with both ends open.
Fig. 4. " base of tube with convex extremity of enclosed insect.
Fig. 5. " tube cut open, empty.
Fig. 6. " diagram of female and indusium in tube.
Fig. 7. " adult female, side view.
Fig. 8. " abdominal extremity of female.
Fig. 9. " extreme tip of abdomen with anal orifice.
Fig. 10. " female of second stage (diagram).
Fig. 11. " antenna of female, second stage.
Fig. 12. " spinnerets of female, second stage.
Fig. 13. " rostrum and mentum of female, second stage.
Fig. 14. " larva, dorsal view.
Fig. 15. " larva (diagram).
Fig. 16. " antenna of larva.
Fig. 17. " foot of larva.

ART. II.—*Notes and Observations on New Zealand Birds.*

By Sir WALTER L. BULLER, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 9th September, 1891.*]

Plate XIV.

Platycercus unicolor. (The Antipodes Island Parrakeet.)

I have mentioned in "The Birds of New Zealand" (vol. i., pp. 148, 149) the interesting circumstance of the rediscovery of this lost species on Antipodes Island by Captain Fairchild, half a century after the type specimen had been placed on the shelves of the British Museum. On the last visit of the "*Hinemoa*" to the same island, the crew obtained a number of them, which were brought to New Zealand alive. They bear confinement well, and soon become tame and tractable. The male bird has a conspicuously larger bill than the female. The irides are cherry-brown in colour, and the feet are dull-grey.

On Antipodes Island these birds were found frequenting the grass tussocks, and were easily run down and caught by the hand or by means of a neck-snare.

Sir James Hector records his belief (*l.c.*, p. 149) that this Parrakeet resembles a Kakapo, being "a ground Parrakeet, which flies feebly, does not care to perch, climbs with its beak and feet, and walks in the same waddle-and-intoed fashion as the Kakapo;" and a scientific correspondent in England, to whom I sent a pair of live ones, writes me that it seems "far more like a *Conurus* than a *Platycercus*." But, although I have made a careful comparison between the bones of the two species, I cannot find that the sternum of *Platycercus unicolor* differs in any respect from that of *P. novæ-zealandiæ*, except as to size.

Antipodes Island—a mere rock in the ocean, 640 miles from Port Chalmers in a southerly direction—is the only known spot on the face of our globe inhabited by this Parrakeet. One can understand how, under the laws of evolution, isolation for perhaps many centuries has enabled this bird to develope its specific characters of form and colour. But how about *Platycercus erythrotis*, living alongside of it in the same island-home, and so slightly differentiated from *P. novæ-zealandiæ* that some ornithologists regard them as one and the same species? The only explanation I can offer is in a theory of colonisation at a later period of time, but sufficiently remote to account for a certain amount of divergence from the parent stock. The differences consist in an appreciably larger size, with paler irides, and a colder shade of green throughout the plumage, in having the red patch on the vertex much reduced in extent and mixed with the green, the line of red from the bill to the eye narrower, and the extension beyond reduced to a mere point. These are just such changes and modifications as would naturally mark the gradual transition from *Platycercus novæ-zealandiæ* to *P. unicolor*.

Owing to the uniform colour of the plumage, and the delicate shades through which the green passes, being lightest and brightest on the forehead, *Platycercus unicolor* is, to my mind, the prettiest of the whole group. I remember being struck many years ago with the portrait of the then unique specimen in the British Museum, in an illustrated folio monograph of Parrots, as being one of the handsomest plates in the book.

The species appears to have no note but a low chatter, except when fighting, when this is prolonged into a little scream like the cry of a Tern (*Sterna frontalis*).

My captive birds seemed perfectly happy, although caged as adults. They partook freely of maize and oats, also of apples, grapes, figs, and, indeed, ripe fruit of any kind. They could bite severely, as I soon learned to my cost.

Platycercus erythrotis. (The Auckland Island Parrakeet.)

Curiously enough, associated with *Platycercus unicolor* on Antipodes Island, as already stated, is a form more nearly allied to our Red-fronted Parrakeet. This is *Platycercus ery-*

throtis, of which several living examples were brought by the "Hinemoa." The Parrakeet from the Auckland Islands of which I exhibited a pair at a former meeting of this Society is no doubt referable to the same species. The Parrakeet from Macaulay Island (Kermadec group), of which several were brought by the "Hinemoa," is undoubtedly the same as our *Platycercus novæ-zealandiæ,* which enjoys a wide geographic range.

I had one of these birds caged for some time. Its irides were of a clear pink colour when in health, but they became paler when the bird sickened and died.

Platycercus novæ-zealandiæ. (The Red-fronted Parrakeet.)

Specimens brought from Macaulay Island, in the Kermadec group, do not differ in any respect from the New Zealand bird. An example of the latter has lately come into my possession in which the entire abdomen is greenish-yellow, whilst there is a narrow halo of the same colour around the frontal spot of crimson.

Nestor notabilis. (The Kea Parrot.)

In vol. ix. of our "Transactions" I have recorded some curious instances of deformity in the bill of *Nestor meridionalis.* I have lately received from Dunedin a specimen of *Nestor notabilis* in which the upper mandible presents a very strange malformation, as shown in the accompanying sketch (Plate XIV., fig. 1).

Ocydromus earli. (The Brown Woodhen.)

Captain Fairchild brought to me from the Macquarie Islands a live female Weka. It undoubtedly belongs to the above species, the irides being bright chestnut-red, and the legs of a beautiful lake-red colour. Seeing that the range of this species in New Zealand is, so far as we at present know, restricted to a portion of the west coast of the South Island, its occurrence on Macquarie Islands, about five hundred and fifty miles to the south-south-west of New Zealand, is a very curious fact in geographical distribution.

Ocydromus greyi. (The North Island Woodhen.)

To the numerous instances of albinism in New Zealand birds I have now to add another. A specimen of the above species from Hawke's Bay presents a singular piebald character: The forehead, fore part of crown, sides of head, throat, foreneck, and all the under-parts are pure white; the normal colour appearing in a small patch in the middle of the breast, behind the thighs, and under the tail. The plumage of the upper parts is normal, except that on the left side of the head the white extends half round the nape. In both wings some of the secondaries and primaries and a few of the large coverts are pure white, and there is likewise one white tail-feather. Bill whitish horn-colour. Legs pale-brown; claws yellow horn-colour.

Diomedea cauta. (The Shy Albatros.)

I have received four eggs of the Shy Albatros from the Snares, where Captain Fairchild discovered its breeding-place. They differ slightly in size, the largest measuring 4in. in length by 2·6in. in breadth, and the smallest 3·75in. by 2·3in. They are broadly ovoido-elliptical in shape, and the shell is finely granulated. Two of them are creamy-white, with the larger end thickly splashed with umber-brown, the colouring in one of them being almost as rich as in a merlin's egg, with a few rounded spots at the smaller end. The other two eggs have only a faint wash of brown at the larger end, with widely-scattered blots (some of them with open centres) all over the surface.

I lately obtained a live bird of this species which was captured at Island Bay. What struck me most was the beautiful appearance of the head—"quite a model," as the intelligent cabman who brought it to me observed. It has a perfectly rotund appearance—most noticeable in a front view —owing to the feathers being puffed out. This character is lost in the dead bird, and necessarily so in the ordinary cabinet skin, but it could easily be represented in the mounted bird. I think this species is without question the most beautiful of the group, as to form and colour, although *Diomedea regia* for size and snowy whiteness takes the palm. In life, the bare membrane down the base of the lower mandible, and the moustachial membrane on the cheeks (usually hidden by the feathers), are of a rich orange-yellow. The black line along the base of both mandibles (outside the yellow membrane on the lower) and from the root of the fore-head to the nostrils is far more conspicuous in the living bird than in dried specimens. The ridge or space between these lines, as well as the whole of the culmen, is of a very delicate lemon-yellow, changing to light horn-colour on the hook. The sides of both mandibles are dull olive-grey, changing to dull pinky-yellow along the rami of the lower mandible, which has its terminal expansion uniform slaty-black. The sides of the mouth, upper and lower, are fringed with a yellow membrane, which, from the junction at the gape, extends obliquely upwards and outwards for the space of an inch, forming the peculiar feature already described in my account of this species ("Birds of New Zealand," vol. ii., p. 203). The irides are of a lustrous coal-black, and are wonderfully expressive in their dark facial setting, with a white eyelid underneath. The legs and feet are greenish-grey with flesh-coloured webs, shaded with brown towards the outer edges.

Diomedea fuliginosa. (The Sooty Albatros.)

At a former meeting of this Society I exhibited a down-covered nestling of this species, received from the Auckland Islands. The carpenter on board the "Hinemoa," who is a very intelligent man and has collected many good specimens at the Islands, informs me that this species of Albatros—unlike the others, which place their nests on the ground within easy reach—selects for nesting purposes the ledges of rocks on the face of the cliffs, and often in the most inaccessible places.

Diomedea culminata. (The Grey-headed Albatros.)

This species, I am credibly assured, breeds on the Snares. My informant has supplied me with a number of eggs. They are very elliptical in form, and vary slightly in size, an average one measuring 4in. in length by 2·5in. in breadth. Some are uniform creamy-white; others have the larger end more or less splashed with extremely fine dots of reddish-brown, becoming confluent in some places and forming an indistinct zone.

Diomedea regia. (The Royal Albatros.)

Since writing my paper on this new species of Wandering Albatros, I have had an opportunity of comparing its nestling with that of *Diomedea exulans.* The former, as already recorded, is entirely covered with down of the purest white; the nestling of *Diomedea exulans*, on the other hand, has a covering of light-grey down, changing to white on the head.

The distribution of these Albatroses on their breeding-grounds is very curious. Although Mollymawks are plentiful on the Snares and on the Bounty Islands, neither *Diomedea regia* nor *D. exulans* is to be found there. On Campbell Island, where *D. regia* reigns supreme, *D. exulans* is never seen. On the Auckland Islands, with the exception of the small colony of *D. regia* mentioned in a former paper, all the breeding birds belong to *D. exulans*. On the Antipodes Island, again, there are no *Diomedea regia*, and the breeding birds of the other species are, for the most part, in the dark-grey plumage with white face and throat. One of the officers of the "Hinemoa" told me that he turned many of these dark-coloured birds off the nest, and always found an egg, which seemed to him far more elliptical in form than the ordinary albatros's egg. He noticed moreover that sometimes a very dark bird was paired with a much lighter one.

Diomedea exulans. (The Wandering Albatros.)

Captain Fairchild brought in from near the Chatham Islands (early in September) two birds, apparently male and female, in both of which the blood-red mark first described by Professor Hutton was visible on the sides of the neck. This character cannot therefore be a sexual one, although it may be peculiar to the breeding-season.

Adamastor cinereus. (The Brown Petrel.)

Captain Fairchild has brought me a pair of this comparatively-rare species of Petrel, shot by him, a few days ago, half-way between Wellington and the Chatham Islands. One of them being in the flesh, I am able to supply the actual measurements, hitherto known only from the skin.

Female.—Extreme length, 22in.; extent of wings, 51in.; wing from flexure, 15in.; tail, 5in.; bill, along the ridge 2·2in., along the edge of lower mandible 2·3in.; tarsus, 2in.; middle toe and claw, 3·25in. The bill is perfectly black on the ridge, but changes to horn-colour on the hook; the sides of both mandibles are bluish-grey, but a black line extends down the middle of the lower mandible and widens out on meeting the unguis, which is dull horn-colour. The irides are very dark brown, almost black. The legs and feet are greyish flesh-colour, shaded with slaty grey on the heel and on the outer side of tarsus and toe; interdigital webs yellowish with grey edges.

This is the first time Captain Fairchild has obtained specimens of this Petrel during the many years he has been navigating the "Hinemoa." It cannot therefore be very plentiful. But it appears to enjoy a wide oceanic range, for I have in my collection an example taken at sea not far from the Cape of Good Hope.

Aptenodytes longirostris. (The King Penguin.)

The Penguins as a family are noted for their ferocity, snapping and biting in a very determined manner when interfered with or handled. The King Penguin, however, notwithstanding its great size and its power of muscle, is one of the gentlest of birds. On being captured they naturally struggle to escape, and sometimes utter a peculiar guttural cry; but in confinement they immediately become quite tame and tractable. Although armed with a powerful bill they never use it for offensive purposes. They submit to being stroked on the head and back without showing even a sign of impatience, and when an attempt is made to handle them they merely parry the intrusive hand with their long flippers, and in the gentlest manner. Captain Fairchild brought me four fine adult birds and a nestling from the Macquarie Islands. One of the former went immediately to the dissecting-room. The others I turned loose in the garden, together with a large contingent of *Eudyptes sclateri* and *Eudyptes schlegeli*. The latter scuttled off and took refuge in the shrubbery; but the three King Penguins remained on the grass slope, and made themselves perfectly at home at once. Owing to their peculiar conformation they do not rest in a squatting attitude like the other Penguins, but either sit bolt upright, resting the whole weight of the body on the heel of the foot, or lie full length on the ground. In the early morning I found them lying prone on the belly, with their heads meeting and crossing one another. They remained in this position and perfectly motionless till the sun was well up in the heavens. On two of these birds being removed the remaining one appeared quite disconsolate, and wandered over the place a whole morning looking for his mates. He stalked about in the drollest manner, walking perfectly upright and swaying his outstretched flippers for the purpose of steadying the body. Having failed to find his companions, he settled down in the most philosophic fashion, and never left that corner of the garden where he had taken up his abode. He would not take food when offered, but on my forcing open his mandibles and placing minced raw meat in his mouth he swallowed it with avidity.

The nestling is covered with thick woolly down of a uniform sooty colour. It is a voracious feeder, uttering all day long a shrill squirling cry and opening its beak to be fed. Its appetite appears to have no limit, for no sooner has it swallowed one handful of minced meat than it stretches up its neck and clamours for more. When calling for food it sways its neck to and fro, after the manner of a young Cormorant, as if to give greater emphasis to its demands. When alarmed the King Penguin utters a low cry like that of a domestic goose.

The nearest point at which it can be obtained is Macquarie Island, lying about lat. 55° S. There is a tradition, however, on board the "Hinemoa," of one having been seen, among a group of Crested Penguins, on Campbell Island. It was made out with the glass long before the ship came alongside. It is not unlikely, however, that this was a bird that had made its escape from one of the sealing ships on its way from Macquarie Island.

The bird of the first year is covered with a shaggy, hair-like down of a yellowish-brown colour. This is gradually replaced by short plumage, presenting the colours of the adult, but much duller. The spatulate marks on the side of the head are of a pale greenish-yellow colour, and on the breast there is at first only a tinge of yellow, where in later life this colour becomes so rich. The young birds are phenomenally fat.

Eudyptes chrysolophus. (The Royal Penguin.)

By the courtesy of Captain Fairchild I received several living birds, both old and young, of this species. It is evident that *Eudyptes chrysolophus*, Brandt (described at page 297 of "The Birds of New Zealand," 2nd ed., vol. ii.), and *Eudyptes schlegeli* are one and the same bird. The Penguin with the grey throat and scant crest is the young of the Royal Penguin; but, as *Eudyptes chrysolophus* is the older name, it must take precedence of *Eudyptes schlegeli*. In disposition and character this bird differs entirely from the ordinary Crested Penguin (*E. pachyrhynchus*). It is naturally one of the tamest and boldest of birds. It was quite amusing to notice the behaviour of the four I turned loose in my garden. They always kept in close company and acted together, as it were, automatically. They sometimes walked up and down the garden paths Indian file, at other times they walked abreast, but always in unison. Where one went the others would go; and, if interrupted, or crossed in their path, they would attack savagely with their powerful beaks and endeavour to turn the flank of the intruders, instead of turning back. They were more noisy than the other species, especially at night and during the early morning, uttering at intervals a cry like that of the domestic gander, and at other times a sound strangely like the bleating of a sheep—such as one hears at intervals from the pen at shearing-time. Their ordinary cry, frequently repeated, is not unlike the cawing of Rooks. They selected a favourite resting-ground, and, although they wandered freely over an acre of garden, they always came back to it. They seemed never tired of dipping in the water and preening their feathers. When brought to me they were undergoing their annual moult, and presented a singular appearance with the old plumage hanging about them and peeling off in strips. By the end of July they had completed their moult, and were in bright plumage, although their crests were only half developed, and their tail-feathers only just appearing. This species has a bare flesh-coloured membrane round the angles of the mouth, which imparts a very peculiar expression to the face, and admits of a wide expansion of the mandibles. It has bright red irides, and feet of a dull gamboge-yellow colour.

Observations on caged birds, or those kept in close captivity, are not perhaps of very much value from a scientific point of view; but, when (as in the present case) the birds have the freedom of a garden and shrubbery, with access to water, they may be studied with almost as much advantage as in their native habitat. Having several species of Penguin associated together in this way, I was much struck with the wide difference in their natural disposition and habits of life. Even individuals exhibit differences of character; but as between the species these differences are very marked.

The ordinary attitude of the Royal Penguin is half upright, sometimes with both flippers extended, then one depressed, then both, just as if the bird was signalling to his fellows by semaphore.

Eudyptes pachyrhynchus. (The Victoria Penguin.)

The name of Rock-hopper, by which *Pygoscelis tæniatus* is known, might well be applied to this species. It moves along the ground with great celerity, and generally surmounts small bushes and other obstacles in its way by jumping clean over them. I have known one voluntarily enter a house and ascend the back staircase, right to the landing, hopping up step by step. It moves about through the scrub very deftly, picking its steps in a very cautious catlike manner.

Unlike *Eudyptes chrysolophus*, this species is naturally wild in disposition and habitually silent. On turning out half a dozen of them in my garden, they all scuttled rapidly away into the shrubbery, and when fairly out of sight one of them indulged in a vociferous chatter for some time, as if addressing his fellows and proposing some plan for their mutual safety. This reminded me of an amusing circumstance Captain Fairchild had mentioned. His practice when he gets a lot of live Penguins on board the "Hinemoa" is to secure them in separate pens according to the species. He told me that on one occasion, in the pen occupied by the Victoria Penguins, one of the birds, on gaining a higher foothold than the rest, vociferated loudly, whilst the others kept quiet and appeared to listen. So, to accommodate the birds, he had what he termed a little pulpit erected in the midst of the pen. He says it was most ludicrous to see one of the Penguins, like a member of the French Senate, sedately mount this rostrum and address his fellows for several minutes at a time in the most energetic manner, the other Penguins keeping perfectly silent. Then an impatient auditor would waddle up alongside, turn the speaker out of the chair, mount into position, and have his say to the crowd, and so on, the audience being perfectly quiet and orderly.

This species bites fiercely, and I saw one fairly run after and attack the hands of a man who had been attempting to capture it.

One of the birds brought by Captain Fairchild from the Snares was saved when the others were converted into specimens. Originally very savage and pugnacious, this bird became quite tame and docile. He would follow the gardener about in the most persistent manner to be fed. After he had settled down to the new conditions of things he took up his quarters in the kennel with a young Gordon setter. During the heat of the day he would take refuge in the kennel, coming abroad in the cool of the evening and during the early morning. He lived on terms of perfect amity with the dog, for whom at times he testified his affection by gently pecking him all over the body with his bill, an attention which the sagacious animal seemed quite to appreciate.

Eudyptes sclateri. (Sclater's Penguin.)

The local distribution of the Penguins, like that of the Petrels, as determined by their breeding-grounds, is very curious. So far as I can make out at present, *Eudyptes chrysocome* is found exclusively on Antipodes Island, *E. pachyrhynchus* on the Snares, and occasionally on the New Zealand coast, *E. sclateri* on the Auckland Islands and also on Antipodes Island. *Aptenodytes longirostris* and *Eudyptes chrysolophus* appear to be confined to the Macquarie Islands, where *Pygoscelis tæniatus* is also to be found.

This Penguin is conspicuously larger than *E. pachyrhynchus*. The golden facial streak commences near the angle of the mouth, which is surrounded with a bare membrane as in *E. chrysolophus*, although not to the same extent. The irides are reddish-brown, and the legs and feet flesh-white.

Eudyptes chrysocome. (The Tufted Penguin.)

Writing of one of this family Mr. Gould says: "Its powers of progression in the deep are truly astonishing. It bounds through this element like a porpoise, and uses its short fin-like wings as well as its feet to assist it in its progress; its swimming powers are, in fact, so great that it stems the waves of the most turbulent seas with the utmost facility, and during the severest gale descends to the bottom, where, among beautiful beds of coral and forests of seaweed, it paddles about in search of crustaceans, small fish, and marine vegetables, all of which kinds of food were found in the stomachs of those I dissected. A considerable portion of the year is occupied in the process of breeding and rearing the young, in consequence of its being necessary that their progeny should acquire sufficient vigour to resist the raging of that element on which they are destined to dwell, and which I believe *they never again leave till they in turn seek the land for the purpose of reproduction.*"

A singular confirmation of Mr. Gould's view is supplied by the dried specimen of a Penguin's foot (belonging, I believe, to the above-named species) which I now exhibit. It will be seen that through long-continued immersion in sea-water a number of barnacles have become firmly attached to the end of the toes. The other foot was similarly attacked, but was in a worse condition, the irritation set up by the foreign growth having caused the claws to come off, leaving the extremities sore and diseased. An occasional resort to land, with the incidental friction or wear-and-tear, would of course have rendered such a condition of foot as this impossible. (Plate XIV., fig. 2.)

Eudyptes antipodum. (The Yellow-crowned Penguin.)

The officers of the "Hinemoa" tell me that this is the most delicate of all the Penguins, seldom surviving confinement more than a day or two.

Eudyptula undina. (The Little Blue Penguin.)

Some ornithologists are for uniting this species with *Eudyptula minor*; but, as will be seen by the two specimens now exhibited, they are readily distinguishable from each other. There is a manifest difference in the size of the bill, and *E. undina* is further separable by having the entire under-surface of the flippers white.

I had recently an opportunity of examining a pure albino of this species, obtained last year by Mr. Black at Mercury Bay. The entire plumage was snow-white, with a silky gloss on the under-parts.

Tachypetes aquila. (The Great Frigate-bird.)

I have much pleasure in exhibiting a specimen of the Great Frigate-bird, only the second known example obtained in New Zealand. This bird struck itself against the lantern at the Cape Farewell Lighthouse on the night of the 15th April, and was picked up in an injured state. It was kept alive by the lighthouse-keeper for a few days, but could not be induced to eat anything. It was then killed and converted into the very presentable specimen now on the table.

This is a more mature bird than the one captured at Castle Point in February, 1863, and now with my original collection in the Colonial Museum. (See "Birds of New Zealand," vol. ii., p. 183.)

Fig. 1.

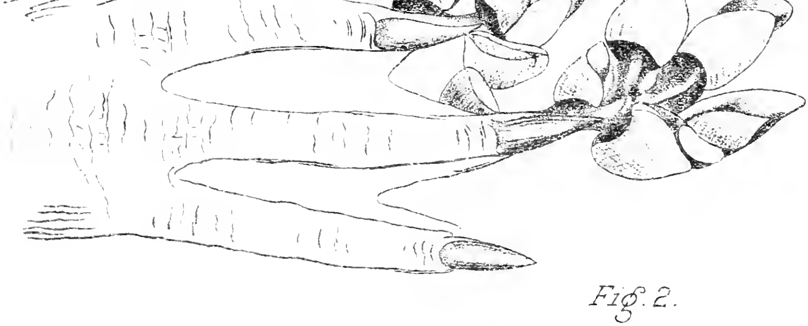


Fig. 2.

To illustrate paper by Sir W. L. Buller.

W. L. B. del.

C. H. P. lith.

ART. III.—*Further Notes and Observations on Certain Species of New Zealand Birds (with Exhibits).*

By Sir WALTER L. BULLER, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 21st October, 1891.*]

IN continuation of the paper which I read at a recent meeting of this Society, and following the same mode of illustration, I have now to lay before you another budget of notes, and to exhibit for your inspection some very interesting specimens.

It is one of the charms of natural history that the more the field is worked the more it yields. It matters not how exhaustively the history of any living species has been treated, its further study is bound to yield some result to reward the untiring naturalist. I remember on one occasion hearing Professor Owen discourse for more than an hour before the Royal Society on the habits of a Crab, with which every visitor to the sea-shore thought himself perfectly familiar; and yet at every turn the learned professor brought out some new fact in the life-history and social economy of this apparently dull and common-place creature. And we all know the charm, equalling that of any work of fiction, with which Charles Darwin invested a very unpromising subject by his masterly treatment of Earthworms.

We have fresh evidence every day that the native fauna is passing away; and this is particularly true of the birds, several of the species being already extinct, whilst many others are on the border-land, so to speak, from which they must soon disappear. It seems to me that it is one of the most important functions of such a society as this to collect and preserve for all time the fullest possible record of these expiring species.

Turnagra hectori, Buller. (The North Island Thrush.)

The South Island Thrush (*T. crassirostris*) is still comparatively plentiful in some parts of the West Coast, but its numbers have been grievously diminished by the diggers' dogs, by wild cats, stoats, and weasels. The North Island bird has all but disappeared, and the specimen exhibited is the only one I have been able to obtain since my return to the colony. Mr. C. Field, the surveyor, writing to me from Moawhango, Inland Patea, says: "I know of four places where the Piopio was to be found *seven years ago*. In the Turakina Valley, about five miles south of the Te Ruanui, we used to see them every week; also in the Mangamahu Valley, and about four miles from the last-mentioned place. At two different places in the Mangawhero Valley they were to be found, and one of these localities was not more than two miles from Mason's house, but the other was far inland. In the Porewa, north of Hunterville, they were to be found at that time, and I believe some still remain. They were formerly so plentiful in the Turakina and Mangamahu Valleys that I think it is likely a few might still be found there."

Myiomoira toitoi, Garnot. (The North Island Tomtit.)

An albino specimen of this bird from Otaki, for which I am indebted to Mr. Capper, has the plumage of the body almost entirely white, with a few clouded specks on the breast and sides. The wing-feathers, both primaries and secondaries, are irregularly pied; the lateral tail-feathers are marked as in the ordinary bird; the middle feathers are perfectly white. Bill, legs, and feet normal.

Clitonyx albicapilla, Lesson. (The Whitehead.)

Last week, accompanied by my son, I made an expedition into the wooded ranges at the back of Waikanae in quest of Huias. We were disappointed in the object of our search, but after tramping on foot over some ten miles of bush-paths we were rewarded by finding a pair of Popokatea, or Whitehead, positively the only ones I have even heard of on the mainland for the last ten years or more. I brought down both with a small charge of dust-shot, and have much pleasure in exhibiting them. I can remember when this bird was absolutely the commonest and most numerous in the North Island. It is now one of the rarest, being met with only on the Little Barrier Island, in the north, and on Kapiti, in Cook Strait. Another bird equally common was the Wood-robin (*Miro albifrons*), and this has disappeared just as completely, my last specimen having been shot at Kaitoke in the spring of 1880.

Anthus aucklandicus, G. R. Gray. (The Auckland Island Pipit.)

Although hitherto rejected by me, I feel constrained at last to admit the Auckland Island Ground Pipit to the rank of a separate species. I have now the opportunity of exhibiting a series of specimens representing the adult male and female and the young. On comparing these birds with specimens of *Anthus novæ-zealandiæ* the difference is at once apparent. In the Auckland Island bird the white superciliary streak is wanting; the feathers of the upper surface are not margined as in *Anthus novæ-zealandiæ*, and the under-parts, instead of being white, are of a fulvous cream-colour, slightly mottled on the sides of the breast with brown.

Young.—A young bird, just from the nest, has the plumage of the upper surface strongly suffused with fulvous, the quills and their coverts, as well as the tail-feathers, broadly margined with fulvous, and the face, throat, and under-parts entirely of that colour. The outer tail-feathers, which are white in the adult, are of a uniform pale-fulvous. This colour is brightest on the foreneck and breast, where the feathers are obscurely centred with brown.

I have received a specimen from the Antipodes Island, which does not differ from the Auckland Island bird, except that it is somewhat darker and yellower, being evidently a younger bird.

Anthus novæ-zealandiæ, Gmelin. (The New Zealand Pipit.)

The next specimen I have to exhibit is an albino of the common species. The general plumage is creamy white, more or less stained on the upper surface, especially on the back, with pale yellowish-brown.

Sphenœacus fulvus, Gray. (The Fulvous Fern-bird.)

I have received two more specimens (in the flesh) from the Snares. This species is evidently a ground feeder, for on skinning them I was struck with the great development of the tibial and femoral muscles.

Rhipidura fuliginosa, Sparrm. (The Black Fantail.)

I have received a specimen (in spirits) from the Snares.

It is interesting to note that this Southern species is becoming an inhabitant of the North Island. I have previously recorded the known instances of its occurrence in the Wellington District. This year one has almost constantly frequented my garden on the Terrace.

In a large collection of birds from the Chatham Islands lately received in England there were many specimens of *R. flabellifera*, but none of this species.

Pogonornis cincta, Dubus. (The Stitch-bird.)

A female of this very rare species which recently came into my hands has a yellow tinge on the angle of the wings and on the tips of the white secondary coverts. The specimen, which had been in a private collection at Auckland for some ten years, came originally from the Little Barrier Island. This is undoubtedly the last refuge of the species, and, if a remnant is to be preserved, the island ought to be strictly protected. The indefatigable collector, Mr. A. Reischek, spent a considerable time on the Little Barrier, and shot a number of specimens for local and foreign museums, but I was assured by him that he did not destroy them all; and I do not think any collector has visited the island since his time. There is therefore just a chance of saving the species by timely intervention.

Acanthidositta chloris, Sparrm. (The Rifleman.)

It seems pretty clear that the male of this species assists in the work of incubation, for a specimen which I shot in the Ngarara Ranges on the 13th October had the under-parts completely denuded of feathers. It was evidently the end of the breeding-season, because, on dissection, I found the testes extremely minute. As I have already explained ("Birds of New Zealand," vol. i., p. 115), this singular little bird is in reality a dwarf *Pitta* of a degenerate type. It would be interesting to know whether other members of this family (to which I have given the name *Xenicidæ*) have the same habit, or whether the males of any of the true *Pittas* are known to incubate.

Eudynamis taitensis, Sparrm. (The Long-tailed Cuckoo.)

The next bird I have to exhibit is a specimen of our large migratory Cuckoo, from the Kermadec Islands, presented to me by Captain Fairchild. It differs from ordinary New Zealand examples in its richer colouring, the throat and sides of the neck having a strong wash of chestnut-brown, and the wing-coverts being largely tipped with white instead of yellowish-brown, presenting a spotted appearance, this character extending also, but in a less degree, to the scapulars, uropygium, and upper tail-coverts.

Platycercus unicolor, Vigors. (The Antipodes Island Parrakeet.)

I am now able to give the full measurements of the two sexes, taken from specimens in the flesh.

Male.—Length, 14in.; extent of wings, 19in.; wing from flexure, 6in.; tail, 6·50in.; bill, along the ridge 1·1in., along the edge of lower mandible 0·65in.; tarsus, 1in.; longer fore-toe and claw, 1·5in.; longer hind-toe and claw, 1·3in.

Female.—Length, 12·75in.; extent of wings, 17·5in.; wing from flexure, 5·75in.; tail, 6in.; bill, along the ridge 0·9in., along the edge of lower mandible 0·55in.; tarsus, 0·8in.; longer fore-toe and claw, 1·25in.; longer hind-toe and claw, 1·2in.

Platycercus novæ-zealandiæ, Sparrm. (The Red-topped Parrakeet.)

A specimen which I have lately received from Auckland has the back, rump, and upper surface of wings irregularly marked with yellow, and the sides of the face, foreneck, and breast washed with yellow; tail entirely yellow, slightly clouded with grey. In other respects the plumage is normal, but the bird is somewhat smaller than ordinary specimens.

A specimen received from Dunedin has the whole of the abdomen washed with lemon-yellow; also the vertex along the edges of the crimson cap. A specimen which I lately shot at Eketahuna, in the Forty-mile Bush, has the frontal and uropygial spots delicately edged with yellow, and the tail-feathers tipped with blue.

Coturnix novæ-zealandiæ, Quoy et Gaim. (The New Zealand Quail.)

After closing my account of this species in "The Birds of New Zealand" (vol. i., pp. 225–228)—in which I had said, "It is probably now extinct, for no specimen has been heard of for at least twelve years"—I added a footnote to the effect that, after the article had been sent to press, I had received from the colony the welcome intelligence that the last refuge of this expiring species had just been discovered at the Three Kings, a group of small islands situated about thirty-two miles west-north-west of Cape Maria van Diemen. The "Hinemoa" had called in there on her return from annexing the Kermadec Islands, and those who landed reported having seen several bevies of New Zealand Quail, which were described as being comparatively tame and fearless. Mr. Cheeseman (who was one of the party on that occasion) visited the islands again; and, writing to me on the 10th June, 1890, he said: "I obtained a nest with five eggs of the Quail when at the Three Kings last summer. I almost trod upon the bird: in fact, she rose between my feet; and glancing downwards I saw the eggs. I had no gun with me at the time, and consequently the bird escaped. I spent one morning hunting over the island with a gun, but never got the chance of a shot, although I started three or four couples. They are by no means plentiful. I do not think I saw over a dozen the three days I spent on the island."

The belief that this species yet survived, resting on apparently good evidence, has, I am sorry to say, been rudely shaken. Mr. Cheeseman kindly gave me, on my last visit to Auckland, one of these eggs, and I saw at a glance that it was not that of our New Zealand Quail, but of *Synoïcus australis*, the Brown Quail of Australia, which has been introduced into New Zealand, and is now extremely plentiful in all parts of the country. Its voluntary spread to the Three Kings is very curious.

Carpophaga chathamiensis, Rothschild. (The Chatham Island Pigeon.)

The recent exhibition at a meeting of the Zoological Society of London of a series of specimens of the Wood-pigeon from the Chatham Islands, characterized as a new species, under the above name, shows how important it is to collect and examine even the apparently most common species. We have always known that the Wood-pigeon existed at the Chathams, but till these specimens were received in England no one ever suspected that it was a different species from that inhabiting New Zealand. Mr. Henry Travers made a large collection of birds there, but he appears to have avoided this bird as being too common, and so the new species was missed by him altogether. The Maoris, who are only practical ornithologists, do not seem to have detected any difference between this bird and the Kereru of their old home. As far back as 1855, when visiting those islands on Government business, I saw some wild Wood-pigeons consorting with tame Blue Rock Pigeons introduced by the settlers; but on the wing they were quite undistinguishable from our New Zealand bird, and I did not attempt to shoot any.

The new species is said to be one-fifth larger than *Carpophaga novæ-zealandiæ,* and is "purple and pearl-grey where the latter is green and bronze-red." I am expecting to receive a specimen shortly from England, and shall then take an opportunity of exhibiting it to the Society.

Thinornis novæ-zealandiæ, Gmelin. (The Stone Plover.)

I learn by letter that in a collection of birds made by Mr. Palmer at the Chatham Islands, and taken to England this year, there was a perfect albino specimen of this very handsome Plover.

Charadrius bicinctus, Jard. and Selby. (The Banded Dottrel.)

I have described in "The Birds of New Zealand" (vol. ii., p. 2) the young state of this beautiful Dottrel. I have now to exhibit a series of seven specimens, showing the different states of plumage in the progress of the bird towards maturity: No. 1 is in the first plumage, with an indistinct zone of mottled grey encircling the foreneck; No. 2 has a broader and darker zone; Nos. 3 and 4 have it still darker, the centre of each feather being blackish-brown or black, one of them presenting a faint indication of the second band; No. 5 exhibits this pectoral band, the chestnut being mixed with white, and consequently indistinct; Nos. 6 and 7 (adult ♂ and ♀) present the double bands of black and chestnut respectively in full perfection.

I have in my collection a specimen, obtained at Kaikoura, in which the chestnut band is considerably broader.

Recurvirostra novæ-hollandiæ, Vieill. (The Red-necked Avocet.)

Among the rarer forms of our Waders, this beautiful Red-necked Avocet (presumably a visitant from Australia) holds a conspicuous place.

I have recorded in "The Birds of New Zealand" (vol. ii., p. 20) the only instances, within my knowledge, of the occurrence of this graceful Plover in this colony. The only specimen since obtained is that which I have the pleasure of exhibiting this evening—a male in full plumage, which was shot at Invercargill.

Although the western and southern portions of Australia appear to be the home of this species, it is apparently a rare bird even there, for Mr. Gould states he never met with it himself during his rambles in New South Wales, and had "only seen it now and then in collections from those parts." It is called Yä-jin-goo-rong by the aborigines of Western Australia.

Himantopus novæ-zealandiæ, Gould. (The Black Stilt.)

A specimen lately came into my hands in which there were scattered white feathers on the foreneck and on all the under-parts.

Stercorarius antarcticus, Gray. (The Southern Skua.)

In "The Birds of New Zealand" (vol. ii., pp. 63, 64) I gave the history of one of these birds that had been in my possession for some five years. In March last I received, through the courtesy of Mr. Lewis Wilson, Under-Secretary of Marine, a healthy young bird of the year which he had caught during a visit to the Snares. It is still an inhabitant of my garden, where it seems quite at home, manifesting the same characteristics of appetite and inquisitiveness as its predecessor, fraternising with a Gordon setter, but lording it over the Seagull and other birds within reach at feeding-time. It has a piercing black eye, which is ever on the alert.

I have been much struck with the readiness with which this bird adapts itself to a strictly terrestrial existence. Writing of the species, however, on Kerguelen's Land, Dr. Kidder says: "As a general rule its habits are terrestrial; and on the few occasions when, probably after poor success in hunting, I have seen it alight in the water, it has held its wings up perpendicularly, like a butterfly, as if afraid of wetting them. . . There being no land-birds on Kerguelen Island besides *Chionis*, the office and most of the habits of a Buzzard-hawk have been assumed by this great Skua. It was at first taken for a Hawk by all of us, its manner of flight, watchfulness of the ground over which it flew, and habit of perching on spots commanding a wide view, all suggesting this impression. It was, indeed, difficult to believe the evidence of my own senses when I found a web-footed bird avoiding the water, and preying solely, so far as my observation extended, upon other birds."

Ocydromus earli, Gray. (The Brown Woodhen.)

Captain Fairchild assures me that the same species of Woodhen inhabits Solander Island, in Foveaux Strait, as that found by him on Macquarie Island and identified by me as *Ocydromus earli*. He saw a good many during his brief visit to the island, and caught two, the skins of which were sent to the Auckland Museum.

Phalacrocorax carunculatus, Gmelin. (The Rough-faced Shag.)

Captain Fairchild brought me a fine specimen of this Shag from Queen Charlotte Sound on the 11th instant; and, as this is the first adult bird of that species I have had an opportunity of examining in the flesh, I give the actual measurements: Extreme length, 32in.; extent of wings, 49in.; wing from flexure, 12·75in.; tail, 6in.; bill, along the ridge 2·9in., along the edge of lower mandible 3·75in.; tarsus, 2·5in.; longest toe and claw, 5in. Irides clear hazel-grey; orbits of the eyes naked, slightly raised, and of a beautiful blue colour. The bare space surrounding the orbits and filling the lores has a roughened surface as if covered with minute papillæ, and is of a greyish-brown colour; on each side of the forehead these papillæ develope into small caruncles of a bright orange-yellow colour. Bill whitish horn-colour, changing to dull-brown on the ridge and towards the angles of the mouth, and shading into bluish-grey towards the base of the lower mandible. The naked gular sac or pouch, divided by a feathered stripe running to a point near the junction of the rami, has a streaky appearance, being of a dark greyish-green colour. The legs are flesh-white, the hind part of the tarsi and the undersurface of the toes being dull blackish-brown; claws dark-grey.

This bird proved on dissection to be a male; and, although this is the height of the breeding-season, it exhibits nothing in the form of a crest, not even a lengthening of the coronal and occipital feathers. This confirms the view put forward by me in "The Birds of New Zealand" (vol. ii., pp. 153–160), in opposition to Dr. Sclater and other leading authorities, that this species is the true *P. carunculatus* of Latham, and must not be confounded either with *P. imperialis*, King (the crested

Chatham Island form), or with *P. cirrhatus*, Gmelin, from Magellan Straits.*

I received at the same time two immature birds—in the first year's plumage, which is very different from that of the adult. The alar bar of white is absent, and there are no dorsal spots. The blue orbits are wanting, and there is no appearance of caruncles on the side of the forehead; added to which, the loral space, which is bare in the adult, has its surface covered with extremely minute feathers. The irides are dull greenish-grey; the sides of the lower mandible and the naked gular pouch, as well as the legs, are flesh-white. The plumage of this young state is fully described in my "Birds of New Zealand" (vol. ii., p. 174), where, with much hesitation, I treated the bird as a new species under the distinctive name of *Phalacrocorax huttoni*.

The breeding-season of this species appears to extend over several months. In July last Captain Fairchild visited the White Rocks, and found both eggs and young in the nests. Of the latter he brought over abcut half a dozen, which were forwarded by His Excellency the Governor to the Zoological Society of London. On his recent visit (some three months later) he again found both eggs and young. Of the former he has given me specimens; of the latter he brought away all that remained (five nestlings of different ages and sizes), which will be forwarded by Lord Onslow to London by the "Tainui" this month.

The egg of this species is of a delicate pale-blue colour, and a perfect ellipsis in shape, measuring 2·5in. in length by 1·5in. in breadth.

The only colony of these Shags of which we have any positive knowledge is that inhabiting the White Rocks in Queen Charlotte Sound, and numbering, according to Captain Fairchild's estimate, about fifty birds. All the specimens collected by Mr. Henry Travers, notices of which have from time to time been communicated to the Society, came from this locality. And it is worth remembering that Latham, who originally described the species, states that it inhabits New Zealand as well as South America, being "found in Queen Charlotte Sound, but not in plenty."

In my account of *Phalacrocorax carunculatus* in "The Birds of New Zealand" (vol. ii., pp. 160, 161), I have quoted Mr. Percy Seymour's remarks respecting a colony

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* Dr. Kidder refers a Shag he brought from Kerguelen Island to *P. carunculatus*, Gmelin, of which he makes *P. cirrhatus*, Gmelin, a synonym. But he states that "during the breeding-season the bird carries an erectile crest of about a dozen small plumes upon the top of the head; tarsus and foot yellow." Is not Kidder's bird the true *P. cirrhatus* or "Tufted Shag" of Gmelin?

of Shags, breeding at the foot of a small cliff on Otago Peninsula, as referring to this species. But this can hardly be the case, because he states that "their feet appeared from a distance of a few yards to be reddish or brownish," whereas *P. carunculatus* has flesh-white feet at all ages.

Phalacrocorax punctatus, Sparrm. (The Spotted Shag.)

To the already long list of New Zealand albinisms I have now to add the above species, of which I exhibit a pure albino obtained, as I am informed, at Kaikoura. Being without crests, it is evidently a bird of the first year; but it is in excellent plumage, except that the tips of the tail-feathers are abraded by wear.

Phalacrocorax brevirostris, Gould. (The White-throated Shag.)

I have received from Otago a very curious variety of this species. The plumage of the upper surface is normal; patch on throat much restricted in extent and creamy-white; middle of foreneck, breast, and under-parts to the vent greyish-white and brown intermixed, this effect being produced by each feather having a brown centre and greyish-white filaments.

Diomedea fuliginosa, Gmelin. (The Sooty Albatros.)

This species is more wary in its breeding habits than any other species of Albatros. It breeds both in the Auckland and Campbell Islands. But it usually selects as a nesting-place a ledge of rock high up on the face of the cliff, and quite inaccessible, either from above or below. The nestling in down which I exhibited at a former meeting of the Society was brought by the "Hinemoa" from the Auckland Islands; but the eggs of this species have not yet been obtained, although strenuous efforts have been made from time to time by the officers of the "Hinemoa" to reach the nests. Apart, therefore, from its modifications of structure, the entire difference in its habits of nidification would seem quite to justify the placing of this Albatros in a genus by itself.

Æstrelata affinis, Buller. (The Mottled Petrel.)

Mr. Cheeseman showed me, at the Auckland Museum, a fine specimen of this Petrel which he had obtained from Taupo. And Mr. Percy Seymour, writing from Preservation Inlet, after giving the description of a Petrel which fits in exactly with that of my *Æstrelata affinis*, says: "I have found a hill where these birds breed. I found two specimens dead and mutilated; and my dogs caught a third, but pulled most of the tail out. I took measurements of this one, but did not preserve it, as I intended to make a camp in a cave near the breeding-ground and collect a number. I visited the place at intervals, and the birds were just cleaning out their burrows (February), when some mining business called me away to another part of the district. However, I hope to get specimens next season. The burrows were very deep, and it would scarcely be practicable to collect a single specimen and return to the hut under eight or nine hours, unless a track were first cut through the dense bog-pine—a week's work, I suppose."

Æstrelata mollis, Gould. (The Soft-plumaged Petrel.)

Of this species Mr. Cheeseman lately showed me at the Auckland Museum an interesting series of skins from Sunday Island (Kermadec group). Two of them had the plumage entirely dark, showing that this species, like many other sea-birds, exhibits a peculiar phase of dimorphism. This is a subject about which we at present know very little, and it would be interesting to ascertain whether the dark character of plumage becomes hereditary under favourable conditions—that is to say, when dark birds pair together—or whether in such cases there is a latent tendency to revert to the normal colouring. It would be instructive also to note the character of the offspring when birds of the two phases mate together, as is often the case.

In Mr. Cheeseman's series there are two albinoes, both handsome birds, but one having the plumage of a purer white than the other.

Ossifraga gigantea, Gmelin. (The Giant Petrel.)

Of this fine Petrel, several remarkable examples have lately come under my notice. The specimen exhibited, which is an almost pure albino, was captured a few weeks ago off the coast near Kaikoura. The general plumage is white, but there are widely scattered feathers of the normal colour. There is a similar specimen in Mr. S. W. Silver's fine collection of New Zealand birds at Wantage. There is on board the "Hinemoa" the skin of another which was shot by the chief steward off the Snares about a year ago. In this the dark feathers are fewer, or more widely scattered, and the bill is of a yellowish horn-colour. Captain Fairchild tells me that for a long time past he has observed a perfectly white one at the Bounty Islands; but it is a very shy bird, and hitherto has kept well out of gun-range.

Since the above was written I have received another beautiful albino which was shot at sea about ten miles north of Milford Sound.

Puffinus gavia, Forst. (Forster's Shearwater.)

At the meeting of the Society held on the 29th October, 1890, I exhibited a specimen of this rare species (adult male) received by me from Otago. I have now the pleasure of exhibiting another specimen (adult female) recently received from Cape Farewell.

There are two examples in the Canterbury Museum; but, so far as I am aware, the species is not represented in any other local collection.

Garrodia nereis, Gould. (The Grey-backed Storm-petrel.)

Captain Fairchild brought me a specimen from Cape Farewell Lighthouse, where it had killed itself by striking against the lantern at night.

Puffinus griseus, Gmelin. (The Sombre Shearwater.)

Of this species there is a partial albino (received from the Snares) in the Auckland Museum. The back is almost entirely white, and the grey plumage of the under-surface is largely mixed with white.

Nesonetta aucklandica, Gray. (The Auckland Island Duck.)

I have now to exhibit another rare form, being the nestling of the Flightless Duck of the Auckland Islands. The body is covered with thick down, with long central filaments, especially on the upper parts. The general colour is dark olivaceous-brown, fading to pale fulvous-brown on the throat and foreneck, and to dull fawn-colour on the breast and abdomen. There is a purer shade of dark-brown passing through the eyes and melting away behind. The rudimentary wings have an outer fringe of yellowish-brown; the produced filaments on the shoulders and mantle are of the same pale colour. The bill is dark-brown, with the terminal shield and the whole of the under mandible yellowish-brown. Legs and feet olivaceous-brown, the webs being darker; claws yellowish-brown.

Hymenolæmus malacorhynchus, Gmelin. (The Blue Duck.)

I have now to exhibit a very interesting specimen of the Blue Mountain Duck in the condition of a fledgling—the first that has come into my possession. In "The Birds of New Zealand" I have described the young bird and the nestling of this species; but this is the intermediate state. The colours are those of the adult, but paler. The long, soft, white down is still present on the throat and lower side of the cheeks, whilst broken or irregular lines of the same proceed from the frontal base and from the sides of the upper mandible, and become scattered beyond the eyes. The dull olive-green down, with long disunited filaments, still adheres to the crown and other portions of the upper surface, being most pronounced immediately above the tail. The bill is slaty-brown (in the dried specimen), the terminal points of both mandibles and the serrated edges being dull-yellow.

I have already, in writing of the Penguins, stated that I consider the King Penguin (*Aptenodytes longirostris*) the most gentle of the group. Among the Ducks, this distinction undoubtedly belongs to the Blue Duck. The following incident is sufficient evidence of the fact: On the 13th October I was shown by the men at the survey camp a nest of this species in a hollow log lying about twenty yards from the stream at Rikiorangi, some seven or eight miles up the Waikanae River. The duck was on the nest, which was composed of soft down torn from her own body, and there were four eggs, one having been previously broken by the finder. On being captured, the duck, although apparently much frightened, uttered no sound, and made no attempt to escape. We brought her to Wellington shut up in a canvas bag, and, on being taken therefrom some hours later, she sipped water from a drinking-cup in the most unconcerned way. On being placed in a cage with her nest and eggs, she immediately claimed possession, and continued to sit, with few interruptions, for several days. But the eggs, which had been long incubated when taken, must have got chilled in transmission, for the duck, having apparently discovered that they were lifeless, first turned one out and then abandoned the nest. I do not know of any species of wild duck that, under similar circumstances, would have resumed, even for a time, the work of incubation. Had the duck been left undisturbed she would have hatched out her young in about a week or ten days. Some clutches, however, are earlier, for in the stream near which this nest was discovered a pair of Blue Duck had been disporting with five young ones for more than a week before our arrival.

The young of the first year has much less chestnut on the breast than the adult bird, all the true pectoral and surrounding feathers having only a minute spot of rufous with a point of black beyond, giving a speckled appearance to that part of the body; the head is washed with brown, and so is the mantle; the irides are dark-brown instead of being golden-yellow; and the bill is bluish-grey instead of white.

The eggs vary slightly in size, but 2·3in. in length by 1·5in. in breadth may be taken as a fair measurement. They are of a beautiful ovoido-elliptical shape; and, on being washed, the surface presents a delicate pale cream-colour, the green tinge referred to in "The Birds of New Zealand" (vol. ii., p. 278) being apparently due to soiling by contact with the bird's feet. One of these specimens also exhibited a decidedly green tinge before being washed.

Mergus australis, Hombr. et Jacq. (The Auckland Islands Merganser.)

I have much pleasure in now exhibiting the young of one of the rarest of our endemic species, the Merganser of the Auckland Islands. The bird exhibited is apparently about a week or ten days old. It is covered with thick, long, and somewhat glossy down. The upper part and sides of the head, the hindneck, and the entire upper surface and sides of the body, dark olive-brown; throat and foreneck and spot under each eye, bright rufous, fading away towards the breast; under-surface yellowish-white; wings dark olive-brown, marked along the outer edge and longitudinally on the under-surface with yellowish-white. Bill very dark olive, shaded with brown on the ridge, the terminal shield on both mandibles reddish-brown with a polished surface; legs and feet dull olive-brown, paler on the toes, the interdigital webs darker, and the claws yellowish-brown.

It is very desirable that specimens of this interesting form in the adult state should be obtained for our museums before it is too late. Although the "Hinemoa" makes periodical visits to the Auckland Islands, its only known habitat, and eager search is made, the bird is scarcely ever seen; but in the absence of the natural enemies, which abound elsewhere, there is no reason why the species should become extinct. There is a good specimen in the Colonial Museum, and, I think, another in the Otago Museum. The British Museum collection contains a pair; there is another pair in the Imperial Museum at Vienna, and a single specimen in the University Museum at Cambridge. Besides those in my own collection this completes, as far as I am aware, the known record of this interesting species.

It will be noticed that the toothed character of the mandibles is well developed even in the nestling.

Eudyptes pachyrhynchus, Gray. (The Crested Penguin.)

At the end of February I saw a nestling of this species partly fledged. The down of the upper surface sooty-black, with a brownish tinge; that of the under-parts white, excepting a band of the dark colour, which crosses the foreneck under the chin.

Eudyptes chrysolophus, Brandt. (The Royal Penguin.)

I am able now to give the measurements of this species, taken from specimens in the flesh, from Macquarie Island.

Adult Male.—Length, 29in.; extent, 23·5in.; length of flipper, 9in.; bill, along the ridge 3·25in., along the edge of lower mandible 3·5in.; tarsus, 1·5in.; middle toe and claw, 3·7in.

Adult Female.—Length, 26·5in.; extent, 21in.; length of flipper, 8in.; bill, along the ridge 2·5in., along the edge of lower mandible 2·8in.

The birds having just completed their seasonal moult, their tails have not grown, and therefore no measurements are given.

In both sexes the feet are of a delicate yellow colour. Irides bright chestnut-red; the eye flat, as in the other species, having the appearance of a button, the pupil being extremely small. At the angle of the mouth there is a fleshy membrane of a dull pink colour, forming, when the bill is closed, a conspicuous, slightly tumid, triangular patch. The sexes are alike, but the male has a more robust bill and a larger amount of golden yellow in the vertex and crest.

It is very certain that this is not the same species as that referred to *E. chrysolophus*, with a query, by Dr. Kidder in his notes on the Birds of Kerguelen Island (Bull. U.S. Nat. Mus., 1875, pp. 45, 46). The measurements he gives point to a much smaller bird, the largest of his specimens being only 23·85in. in length, with an extent of 15·5in., and a flipper measuring 6·5in. in length. Besides, the information which he gives of the habits of his Penguin does not fit in with what we know of *Eudyptes chrysolophus*. He writes: "The nests are rather more distinct than those of *Pygoscelis*, and most of them were lined with dried grass. Each contained two white eggs, of which one was usually larger than the other; and both birds were, as a rule, by each nest. Whether one hunts to feed the other or not, I cannot say. A small flock came in from sea while I was present, announcing their arrival by a single shrill whistle, frequently repeated, and answered from the shore. They were wonderfully courageous, erecting their sulphur-coloured plumes and trembling all over with excitement on my approach, while they kept up a strident cackling that was almost deafening. Although knocked off their nests and driven over the steep rocks for often 12ft. or 15ft., they would pick themselves up and scramble back again with unabated courage, threatening, and even biting sharply, to the very last. . . . . The apparent widening of the cheeks, caused by the erectile plumes and the position of the feathers below them, looking not unlike 'whiskers' on a front view, have given rise to the name of 'sea-cats,' occasionally applied to these birds."

It is abundantly evident from the above extracts that Dr. Kidder was writing of a very different bird from ours and a much smaller one: indeed, he refers to it as a "brave little

Penguin." I have no doubt whatever that I am right in my identification of the true *E. chrysolophus*, because, in company with Mr. R. Bowdler Sharpe, who had been working out the Penguins, I examined a good series of specimens in the British Museum so labelled; and, as I have now explained, this is the young state of *E. schlegeli*, which, for the reason I have before given, sinks into a synonym.

Aptenodytes longirostris, Scop. (The King Penguin.)

The young of the second year differs from the adult in having the corniform occipito-lateral markings detached from the yellow of the foreneck, and these as well as the latter, instead of being bright yellow, have only a wash of pale lemon-yellow on a white ground. The green velvety sheen, so conspicuous in the adult, is absent from the head and throat, these parts being dull black. The plumage of the upper parts is darker and lacks much of the slaty-blue hue which characterizes the adult.

In a previous paper I have described the nestling and the young of the first year, these transitional states being very curious and interesting.

Apteryx oweni, Gould. (The Little Grey Kiwi.)

Mr. Percy Seymour, who has been residing some years at Preservation Inlet, collecting the birds in that locality for European museums, writes me, under date the 17th July, "I have ascertained that since this time last year *Apteryx oweni* has bred, at intervals of about seven weeks or so, no less than *five* times, if not *six*." If this be the case there ought to be no difficulty in perpetuating the species, if the surrounding conditions are favourable. Whatever its fecundity may be, however, a wingless species stands no chance whatever in the face of stoats, ferrets, and weasels, of which some thousands have lately been introduced by the Government and turned loose in all parts of the country, in the hope of suppressing the rabbits.* The only chance now of saving the various species of apterous birds is in their complete isolation. If Lord Onslow's proposal to set apart the Little Barrier Island in the North and Resolution Island in the South as inviolable

* It is too late now to discuss the wisdom or folly of this introduction. But there is reason to fear that the colonists will soon become familiar with reports of the kind recently telegraphed from Palmerston North, as follows: "A child named Just was attacked on Sunday morning, whi playing on the racecourse, by four stoats, two of which fastened on to the child's neck, maintaining their hold until driven away by the child's parents, whose attention was attracted by the screaming of the child. A number of lambs were also found dead on the course, appearances indicating that their death has been caused by stoats."

preserves, stocking them from time to time with all the desirable species and placing them under the strictest protection, be carried out, then we may hope to be able to save from extinction some, if not all, of these interesting forms. Failing that, their final extirpation is not far distant, and the student of the future will have nothing left to him but the dried specimens in European and colonial museums, and such memoirs of the indigenous species as the industry or opportunities of present observers may have furnished. I have done what I could, both by pen and pencil, to preserve a history of all these birds, but I believe we have yet much to learn respecting many, if not all, of them; and on every account it is most desirable that the birds themselves should be preserved, with, as far as may be possible, their natural environment.

ART. IV.—*On the large Kiwi from Stewart Island* (Apteryx maxima).

By Sir WALTER L. BULLER, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

AT a meeting of this Society, held on the 2nd July, 1890, I exhibited and made remarks on a large Kiwi from Stewart Island, which I had no hesitation in referring to *Apteryx maxima*, Jules Verreaux (see Trans., vol. xxiii., pp. 602, 603). At that time, as I then stated, this was the only known example of the species in any public or private collection. Since that date, however, four more examples, two males and two females (all from Stewart Island), have been brought to Wellington, and I had favourable opportunities of examining them before they were shipped alive for Europe. All these birds presented the same distinguishing characters as the specimen I had the pleasure of exhibiting; so that the species may now be considered well established. One of the females was even larger in all its proportions. This was one of a pair sent to England by the "Arawa" in December last, consigned to a private collector, who had already received the former pair in safety.

On the day prior to their shipment I made the following descriptive notes:—

Male.—Extreme length, following curvature of the back 30·5in., to end of outstretched legs 36·5in.; bill, along the ridge 5·5in., along the edge of lower mandible 5·5in.; from anterior margin of cere to extreme point of upper mandible, 4·5in.; wing, 2in.; tarsus, 3·5in.; middle toe and claw, 3·5in.; hallux, 1in.; largest circumference of foot, 4in. The rudimentary wings are furnished at the extremity with a long, slightly-curved, greyish-black claw; that on the right wing is 0·75in. in length; that on the left wing is ¼in. shorter and less curved. Weighed exactly 6lb.

Female.—Extreme length, following curvature of the back 33in., to end of outstretched legs 43in.; bill, along the ridge 7·75in., along the edge of lower mandible 7·75in.; wing, 2in.; tarsus, 3·5in.; middle toe and claw, 3·75in.; hallux, 1in.; greatest circumference of foot, 4·25in. The claw or spur on the rudimentary wings is ½in. in length, more curved than that of the male bird, sharply pointed, and of a dark-grey colour. The bill is greyish-brown, shading into black on the culmen, especially in its apical portion, the tip being whitish horn-colour. Tarsi and toes dark bluish-grey; claws paler. Weighed 6½lb.

The plumage of these birds is very similar to that of *Apteryx australis*. The male presents more chestnut in the colouring, and the lanceolate markings on the upper surface are more distinct than in the other sex. This richer appearance is due to the feathers having chestnut tips, pointed with black. The bill and feet are likewise darker, and more uniform in colour, with lighter claws.

In the male bird the tarsi towards their distal extremities and the phalangeal joints are scutellate, but in the female these parts are entirely covered by rounded scales. This goes to confirm the view already advanced by me that this character, to which so much importance has been given by some naturalists, has really no specific value.

Postscript.—Since the above notes were written I have received a letter from Lord Onslow (dated from the Bluff, 3rd February), stating that he had just returned from a visit to the Sounds and Stewart Island in the "Hinemoa," and had been successful enough to obtain another of these large Kiwis, which he hoped to take to England with him alive. Assuming the identification to be right, this gives us six examples of *Apteryx maxima* during the last eighteen months; but, unfortunately, not one of our local museums possesses a single specimen.

ART. V.—*The Moas of New Zealand.*

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

[*Read before the Philosophical Institute of Canterbury, 1st October and 4th November, 1891.*]

Plates XV.-XVII.

CONTENTS.

INTRODUCTION.

NOTHING connected with the natural history of New Zealand has attracted more attention than the extinct moas. Ever since 1840, when Sir R. Owen announced to the scientific world the former existence in New Zealand of a large struthious bird, exceeding the ostrich in size, interest in the subject has not flagged. And the discovery that the moas were wingless, and had formerly existed in great numbers and in great variety, opened up several new problems for naturalists to solve. With the exception of the moas, every known bird, whether living or dead, has wings. In some they are so small as to be useless, as in the kiwi and the cassowary; while in the penguins they are used only for swimming. Still, some kind of fore-limb exists in all birds but the moas. We know that the moas were wingless, partly by the negative evidence of no wing-bones having ever been found, and partly by the positive evidence of the skeleton, which has no cavity for the articulation of a wing, and in many cases does not show the existence of any shoulder-girdle at all. However, as will presently appear, it is probable that one genus of moas (*Palapteryx*) had rudimentary wings like the kiwi.

Our knowledge of the moas, of their structure and of their history, is very fragmentary, and the information is scattered through various publications. There is considerable confusion in the characters given of the different species, and different opinions are held as to when the moas came to New Zealand and when they became extinct. Under these circumstances I have thought that an attempt to clear up the confusion and to give a connected account of what is known on the subject would prove useful as a basis for further investigation. With this object in view I have been collecting materials for some time. I have examined most of the collections in New Zealand, and I have collated all the measurements hitherto published—those by Sir R. Owen in the Transactions of the Zoological Society; those by Sir James Hector in the Proceedings of the Zoological Society for 1865 (p. 751); as well as those given in various volumes of the Transactions of the New Zealand Institute by Sir Julius von Haast, Mr. Thorne, Mr. Taylor White, and by myself. Mr. Aug. Hamilton has also supplied me with measurements of all the leg-bones found in the Patangata Swamp, near Te Aute—a large and valuable collection which has been most useful to me. I have also to thank Sir James Hector, Professor T. J. Parker, Mr. H. O. Forbes, Mr. T. F. Cheeseman, and Mr. R. J. Kingsley, for allowing me to examine the collections of moa-bones in the Museums of Wellington, Dunedin, Christchurch, Auckland, and Nelson respectively. In addition, I have received valuable information from private collectors, including Mr. F. W. Stubbs; Mr. Mitchell, of Manapouri Station; Mr. W. Colenso; and the Hon. W. Mantell; to all of whom I here tender my best thanks. The magnificent series of plates published by Sir R. Owen in the Transactions of the Zoological Society, and reissued in his "Extinct Birds of New Zealand," have made the collections in London known to all naturalists, and they have been of the greatest use to me. In my paper I have quoted these plates from the "Extinct Birds," and not from the Transactions of the Zoological Society, because the former is to be found in all good libraries in New Zealand, while the latter are very rare.

By the means just enumerated I have become possessed of an amount of information far greater than has been got together before, and it has, I think, enabled me to clear up the classification of the moas, as well as to throw some new light on their distribution and history. My work is founded on the measurement of the leg-bones of individual birds belonging to sixteen different species, and from these I have inferred with considerable certainty the proportions of the leg-bones in the other species. There is still, however, in many cases much conjecture in placing the other bones of the skeleton with the legs. In those genera of which I have seen a considerable number of skulls, sterna, and pelves, the chance of error is small in assigning the largest bones to the largest legs, and *vice versa*, and then fitting in the intermediate forms. And when we have an occasional check in an individual skeleton the chances of error are further reduced. Again, geographical distribution sometimes gives a clue to the assignment of bones, some species being found in both Islands, and others only in one. And, lastly, we have relative numbers to help us, as the commonest skulls, &c., will usually belong to the commonest legs. It is by these means that I have drawn up the tables of measurements of the species. I do not expect that I have escaped error altogether, but I hope that I have arranged my conclusions in such a way that any errors may be readily detected by future investigators. I regret much that I have not been able to make as close an examination of the crania as I could wish, for, with the exception of a few skulls from Shag Point belonging to the genus *Euryapteryx*, which have been kindly lent me by Mr. Aug. Hamilton, I have only had opportunity for hurried observations in the different museums I have visited.

The first announcement of the former existence of large struthious birds in New Zealand was by Mr. J. S. Polack, who, in his book "New Zealand," published in 1838, stated that he had found their bones near the East Cape of the North Island. Subsequently—1839 to 1843—several collections were made by Mr. W. Colenso, the Rev. W. Cotton, and the Rev. W. Williams in that district and at Poverty Bay. In 1844 the Rev. R. Taylor found them in numbers at Waingongoro, near Wanganui, and a large collection was made from here by the Hon. W. Mantell in 1847,* and by Sir G. Grey in 1850. In 1852 Dr. A. S. Thomson found many bones in the limestone caves in the upper Waipa country,† and others have been found about Tongariro and Lake Taupo, as well as near Wellington. In 1875 Mr. J. Thorne made a valuable discovery of bones at Pataua, near Whangarei, and others have been since found in that neighbourhood, as well as near Auckland, by Mr. T. F. Cheeseman. In 1887 a rich locality was found at Te Aute, near Napier, and was collected from first by Mr. Aug. Hamilton, and afterwards by Mr. James Park, for the Geological Survey.

The first discovery of bones in the South Island was made by Dr. Mackellar and Mr. Percy Earl at Waikouaiti, in Otago, in 1846; a locality which was explored three years later by the Hon. W. Mantell,‡ who again, in 1852, made a good collection from an old Maori cooking-place at Awamoa, near Oamaru. In 1861 the limestone caves in Collingwood County were explored by Sir J. von Haast and Mr. Maling, and from this time onwards numerous discoveries were made in Canterbury and Otago. In 1866 Sir J. von Haast began his classical explorations at Glenmark; and the almost equally rich deposit at Hamilton, in Central Otago, was explored by me in

* Quar. Jour. Geol. Soc., vol. iv., p. 238; and "Petrifactions and their Teachings," p. 94.

† Edin. New Philos. Jour., 1856, vol. lvi, p. 268.

‡ Quar. Jour. Geol. Soc., vol. vi., pp. 327 and 334; and "Petrifactions and their Teachings," p. 98.

1874. Interesting discoveries have been made lately in caves in the Nelson District, as well as at Castle Rock, in Southland; and only last month another large deposit was found near Oamaru, and collected from by Mr. H. O. Forbes.*

Fragments of egg-shell have been found in abundance at Whangarei and Wanganui,† as well as in Canterbury and Otago. The Hon. W. Mantell restored, more or less perfectly, about a dozen eggs from Awamoa;‡ and several have been found in the interior of Otago. A nearly perfect one was found in 1867 at Cromwell, which contained the bones of the embryo chick.§ It measured 9in. by 6in., and was found in sand about 2ft. below the surface. Another, still more perfect, was found at the end of 1859, or the beginning of 1860, at Kaikoura, with a Maori skeleton. It measured 10in. by 7¾in., and was sold in London for £120.‖ The specimens of shell are almost always white or stained brown with earth; but two fragments of a pale-green colour have been found, one at Queenstown, the other in sand on the banks of the Kawarau River.¶ We may therefore conclude that the egg was probably white in some species, but pale-green, like that of the cassowary, in others. The egg-shell consists of two calcareous layers: the outer layer is the thicker, and is laminated; the inner layer has a columnar structure, each column sometimes containing triangular prisms,** but the structure differs much in different eggs. The canals through the shell are oval and simple.

Little heaps of stones—moa-stones—from the gizzards of the birds have been often found. These stones vary in size from quite small up to 2oz. in weight, while a complete set weighs from 8oz. up to 5lb.†† Sir J. von Haast noticed that these stones had always been picked up by the birds in the immediate neighbourhood,‡‡ showing that they did not travel fast.

Feathers have been found in the alluvial sands of the Clutha River, between Alexandra and Roxburgh, 18ft. below the surface; and also in caves near Queenstown. Most of them have two shafts to each quill, but some have only one

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* For a list of localities at which moa-bones have been found see Geol. Mag., series 3, vol. i., p. 129 (1884).

† "Petrifactions and their Teachings," G. A. Mantell, p. 121.

‡ See Owen's Ext. Birds of N.Z., pl. cxv., as *crassus*.

§ Trans. N.Z. Inst., vol. iv., p. 110.

‖ "Zoologist," 1866, p. 34; Trans. N.Z. Inst., vol. iv., p. 403; Ext. Birds of N.Z., pl. cxvii.

¶ Trans. N.Z. Inst., vol. viii., pp. 98 and 101; and vol. xviii., p. 83.

** Nathusius, Zeit. Wissensch. Zool., xx., p. 118; and Hutton, Trans. N.Z. Inst., vol. iv., p. 166.

††.Ext. Birds of N.Z., pl. xcii.; Trans. N.Z. Inst., vol. xvii., p. 174.

‡‡ *L.c.*, vol. iv., p. 73.

shaft. When there are two shafts to a quill one is usually, but not always, shorter and more slender than the other. The largest are not more than 7in. in length. It would appear probable, from specimens of skin which have been found, that the feathers of the neck were two-shafted, while those on the legs were one-shafted. In colour they differ. Those from the Clutha are brown at the base, shading upwards into black, while the top is white.* Those from Queenstown are either reddish-brown with a central longitudinal stripe of dark-brown near the apex, or they are pale-brown margined with darker. One was pure-white.† Evidently the Clutha bird was speckled with white on a black ground, while the Queenstown birds were streaked longitudinally with two shades of brown. A bone of *S. casuarinus* was found in the cave with the latter feathers, but there is no proof that the feathers and the bone belonged to the same bird. Professor Owen has shown that the legs of *M. didinus* were feathered down to the toes, the feathers on the metatarsi being from 1in. to 2¼in. in length, and without an accessory plume. The basal part of each feather is light-grey, deepening towards the apex into reddish-brown.‡ There were also feathers on the specimen of *D. potens* found at Tiger Hill.§ The feathers are furnished with barbules up to the very tip, except in a few cases; but barbicels are always absent. The shafts are slender and flexible, and do not project beyond the barbs.

Not only were the moas at one time very numerous, but there were many different kinds, ranging in height from 2½ft. up to 11ft. or 12ft.—that is, 3ft. or 4ft. higher than the largest ostrich; but the smaller birds were far more common than the large ones. They all agreed in being remarkably robust in build, with strong legs, and rather flat heads with small eyes but well-developed olfactory organs. The whole bird, from the head downwards, was covered with soft fluffy feathers. There were no long plumes on the head or on the tail. Dr. von Hochstetter, in his book "New Zealand," has given, on page 176, an admirable restoration of one of the species of *Dinornis*.

The brain was very small in proportion to the size of the spinal cord.‖ The beak differed a good deal in the different kinds, being sharp and pointed in some, obtuse and rounded

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* Trans. N.Z. Inst., vol. iv., p. 166; Ext. Birds of N.Z., p. 442, and pl. cxiv., figs. 8–11.

† Trans. N.Z. Inst., vol. viii., p. 101, and vol. xviii., p. 83.

‡ Trans. Zool. Soc., vol. ii., p. 257.

§ Dallas, Proc. Zool. Soc., 1865, p. 265.

‖ Ext. Birds of N.Z., p. 326, pl. xci., figs. 11–13.

in others, but it was never much longer than the head. The neck was remarkably long, having nearly as many vertebræ as a swan, and was very strong and muscular. The body was short and plump, without any wings; while the legs were very massive, and with particularly muscular thighs. The length of the leg differed very much; and some of the South Island species must have been absurd-looking creatures—nearly as broad as high, with short, heavy, stumpy legs, on which they could hardly waddle. Probably all of them had a hind-toe which was raised from the ground. The claws were strong, and formed good implements for scratching. Those of the front toes were curved, while that of the hind-toe was nearly straight. Like other struthious birds, they voided their urine separately, and dry fæces have been found in a cave near Queenstown, which proved, what had previously been inferred from the gizzard-stones, that the moas were vegetable feeders.* Evidently the birds were stupid and sluggish, and probably diggers of the ground.

Very little is known about the soft parts, but the integument, tendons, and some of the muscles of the leg and foot of *D. potens*,† *S. crassus*,‡ and *M. didinus*§ have been described by Sir R. Owen, by Dr. Coughtrey, and by myself. The integument and muscles of the neck of *S. crassus*|| have been described by Sir James Hector and by Dr. Coughtrey; and the head of *M. didinus*¶ by Sir R. Owen. Two fragments of egg-shell found in Monck's Cave, near Sumner, have the shell-membrane still remaining.** It is very thick, fibrous, and stained brown: the egg-shell is white.

Classification of the Moas.††

Sir Julius von Haast, in 1874, divided the moas into two families—the Dinornithidæ and the Palapterygidæ, characterized by the absence or presence of a hind-toe, and by a supposed difference in the osseous tissue of the bones; those of the Palapterygidæ being, he thought, rougher on the exterior, harder, thicker, more dense, and consequently heavier, than

* Taylor White, Trans. N.Z. Inst., vol. viii., p. 99.

† Ext. Birds of N.Z., p. 248, pl. lxxi.; Trans. N.Z. Inst., vol. vii., pp. 267 and 271.

‡ Trans. N.Z. Inst., vol. vii., p. 143.

§ Trans. Zool. Soc., vol. xi., p. 257.

|| Trans. N.Z. Inst., vol. iv., p. 114; and vol. vii., p. 141.

¶ Trans. Zool. Soc., vol. ii., p. 257.

** The "internal epidermis" of Mr. Forbes. Trans. N.Z. Inst., vol. xxiii., p. 374.

†† I regret that I have not been able to see Mr. Lydekker's "Catalogue of the Fossil Birds in the British Museum," 1891. No copy has as yet been received in Christchurch.

those of the Dinornithidæ.* In this he has been followed by Dr. H. Woodward,† and doubtfully by Professor A. Newton, who included the two families in a separate order, which he called "Immanes."‡ But long ago I pointed out that these characters would have been too slight to distinguish the families even if they had been correct;§ and it is now known that most, probably all, of the moas had hind-toes, and that no distinction in osseous tissue can be made out. I therefore include them all in one family.

Genera.

Sir R. Owen founded the genus *Dinornis* in 1843, on the leg-bones of *D. struthioides*‖ and several other species. In 1846 he formed a new genus—*Palapteryx*—to receive those species in which he had inferred the existence of a hind-toe—namely, *P. ingens*, and *P. dromioides*. In 1848 he described a cranium as that of *P. geranoides* (really *P. dromioides*), and another as *P. dromioides* (probably *C. geranoides*). Still later he unfortunately described the skull of *Aptornis* as that of *Dinornis casuarinus*, and he thus made a wide difference between *Dinornis* and *Palapteryx*. The mistake was pointed out by Professor W. K. Parker; and Owen abandoned his genus *Palapteryx*, not considering that the absence or presence of a hind-toe was, by itself, sufficient to distinguish the two genera.¶

In 1850 Reichenbach, in his "Das Natürliche System der Vögel," made six new genera out of the eight species which Professor Owen had described up to that time, so that each genus contained one species only. I have not seen this book, and know it only by Owen's quotation,** but it would seem that Reichenbach shot at a venture, because he could not possibly have given good characters to his genera. In 1874 Sir J. von Haast grouped the moas of the South Island into four genera—two in his Dinornithidæ and two in his Pal-

* Trans. N.Z. Inst., vol. vi., p. 424. In Nicholson's "Manual of Palæontology," vol. ii., p. 1226, Mr. Lydekker says, "According to the late Sir J. von Haast, the Palapterygidæ were provided with rudimentary wings." This is a mistake, for Dr. Haast distinctly says that his Palapterygidæ had not even a scapulo-coracoid.

† Proc. Geol. Association, 1885, p. 363. Dr. Woodward's reference in this paper to *Erythromachus* as belonging to the Apterygidæ is a mistake. It is a carinate ralline bird, thought by A. Milne-Edwards to be allied to *Ocydromus*.

‡ Encyclopædia Britannica, 9th ed., art. "Birds," p. 73, and art. "Ornithology," p. 44.

§ Trans. N.Z. Inst., vol. ix., p. 363.

‖ Proc. Zool. Soc., 1843, p. 8; and Trans. Zool. Soc., vol. iii., p. 235.

¶ Ext. Birds of N.Z., p. 258.

** Ext. Birds of N.Z., p. 417.

apterygidæ—and gave several generic characters by which they might be distinguished, some of which were good, but most of them quite incorrect. In fact, at that time the species had not been accurately made out,* and consequently a correct grouping of them was impossible. Sir R. Owen subsequently reviewed the whole question, and came to the conclusion that it was best for the present to retain all the species in the single genus *Dinornis*, and this he has done in his "Extinct Birds of New Zealand," 1879.

But undoubtedly the differences in the crania of the different moas are quite sufficient to indicate the existence of several genera; the difficulty hitherto in defining these genera has been that the cranial differences did not appear to go with the other characters. But the extensive material examined by me has shown that in many cases the heads have been placed on the wrong birds, the exceptions being *D. robustus*, *D. struthioides*, *D. parvus*, *D. didinus*, and *D. gravis;* and after reducing the species to order I find that they fall into seven well-defined genera, founded on the crania, but generally accompanied by characters derived from the pelvis, the sternum, the absence or presence of a scapulo-coracoid, and the robustness of the leg-bones.

Species.

Nineteen species have already been made by Sir R. Owen, and one by Sir Julius von Haast, the specific characters being based on the bones of the leg. However, only four of these species—viz., *D. maximus*, *D. didinus*, *D. parvus*, and *D. oweni*—have been described from the bones of a single individual. In all other cases, the different bones of the leg had to be put together conjecturally from collections sent to England at different times between 1843 and 1872, and so it is no wonder that many of the bones were wrongly placed. For example, the examination of the legs of individual birds has shown that *D. altus*, *D. ingens*, *D. gracilis*, *D. struthioides*, *D. geranoides*, *D. rheides*, *D. crassus*, *D. casuarinus*, and *D. gravis*, of Owen, are all made up of bones belonging to more than one species. In these cases I have taken the metatarsus as the type of the species, except with *D. ingens*, where the tibia forms the type. These individual legs, together with a comparison of a very large number of bones from all parts of New Zealand, has enabled me, I believe, to correct most of the errors, and to reduce the species to order. The most difficult bones are the femora. Indeed, with our present limited knowledge it is sometimes impossible to refer them with confidence to the right species.

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* See, however, Trans. N.Z. Inst., vol. iv., p. 70, line 9 from top.

The species are not distinguished by any anatomical differences in the leg-bones, but merely by size. In many cases, especially in the genera *Syornis* and *Euryapteryx*, there are considerable differences in the amount of divergence of the metatarsal condyles, which may be of specific value, but I am inclined to think that it depends largely on the age of the individual. Also, the tibiæ vary much in the curvature of the shaft; but there are complete gradations from one form into the other, and I cannot think this curvature to be of specific value.*

There appear to be specific differences other than size in the crania; but this must be left for future investigation. So far as the leg-bones are concerned, my examination has shown that several of the species pass gradually one into another, so that any line separating them must be an arbitrary one; and I should not be surprised if further knowledge showed that this applies to those species which at present appear to be distinctly marked off. For we are here dealing with a large number of individuals which lived for a very long time without the check of natural selection to eliminate the intermediate forms—a case which is probably unique in natural history.

In the tables of measurements of each species I have given first the measurement of Professor Owen's type, then those of individual leg-bones found together, and then the maximum and minimum size and robustness which I allow to each species—the latter being represented by the girth at the middle of the shaft. It may be thought that the twenty-six species which I have admitted are too many; but after a careful consideration of the subject I have come to the conclusion that a less number would not represent the facts sufficiently, and would not give an adequate idea of the great variety of form which the moas exhibit. In the genus *Syornis* only the smaller individuals are found in the North Island, and this gives us a maximum limit for *S. casuarinus*. The larger individuals of the genus, which are found only in the South Island, show too great a diversity to be included in one species at all uniform with *S. casuarinus*, and consequently they must be divided into two. From this we get an idea of the amount of variation to be allowed to each species in the genera *Euryapteryx* and *Cela*. With *Dinornis* and *Palapteryx* the case is different, because with them we have to take geographical distribution into consideration, and smaller morphological distinctions may with advantage be taken to differentiate species when they are combined with a different geographical distribution. It is also a question which must be left for future investigation whether those

* Trans. N.Z. Inst., vol. vii., p. 277.

species in the two Islands which are nearly of the same size are truly representatives of each other, or whether they form two parallel lines of development, one in each Island, both of which are descended from *D. struthioides*. To join the species together would delay the settlement of this question.

Sexual Differences.

In his second paper on *Dinornis*, Professor Owen discussed the question whether some of his species might not be the opposite sex of others, and came to the conclusion that they were not so.* With this conclusion I quite agree. *A. didiformis* has no near ally, and must therefore contain individuals of both sexes. It is the same with *Palapteryx*, of which there is only one species in each Island. *S. casuarinus* and *M. didinus* are not likely to be male and female, because their heads differ so much; and, if they are not a pair, each of these species must contain individuals of both sexes in the North Island, and, consequently, in the South Island also. If *D. struthioides* is only one sex, then the opposite sex must have had different forms in the two Islands—*D. torosus* in the South, and *D. gracilis* in the North. But *D. torosus* and *D. struthioides* cannot be the two sexes of one species, because they have different geographical distributions, *D. torosus* being almost entirely confined to the north part of the South Island, while *D. struthioides* was more abundant in the south than in the north. It is the same with *C. geranoides* and *C. curtus*, the former being more abundant in the south-eastern, the latter in the north-western, part of the North Island. And if this is true for six of the genera we may be sure that it is true for *Euryapteryx* also.

Sir Julius von Haast has on several occasions stated his opinion that several species of moa consist of individuals of two distinct sizes, with no intermediate forms, which he took to be male and female, and he refers to specimens in the Canterbury Museum as confirmatory of this opinion.† Unfortunately, he never published any measurements showing these supposed sexual differences, and the collection he refers to in the Canterbury Museum by no means bears out his statement. Dr. Haast had specially named *S. casuarinus* as one that showed these sizes, and I therefore published, in 1874, measurements of all the bones of this species found in the swamp at Hamilton;‡ and these show a gradual passage from the smallest to the largest. In the following year Mr. Thorne

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* Ext. Birds of N.Z., p. 90.

† Trans. N.Z. Inst., vol. i., p. 81, and vol. vi., p. 425; Geol. Cant. and West., 1879, p. 433.

‡ Trans. N.Z. Inst., vol. vii., p. 278.

published measurements of all the bones found by him near Whangarei,* which proved the same thing for *C. curtus*. Nevertheless, Sir Julius repeated his statement in 1879 without referring to either of these lists of measurements; and in 1886, in his paper on *D. oweni*, he once more says that there are two different sizes in that species.† But again he gives no measurements in proof of his statement; and the extensive table which I have compiled of the measurements of *C. curtus* and *C. oweni*, as well as of several other species, shows positively that they are not divided into two distinct sizes differing either in the length or in the robustness of their limbs. Certainly I admit two varieties, differing in size, in *S. casuarinus;* but the sizes overlap one another, and have been recognised only because they have a different geographical distribution; which is, by itself, a sufficient proof that they cannot be the sexes of one species.

I do not, of course, maintain that there was no difference in size between the sexes. In the ostrich, the emu, and the cassowary the male is rather larger than the female; but in the kiwi the female is considerably larger than the male. Professor T. J. Parker has shown that in the kiwi the hind limbs undergo a relative diminution in size between the time of hatching and the attainment of fully adult proportions,‡ and this is especially the case with the female. This implies that the ancestral kiwis were, like *Megalapteryx*, larger than the living birds; and we may infer the same thing from the great size of the egg. It is a legacy from a larger bird, which is not easy to get rid of. The greater proportionate size of the female is therefore probably due to its having to lay such a very large egg. The males have decreased in size more rapidly than the females, who were handicapped by such large eggs. I shall subsequently show that the moas increased in size during development, so that the usual rule of the male being larger than the female would probably apply to them. But this difference has not yet been proved; and, if it existed, some individuals of the larger sex must have been as small as, or smaller than, some individuals of the smaller sex.

Family DINORNITHIDÆ.

The *skull* is remarkable for the great breadth and flatness of the occipital region, and the broad and deep temporal fossæ. The plane of the foramen magnum is nearly vertical, and the basi-occipital forms nearly a right angle with the basi-sphenoid. There is a broad and deep depression between the condyle and

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* Trans. N.Z. Inst., vol. viii., p. 94.
† Trans. Zool. Soc., vol. xii., p. 172.
‡ Phil. Trans., vol. clxxxii., p. 42, and pl. vi.

the paroccipital process. In the interior of the brain-case the tentorial ridge is low, as also is the bony plate between the cerebral and optic fossæ. The optic foramina are widely separated. The olfactory cavities are very large, extending backward between the orbits nearly to the optic foramina, each with a separate olfactory foramen. The lateral ethmoids are large, but do not appear on the upper surface of the skull; they are rolled up into a small spiral process in the posterior portion of each olfactory chamber, forming the posterior turbinals. The internasal septum is perforated posteriorly. The pterygoids articulate with basi-pterygoid processes, which arise from the basi-sphenoid. The rostrum is very long; the ventral border of the presphenoid is produced on each side into a horizontal triangular plate. The vomers are broad and separate; they articulate posteriorly with the pterygoids, and are connected with the palatines. The palatines join the vomers posteriorly, and also articulate with the pterygoids; the maxillary processes are produced forward, and end anteriorly in horizontal expansions, which are interposed between the maxillaries and the vomers; there are no distinct maxillo-palatine processes. The upper squamosal head of the quadrate is broad and single. The nasals anchylose with each other posteriorly. The beak is rather short, never much longer than the head, more or less curved downwards. The eye had a ring of bony sclerotic plates.

The *vertebral column* consists of from 54 to 56 vertebræ, as follows: Cervical, 20 or 21;* cervico-thoracic, 3 or 2; thoracic, 7, of which the last three or four are united to the pelvis; lumbar and sacral, 10 or 11; caudal, 14 or 15, of which the first three or four are united to the pelvis, and the last two or three are anchylosed into a single bone which gradually tapers to an obtuse point and is of less vertical height than the preceding free caudals. The syn-sacrum (of Professor T. J. Parker) consists of seventeen or eighteen vertebræ. In the cervical vertebræ the median inferior process, which commences on the axis, becomes obsolete on the sixth, and is never present on the seventh. Hypapophyses commence on the seventh, the two laminæ are furthest apart on the fifteenth or sixteenth, then approach again and fuse on the eighteenth or nineteenth without forming a hæmal canal. The neural spine, which is single on the axis, divides into two laminæ on the third, which usually remain separate until the

* Hutton, Ann. and Mag. Nat. Hist., ser. 5, vol. i., p. 407, and vol. ii., p. 494 (1878). Owen, Trans. Zool. Soc., vol. xi., p. 235 (1882). Haast, Trans. Zool. Soc., vol. xii., p. 174 (1886). In Owen's Ext. Birds of N.Z., pp. 392, &c., the 3rd cervical is really the 4th, the 4th is the 6th, the 6th is the 8th, the 12th is the 15th, the 14th is the 18th, and the 15th is the 21st.

nineteenth or twentieth, when they coalesce. The dorsal vertebræ are remarkable for the thick neural spine and the small neural canal. The centrum is saddle-shaped in all of them.

There are nine or ten pairs of vertebral *ribs*, of which the last three or four pairs are attached to the pelvis. The first two or three pairs are cervico-thoracic, are often very short, and have no sternal ribs. The thoracic ribs have sternal ribs, of which the first and second pairs, and in most genera the third pair also, are connected with the sternum. The true ribs, and some of the floating ribs, bear uncinates, which are often anchylosed to the rib. These uncinates are of nearly equal breadth throughout, and are not expanded at the proximal end : their length is from 1·5 to 2·5 times the breadth.

The *sternum* is broad and flat, with its anterior border slightly concave. The costal (anterior xiphoid) processes are nearly horizontal. There is one long lateral (posterior xiphoid) process on each side, and the posterior median process is often notched at the end. Coracoid grooves are reduced to shallow oval pits, and may be absent altogether, or developed on one side only. It is a very variable bone, and often unsymmetrical. There is no median centre of ossification.

A *scapulo-coracoid* is present in three genera and absent in the others. The coracoidal portion is subcylindrical, rounded at the proximal end, and attached to the sternum by ligament only. The scapular portion is nearly one and a half times the length of the coracoid : it is slightly flattened and curved in the plane of the coraco-scapular angle only. This angle varies between 145° and 125°, and the bone is sometimes flattened and broadened at the angle. There were no clavicles.

Wings appear to have been present in *Palapteryx* only.

The *pelvis* is broader than that of any other ratite bird. The ilia commence to diverge a little in front of the acetabula, and come together again, enclosing a broad oval sacrum. The ischia and pubes are generally free for their whole length, but sometimes they are attached together for a short distance a little before the middle, leaving a small obturator fissure; and occasionally (? in very old birds) the posterior ends are united, but the ischia always remain free from the ilia. There is no pectineal process.

The *femur* is nearly straight anteriorly, and is distinguished by the tuberosities on the posterior part of the shaft, by the trochanter rising above the articular head, by the great size of the distal end and the great breadth of the rotular surface. There is no pneumatic foramen, and the dense bony wall of the shaft is very thick.* The patella† is bony and trihedral;

* Ext. Birds of N.Z., pl. xxix., fig. 1.
† Trans. Zool. Soc., vol. ii., pl. li. and lviii.

the outer surface broadest, curved, and rather rough, the two inner surfaces smooth.

The *tibia* (tibio-tarsus) is distinguished by the breadth of the cnemial process, by the oblique bony supratendival bridge at the inner anterior surface at the distal end, by the smallness of the epicondylar tuberosities, and by the prominence anteriorly of the inner condyle. The fibula is not anchylosed to the tibia.

There is a free post-axial *tarsal* bone—the second centrale*—on the posterior and outer side of the tarsal joint.

The *metatarsus* (tarso-metatarsus) is characterized by the smooth and rounded surfaces of the shaft. At the proximal end the depression for the articulation of the inner condyle of the tibia is deeper than that for the outer one. The hypotarsal process is grooved, and the outer side of the groove is more prominent than the inner. The interosseous canals from the two posterior foramina unite and open anteriorly by a single foramen. There are no perforations at the distal end of the metatarsal grooves.† The inner condyle is more produced than the outer one.

A *hind-toe* was probably present in all the species; and there was a sesamoid on the lower surface of the foot, between the metatarsus and the first phalanx of the inner toe.‡ The inner toe has three, the middle one four, and the outer toe five phalanges.

Measurements.

In the table of ratios in the genera, those for the *leg-bones* are the length (L) divided by the girth (G) at the middle of the shaft. For the *skull*, the breadth at the squamosals (B) is divided by the height (H) at the basi-temporal, and the length from the supra-occipital to the nasals (L) is divided by the breadth at the squamosals. For the *sternum*, the length of the body (L), measured from the anterior border to a point midway between the two posterior notches, is divided by the breadth of the body (B) just below the costal region. For the *pelvis*, the length of the ilium (L) is divided by the length of the pre-acetabular portion (*l*), and the breadth at the antitrochanters (B) is divided by the length (*l*) of the pre-acetabular portion of the ilium.

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* Parker, Phil. Trans., vol. clxxxii., p. 100, footnote; Ext. Birds of N.Z., pl. cxiv., figs. 3–6 (sesamoid). Coughtrey, Trans. N.Z. Inst., vol. vii., p. 269 (calcaneo-sesamoid). Buller, Birds of N.Z., 2nd ed., vol. i., p. xxxii., and vol. ii., p. 333 (astragalus).

† In one specimen of *D. firmus* I have seen an osseous bridge over the channel between the middle and inner metatarsal condyles, the perforation answering to that between the second and third metatarsals in *Megalapteryx*.

‡ Ext. Birds of N.Z., pl. lxxi., fig. 1s.

TABLE OF RATIOS IN THE GENERA.

—	—	Metatarse.	Tibia.	Femur.	Skull.		Sternum.	Pelvis.		Coracoid.
		L:G	L:G	L:G	B:H	L:B	L:B	L:*l*	B:*l*	
Dinornis ..	Max.	3·6	5·7	2·5	2·1	0·9	0·6	2·3	1·0	*
	Min.	2·5	4·3	1·7	2·0	0·8	..	1·9	0·9	
Tylopteryx ..	Max.	3·3	5·5	2·2	2·4	0·8	0·6	2·2	1·1	*
	Min.	2·7	4·6	1·9	1·8	0·7	..	2·0	0·9	
Palapteryx ..	Max.	3·2	5·4	2·9	1·8	1·1	0·7	1·8	0·7	*
	Min.	2·5	4·6	2·4	..	..	..	..	..	
Anomalopteryx	Max.	2·3	5·1	2·5	1·6	1·1	1·0	2·0	0·9	*
	Min.	2·0	4·2	2·0	1·5	..	..	1·8	..	
Cela.. ..	Max.	2·2	4·4	2·4	1·7	1·1	0·9	2·5	1·2	0
	Min.	1·7	3·8	1·8	1·6	..	..	2·4	1·1	
Mesopteryx ..	Max.	2·0	4·0	2·2	1·5	1·1	0·7	2·3	1·2	0
	Min.	1·7	3·7	1·8	..	..	..	..	..	
Syornis ..	Max.	2·2	4·6	2·1	1·7	1·2	1·1	2·5	1·3	0
	Min.	1·6	3·7	1·9	1·6	1·0	0·7	2·3	1·2	
Euryapteryx ..	Max.	1·5	3·7	1·8	1·6	1·2	0·6	2·7	1·5	0
	Min.	1·3	3·0	1·5	1·5	1·1	0·5	2·4	..	

In the tables of measurements of the species, the girth in the leg-bones is taken in the middle of the shaft. The length of the pelvis is that of the pre-acetabular portion of the ilium only, and the breadth is taken at the anti-trochanters. The breadth of the sternum is taken across the body just below the costal region. The length of the skull is taken from the supra-occipital protuberance to the commencement of the nasals, the depression for which is often preserved; the breadth of the skull is taken at the squamosals, and the height is the vertical from the basi-temporal. Other measurements are given when known, and explain themselves.

In the tables of measurements given for each species, an exclamation point (!) prefixed means that all the measurements along that line are taken from the same individual bird. If no exclamation point is prefixed the measurements given are only inferred to belong to bones of the same species. The maximum and minimum measurements give the limits in size, and in robustness of the legs, allowed to each species.

None of the measurements given are hypothetical. All are either from actual specimens or from Professor Owen's plates, with the single exception of the length of the metatarsus in *A. antiquus*.

Genus DINORNIS.*

Dinornis (part) and *Palapteryx* (part) of Owen; *Dinornis, Movia*, and *Moa* of Reichenbach; *Dinornis* of Haast.

Skull depressed, the lambdoidal ridge flattened, and the parietals hardly rising above it. Breadth at the squamosals about twice the height from the basi-temporal. Length from the supra-occipital to the nasals less than the breadth at the squamosals. Occipital condyle pedunculate, hidden laterally by the paroccipital processes. Beak rather longer than the head, depressed and obtuse at the tip; the lower jaw much curved.

Sternum with well-marked oval coracoid pits; the length of the body† rather more than one-half the breadth; costal processes slightly developed; the lateral processes long, diverging from the middle line at an angle of between 35° and 50°, but curving inwards again; ‡ median process generally notched at the end. Only two pairs of sternal ribs articulating with the sternum. *Scapulo-coracoid* always present, without any glenoid cavity.

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* Greek δεινός, terrible.

† The "corpus-sterni" of Prof. T. J. Parker, Phil. Trans., vol. clxxxii., p. 85.

‡ See, however, the remark under *D. firmus*.

Pelvis comparatively narrow, the greatest breadth at the anti-trochanters being equal to or slightly less than the pre-acetabular portion of the ilium. The whole length of the ilium is from twice to two and a quarter times the length of the pre-acetabular portion. *Metatarsus* longer than the femur, its length between 2·5 and 3·6 times the girth at the middle of the shaft. *Tibia* rather less than twice the length of the metatarsus, its length between 4·3 and 5·7 times the girth. The *femur* is about 0·9 times the length of the metatarsus, its length between 1·7 and 2·5 times the girth. The presence of a hind-toe has been proved in *D. robustus*, *D. potens*, and *D. torosus*.

Sub-Genus DINORNIS.

Top of the skull flattened. Temporal fossæ very broad, about equal to the orbits. Breadth of the skull at the squamosals from 1·1 to 1·2 times the length to the nasals. Length of the basi-sphenoid from the basi-occipital to the end of the rostrum about two and a quarter times the breadth at the basi-pterygoid processes. Occipital condyle exposed from above. Length of the premaxillæ to the maxillary suture about equal to the breadth. Plate XV., fig. 1.

N.B.—The North Island species are admitted into this sub-genus provisionally, as their skulls are not yet known.

Dinornis altus.

D. maximus, Owen, Ext. Birds of N.Z., p. 253 (Dr. Lillie's specimen), metatarsus only. *D. altus*, Owen, Ext. Birds of N.Z., p. 361 (1879).

Figures.—Metatarsus, Ext. Birds of N.Z., pl. lxxix., fig. 4, dotted outline only.

Metatarsus: Length, 21·5in.; girth, 6·3in.

This species is as yet only known by a single metatarsus from the South Island, the exact locality being unknown. As it is not only longer but also more slender than the similar bone in *D. maximus*, I agree with Professor Owen in keeping it separate. The femur associated with it by Owen belongs to *D. validus*.

Dinornis maximus.

D. maximus, Owen, Trans. Zool. Soc., vol. vi., p. 497 (1867), and vol. x., p. 147; Ext. Birds of N.Z., pp. 250 and 391. *D. maximus*, Haast, Trans. N.Z. Inst., vol. i., p. 87, No. 18.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. lxxix., fig. 3; tibia, *l.c.*, pl. lxxx.; femur, *l.c.*, pl. lxxix., fig. 1. Restoration, *l.c.*, pl. xcvii.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ! ..	20·0	8·3(?)	39·0	8·5	18·25	9·5
No. 1 ! ..	..	..	39·2	8·7	18·4	9·6
Max. ..	20·5	6·75	39·2	8·7	18·75	9·6
Min. ..	20·0	6·4	39·0	8·0	18·0	9·2

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ! ..	..	..	..	..	..	..
No. 1 ! ..	..	..	..	..	..	..
Max. ..	..	..	..	..	..	..
Min. ..	..	..	..	..	..	..

Length of the scapulo-coracoid, from 10·25in. to 9·5in.

Distribution.—This very rare species has been found only at Glenmark, with the exception of a single femur, 18in. in length, collected by Mr. H. Joseph in Otago, and taken to England.

The type was a metatarsus,* obtained in August, 1865, by Major Michael, at Glenmark, and subsequently the femur and tibia of, apparently, the same bird were found in the same locality. No. 1 was obtained at Glenmark by Sir J. von Haast.

This is not the original *D. giganteus*, var. *maximus*, of Owen, but a larger species, to which he afterwards transferred the name.

Dinornis excelsus.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Max. ..	20·0	6·25	38·0	..	..	..
Min.	20·0	5·5	37·5	7·0	..	..

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Max. ..	..	..	..	..	..	..
Min.	..	..	..	..	..	..

* There appears to be a mistake in the measurements given of this bone.

This species is known only by three metatarsi collected by Mr. A. Hamilton in the Te Aute Swamp, near Napier, and by a tibia from the same locality, the dimensions of which have been kindly sent to me by Mr. Colenso. Mr. Hamilton also informs me that two or three tibiæ, with a length of 38in., were obtained by other collectors. It is a smaller and more slender species than *D. maximus*, but considerably larger than *D. giganteus*.

Dinornis validus.

D. maximus, Owen, Trans. Zool. Soc., vol. x., p. 147 (part).
D. giganteus, Haast, Trans. N.Z. Inst., vol. i., p. 88, No. 20.

Figures. — Femur, Ext. Birds of N.Z., pl. xxxvi. and xxxvii., fig. 1 (as *giganteus*); vertebræ described and figured on p. 391, &c.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type	18·9	6·8	35·0	7·0	16·5	8·7
Max. ..	19·0	6·8	35·5	7·7	17·0	8·7
Min... ..	18·0	6·0	34·0	6·5	16·0	7·5

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type	..	..	..	..	..	..
Max. ..	..	..	..	4·0	5·0	2·2
Min... ..	..	..	..	3·7	4·5	2·2

Breadth of skull at temporal fossæ, 2·8in.; at post-frontal processes, 4·6in. Length of the lower jaw, 7·85in. Scapulo-coracoid, 8·7in. to 8in. Middle toe, 11in.

Distribution. — In the swamps at Glenmark and Waikouaiti, and in a few other places in Canterbury, Otago, and Southland. It seems to have been more common in the north part of the South Island, and rare in the south. No bones were found at Hamilton. The type is from Glenmark.

This species is larger and rather more robust than *D. giganteus*. Earl's specimens from Waikouaiti—the original types of *D. maximus*—belong here. I have already mentioned that Owen transferred the name to a larger species, and I think it better to follow him in the change, as it will make less confusion.

Dinornis giganteus.

D. giganteus, Owen, Trans. Zool. Soc., vol. iii., p. 237 (1843), and p. 307 (1846), and vol. iv., p. 59 (1850). *Moa giganteus*, Reichenbach, Das Nat. Syst. der Vögel.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xxvii., fig. 1.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	18·5	5·5	35·0	6·5	16·0	7·25
No. 1 ! ..	17·75	6·75	31·5	7·25	..	..
Max. ..	18·5	6·75	36·0	7·25	16·0	7·5
Min. ..	17·5	5·0	34·2	6·5	16·0	7·25

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	..	..	..	..	..	..
Max. ..	..	..	..	..	..	..
Min. ..	..	..	..	..	..	..

Length of the scapulo-coracoid, 8·75in.

Distribution.—The type of this rare species is from Poverty Bay. Mr. A. Hamilton obtained a few bones from the Te Aute Swamp. No. 1 was found in a swamp at Awhitu, near Auckland, by Mr. Mactier.* The only bones found were a pair of metatarsi, a pair of tibiæ, and a number of toe-bones The cnemial crest of the tibia is probably abraded. The bones are now in the Auckland Museum. The metatarsi in this species and in *D. excelsus* are more slender than in any other of the moas.

Dinornis robustus.

Palapteryx robustus, Owen, Trans. Zool. Soc., vol. iii., p. 345 (1848); vol. iv., pp. 1 and 337 (cranium from Timaru); Mantell, Quar. Jour. Geol. Soc., vol. vi., p. 338.

Figures.—Metatarsus and foot, Ext. Birds of N.Z., pl. xlix.; cranium, pl. lxii. and lxiii.; sternum (?), pl. xxxv., fig. 1.

* Trans. N.Z. Inst., vol. x., p. 552.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	15·7	5·2	32·2	6·7	..	..
No. 1 ! ..	16·2	6·3	32·7	6·2	15·5	7·9
No. 2 ! ..	17·2	6·0	31·5	6·2	14·5	8·1
Max. ..	17·2	6·7	32·7	6·8	15·5	8·1
Min. ..	15·7	5·2	30·0	6·2	14·4	7·2

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	10·0	10·0	8·5	..	..	..
No. 2 ! ..	10·75	10·0	8·3	..	..	..
Max. ..	10·75	10·0	8·6	3·85	4·25	2·1
Min. ..	9·5	10·0	8·0	3·6	4·10	2·0

Breadth of the skull at temporal fossæ, 2·9in. to 2·7in.; at post-frontal processes, 4·6in. Length of the lower jaw, 7·6in. Length of scapulo-coracoid, 7·25in. Length of ilium 22in. to 21·5in., of ischium 12in. to 10·2in.; breadth of sacrum, 8in. to 7·5in.; depth of pelvis, 9in. to 8in. Post-axial tarsal is 2·6in. in length, and 1·5in. in greatest breadth. Length of middle toe, 11·5in. to 9·75in. Total length of head, 8·5in.

Distribution.—Found sparingly all over the South Island, but rather more abundantly in Otago than elsewhere. There is a femur from near Greymouth in the Wellington Museum. Bones are found not only in the swamps but occasionally in the Maori cooking-places. No. 1 is from Shag Valley, and No. 2 from Highley Hill, in Otago: both are in the Otago Museum. The type is from Waikouaiti.

Sir R. Owen originally gave the name *D. ingens*, var. *robustus*, to bones from Waikouaiti, of which the metatarsus was 14·5in. and the tibia 28·75in. in length; but he afterwards transferred the name to larger bones from the same locality, and said that the tibia of his type of *D. robustus* is 32in. in length.* Under these circumstances it seems best to retain the name for this species, especially as it is so used in New Zealand.

In specimen No. 1 the neural spine is single on the fourth and fifth cervical vertebræ.

* Ext. Birds of N.Z., p. 250.

Dinornis firmus.

D. ingens, var. *robustus*, Owen, Ext. Birds of N.Z., p. 160, from Wanganui.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
No. 1 ! ..	16·25	5·6	29·0	6·25	14·5	7·5
Max. ..	17·0	5·6	33·0	6·5	15·25	7·5
Min. ..	15·75	4·75	30·0	5·3	14·5	6·0

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
No. 1 ! ..	..	..	..	..	..	..
Max. ..	..	..	8·25	..	..	..
Min. ..	..	..	..	..	..	..

Distribution.—Rather common; the swamp at Te Aute, also at Poverty Bay, and in the Maori cooking-places at Wanganui and Whangarei. No. 1 is a specimen in the possession of W. Colenso, Esq., from Poverty Bay. The cnemial crest of the tibia is probably abraded.

This was a more slender species than *D. robustus*, but occasionally bones are found which cannot be distinguished from slender South Island specimens. A fragmentary sternum in the Napier Museum has the lateral processes diverging at a less angle than that of *robustus*, which may also indicate a specific difference.

The tibiæ of this species and of *D. ingens* are more slender than those of the other moas.

Dinornis ingens.

D. ingens, Owen, Trans. Zool. Soc., vol. iii., p. 237 (1843); *Movia ingens*, Reichenbach, Das Natürliche System der Vögel.

Figures.—Tibia, Ext. Birds of N.Z., pl. xxv., fig. 1, and pl. xxvi., figs. 1 and 2; femur, *l.c.*, pl. xxi., figs. 1 and 2; skull, *l.c.*, pl. liii., figs. 1–3, juv.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	..	..	29·0	5·25	13·0	5·5
Max. ..	15·25	4·75	29·5	5·3	14·25	7·25
Min. ..	14·6	4·3	27·0	5·0	13·0	5·5

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
Max. ..	..	..	..	..	..	..
Min. ..	..	..	..	..	..	..

Length of the scapulo-coracoid, 7in.

Distribution.—At present this species is only known from the Te Aute Swamp and Poverty Bay, from whence the type specimens came. But the skull, from the Taupo district, figured on plate liii., figs. 1–3, of the "Extinct Birds of New Zealand," probably belongs to a young individual.

The metatarsus assigned to this species by Professor Owen belongs to *D. gracilis*.

Dinornis potens.

D. ingens, var. *robustus*, Owen, Trans. Zool. Soc., vol. iii., p. 307 (1846); Ext. Birds of N.Z., p. 129. *Pal. robustus*, Owen, Trans. Zool. Soc., vol. iv., p. 337, skull and scapulo-coracoid from Manuherikia; vol. vi., p. 495, foot. *D. ingens*, Haast, Trans. N.Z. Inst., vol. i., p. 84, No. 8; Hutton, *l.c.*, vol. vii., p. 278; Hutton and Coughtrey, *l.c.*, vol. vii., p. 266, pl. xix.

Figures.—Skull and scapulo-coracoid, Ext. Birds of N.Z., pl. lxiv., lxv.; integument of foot, *l.c.*, pl. lxxi.; Trans. N.Z. Inst., vol. vii., pl. xix.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
No. 1 ! ..	15·1	5·7	29·5	6·0	14·2	7·6
No. 2 ! ..	15·0	5·4	29·7	6·5	13·0	7·75
No. 3 ! ..	15·0	..	27·7	5·75	13·75	7·0
No. 4 ! ..	15·0	5·5	27·0	6·0	14·0	7·0
Max. ..	15·1	5·7	29·5	6·5	14·2	7·75
Min. ..	14·0	5·0	27·0	5·6	13·0	7·0

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height
No. 1 ! ..	..	..	..	..	..	..
No. 2 ! ..	..	..	..	..	..	..
No. 3 ! ..	..	..	..	..	..	..
No. 4 ! ..	..	..	7·5	3·5	4·1	2·1
Max. ..	8·5	9·5	..	3·6	4·1	2·15
Min. ..	..	..	..	3·5	4·0	2·1

Breadth of skull at temporal fossæ, 2·8in. to 2·6in.; at post-frontal processes, 5·15in. to 4·9in. Length of lower jaw, 7in. to 6·8in. Total length of the head, from 8in. to 7·8in. Length of scapulo-coracoid, 7·5in. Length of ilium, 20in. to 19·5in.; breadth of sacrum, 7·75in.; depth of pelvis, 7in.

Distribution.—Found all down the east side of the South Island from Motunau to Southland, but most common in Otago. No. 1 is from Heathcote, near Christchurch; No. 2 from a cave at Castle Rock, Southland (it is now in the possession of Mr. Mitchell); No. 3 is the leg from the Knobby Ranges, Otago, with integument attached;* No. 4 from Tiger Hill, Manuherikia, Otago. For the measurements of this last specimen I am indebted to Mr. H. M. Platnauer, curator of the York Museum. I am not aware of any bones having been obtained from Maori cooking-places.

This species is more robust than *D. ingens* and smaller than *D. robustus.*

Sub-Genus Tylopteryx.†

Top of the skull more or less elevated. Breadth of the temporal fossæ about two-thirds that of the orbits. Breadth of the skull at the squamosals about 1·3 times the length to the nasals. Length of the basi-sphenoid, from the basi-occipital to the end of the rostrum, about two and three-quarter times the breadth at the basi-pterygoid processes. Occipital condyle hidden by the supra-occipital. Beak rather narrower and not so obtuse at the tip as in *Dinornis;* length of the premaxillæ to the maxillary suture about one and a quarter times the breadth. Plate XV., fig. 2.

Dinornis gracilis.

D. gracilis, Owen, Trans. Zool. Soc., vol.. iv, p. 141 (1854), metatarsus only.

Figures.—Cranium, Ext. Birds of N.Z., pl. lii. (as *ingens*); metatarsus, *l.c.*, pl. xl., fig. 1 (as *ingens*), and pl. liv., fig. 3.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	13·0	4·25	..	..	..	..
Max. ..	14·25	4·9	26·5	5·5	12·75	6·75
Min. ..	13·0	4·25	25·0	4·6	12·0	5·75

* Trans. N.Z. Inst., vol. vii., p. 266.

† Greek, τύλος, a swelling, in allusion to the top of the skull.

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
Max. ..	..	..	..	3·2	3·7	1·8
Min. ..	..	..	..	..	..	..

Breadth of the skull at the temporal fossæ, 2·65in. Length of the scapulo-coracoid, 6·25in. to 5·7in. Total length of the head, 7·3in.

Distribution.—The type of the species is from the sand-dunes near Wanganui. It was plentiful in the Te Aute Swamp, and has been also found at Poverty Bay and the Maori cooking-places near Whangarei. The skull referred here is from the Taupo district. The moa bones found by Mr. Weetman on the Great Barrier Island* belong to a young chick apparently of this species. They consist of a right metatarsus, a pair of tibiæ, a right femur, and an ischium. The metatarsus (without the distale) is 5·2in. in length and 2·4in. in girth. The tibiæ (without the tibiale) are 9·3in. in length and 2·5in. in girth. The femur is 5·2in. in length and 3·1in. in girth. The ischium is 3in. in length, and has never anchylosed to the other bones of the pelvis.

I refer the skull figured in Ext. Birds of N.Z., pl. lii., to this species, because it so closely resembles the skull which we know to belong to *D. torosus*, and differs much from that of *D. potens*. The tibia and femur originally described by Professor Owen as those of *D. struthioides* (Ext. Birds of N.Z., p. 88, t. 7 and f. Colenso), and afterwards dropped altogether, undoubtedly belong here; while the tibia and femur ascribed to *D. gracilis* belong really to *D. struthioides*.

Dinornis torosus.

D. gracilis, Haast, Trans. N.Z. Inst., vol. i., p. 84, Nos. 7 and 9. *Pal. ingens*, Hochstetter, New Zealand, p. 187; Jaeger, Reise der "Novara," Palæ., p. 307, taf. xxv., xxvi.

Figures.—Cranium, Ext. Birds of N.Z., pl. lxxxii. (as *ingens*), Reise der "Novara," Palæ., pl. xxv., xxvi.; sternum, Ext. Birds of N.Z., pl. xcviii. (as *maximus*). Restoration, Ext. Birds of N.Z., pl. cxii., fig. 1, and pl. cxiii., fig. 1 (as *gracilis*), skull incorrect.

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* Trans. N.Z. Inst., vol. xix., p. 193, and vol. xxii., p. 84.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
No. 1 ! ..	12·5	4·0	24·0	5·2	11·5	6·1
No. 2 ! ..	..	..	25·3	4·8	12·5	6·0
Max. ..	13·0	4·75	25·3	5·75	12·5	6·6
Min. ..	12·2	4·0	24·0	4·5	11·5	5·5

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
No. 1 ! ..	8·0	8·3	7·0	3·6	3·7	1·7
No. 2 ! ..	..	..	..	..	..	..
Max. ..	8·75	8·5	7·2	3·6	3·7	2·0
Min. ..	7·0	8·0	7·0	2·75	3·7	1·7

Breadth of skull at temporal fossæ, 2·5in. to 2·2in.; at post-frontal processes, 4·1in. to 3·9in. Length of lower jaw, 6·2in. Total length of skull, 7in. Sternum: Length of body, 4·5in.; breadth, 7in.; length of lateral processes 5·5in., of median process 3·5in., but with a notch 0·5in. deep; breadth at anterior border, 7·5in.; across ends of lateral processes, 12in. Length of scapulo-coracoid, 6in. to 5in. Length of ilium, 17in.; breadth of sacrum, 5·5in.; length of ischium, 8in.; depth of pelvis, 6·5in.

Distribution.—Tolerably abundant in the northern part of the South Island as far as Glenmark, but very rare in Otago. No. 1 is a nearly perfect skeleton, in the possession of Mr. R. I. Kingsley, which was found in a cave in the Takaka district, near Nelson. No. 2 is from Glenmark, and is in the Canterbury Museum.

This species is intermediate between *D. gracilis* and *D. struthioides*, and is more robust than the former. Dr. Hochstetter's skeleton, now in the Vienna Museum, undoubtedly belongs here, but the tibiæ belong to *D. robustus*. This skeleton was collected by diggers and given to the Nelson Museum before Dr. Hochstetter's arrival. The femora were missing. The scapulo-coracoids probably belong to *A. didiformis*. Dr. Hochstetter says that he himself collected the skull described by Dr. Jaeger, in the same cave, and it probably belonged to the skeleton. The skull belonging to Mr. Kingsley's specimen corresponds so closely in shape and size with it that, no doubt, both belong to one species. Sir R. Owen gives no locality for the skull figured in Ext. Birds of N.Z., pl. lxxxii., but, as he says that he has never received so good a skull from the North Island, I presume that it came from the South Island. The Hon. W. Mantell informs me that it was not collected by him, and that he knows nothing about its locality. The swelling on the top of the head is greater than in *D. gracilis* of the North Island.

Dinornis struthioides.

D. novæ-zealandiæ, Owen, Proc. Zool. Soc. (1843), p. 8. *D. struthioides*, Owen, Trans. Zool. Soc., vol. iii., p. 235 (1843); and vol. iii., p. 307, cranium. *Dinornis struthioides*, Reichenbach, Das Nat. Syst. der Vögel.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. liv., fig. 4; tibia, pl. lv., fig. 1 (as *gracilis*) and fig. 2; femur, pl. xxxviii. (as *casuarinus*), and pl. liv., fig. 1 (as *gracilis*) and fig. 2; cranium, pl. xvi., figs. 1–4.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	12·0	4·25	..	..	..	..
No. 1 ! ..	11·9	4·25	22·0	4·7	11·25	5·5
No. 2 ! ..	..	..	23·5	4·5	11·0	4·7
Max. ..	12·0	5·0	23·5	5·0	11·8	5·8
Min. ..	11·0	3·0	22·0	4·3	10·0	4·4

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	..	..	..	..	..	..
No. 2 ! ..	..	..	..	..	..	..
Max. ..	7·75	6·75	..	..	3·25	..
Min. ..	..	..	..	2·9	3·0	1·7

Breadth of skull at temporal fossæ, 2·4in. to 2in.; at post-frontal processes, 3·1in. Length of scapulo-coracoid, 4·5in. Length of ilium 14·75in., of ischium 7·25in.; breadth of sacrum, 6in.; depth of pelvis, 6·25in.

Distribution.—This is one of the few species of moa which have been found in both Islands. The type specimen is from Poverty Bay, but it was scattered sparingly over both Islands from Whangarei and Mercury Bay in the north to Otago in the south, but was nowhere numerous. It occurs in the swamps of Te Aute, Glenmark, and Hamilton, as well as in the Maori cooking-places in the North Island. No. 1 is an individual leg in the Wellington Museum, the exact locality of which is not known. No. 2 is from Opito, Mercury Bay, described by Professor Owen as belonging to *D. gracilis*, Ext. Birds of N.Z., p. 220.

The South Island birds were, on the average, rather more slender than those of the North Island, but the difference is very slight. The cranium figured in Ext. Birds of N.Z., pl. xvi., figs. 1–4, is from Poverty Bay.

Genus PALAPTERYX.

Palapteryx (part) of Owen; *Palapteryx* of Reichenbach, not of Haast.

Skull moderately depressed, the lambdoidal ridge curved, but the parietals hardly rising above it. The breadth at the squamosals rather more than one and three quarter times the height from the basi-temporal. Length from the supra-occipital to the nasals more than the breadth at the squamosals. Occipital condyle exposed from above, hidden laterally by the paroccipital processes. Beak about as long as the head, more compressed than in *Dinornis;* the lower mandible but slightly curved. Plate XV., fig. 3.

Sternum with well-marked coracoid pits. The length of the body about three quarters of the breadth. Lateral processes diverging at a small angle from the middle line, short, the breadth across their ends about 1·1 times the breadth of the body.

Scapulo-coracoid with a glenoid cavity. Probably, therefore, rudimentary wings were present.

Pelvis narrow, and the acetabula set very far back. Greatest breadth at the anti-trochanters about three quarters of the length of the pre-acetabular portion of the ilium. Length of the ilium about 1·8 times the length of the pre-acetabuiar portion. *Metatarsus* longer than the femur; its length between 2·5 and 3·25 times the girth at the middle of the shaft. *Tibia* about twice the length of the metatarsus; its length between 4·6 and 5·4 times the girth. *Femur* more slender than in any other genus; its length from 2·4 to 2·9 times the girth of the shaft.

No complete skeleton of this genus has been found, and the different bones are grouped together by inference only. Professor Owen has inferred the existence of a hind-toe, but it has not yet been actually found. The genus is intermediate between *Dinornis* and *Anomalopteryx*, but the possession of a wing, the backward position of the acetabula, and the slender femora are peculiarities.

Palapteryx dromioides.

Dinornis dromioides, Owen, Trans. Zool. Soc., vol. iii., p. 235 (1843), femur. *Pal. dromioides*, Owen, *l.c.*, vol. iii., p. 307 (1846), metatarsus and tibia. *Palapteryx dromioides*, Reichenbach, Nat. Syst. der Vögel (1850).

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xl., fig. 2; tibia, pl. xxxix., fig. 1; femur, pl. xxii., figs. 1, 2, and pl. xxiii., fig. 2; cranium, pl. xlv. (as *geranoides*), and pl. xlvi., figs. 4–6 (?). Mantell's "Petrifactions and their Teachings," p. 119.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	10·4	3·75	21·0	4·0	9·6	3·9
Max. ..	10·4	4·0	21.0	4·7	9·6	4·0
Min. ..	9·76	3·25	18·4	3·5	9·5	3·8

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
Max. ..	..	..	..	2·7	2·4	1·3
Min. ..	..	..	..	..	..	..

Breadth of the skull at the temporal fossæ, 1·7in.; at the post-frontal processes, 2·6in. Length of the lower jaw, 5·3in. (?). Length of scapulo-coracoid, 3·25in.; coraco-scapular angle about 125°.

Distribution.—The type is from Wanganui sand-dunes, but it has also been found at Poverty Bay and in the Te Aute Swamp. There are two femora in the Wellington Museum from Lyall's Bay.

The skull from Wanganui, attributed by Professor Owen to *C. geranoides*, is certainly too large for that species, while it appears to be too small for *D. struthioides*; and, as the skulls of *S. casuarinus* and *A. didiformis* are known, *P. dromioides* is the only species left to which it can belong. A small scapulo-coracoid of *Dinornis* form is in Mr. Hamilton's collection from Te Aute, which, from its size, I refer to this species. It has a distinct glenoid cavity.

Palapteryx plenus.

Pal. dromioides, Owen, Trans. Zool. Soc., vol. iv., p. 1 (1850), in part.

Figures.—Foot, Ext. Birds of N.Z., pl. li. (as *dromioides*).

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Max. ..	10·6	4·0	21·5	4·6	10·0	4·0
Min.	10·25	3·75	20·7	3·8	9·0	3·2

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Max... ..	7·5	6·0	5·25	..	..	..
Min.	..	..	..	..	..	..

Length of the ilium, 13·5in.; breadth of sacrum, 4·6in.; depth of pelvis, 5·6in. Length of middle toe, 7·3in. Breadth of anterior border of sternum, 6·8in.; across ends of lateral processes, 6·8in. Length of lateral processes, 4in.

Distribution.—Found sparingly over the South Island, but everywhere rare. There were a few bones in the swamps at Glenmark and Hamilton.

This species is rather larger and stouter than *P. dromioides*, but with a more slender femur, which approaches that of *Megalapteryx hectori*. The femur from Glenmark ascribed by Professor Owen to *S. rheides* no doubt belongs here. The sternum which I have placed with this species also comes from Glenmark. It is on the pattern of the sternum in *Syornis*, but has coracoid pits; possibly it may belong to *D. struthioides*, but appears to be too small for that species. The pelvis is from the Manuherikia, Otago, and is in the Wellington Museum. If I am wrong in associating this sternum and pelvis with *Palapteryx*, the generic characters will, of course, have to be altered.

Genus ANOMALOPTERYX.

Dinornis (part) of Owen; *Anomalopteryx* of Reichenbach.

Skull large, very convex. Breadth at the squamosals about one and a half times the height from the basi-temporal. Length from supra-occipital to nasals rather more than the breadth at the squamosals; occipital condyle hidden by the supra-occipital, but exposed laterally. Length of the basi-sphenoid to the end of the rostrum about two and a half times the breadth at the basi-pterygoid processes. The maxillo-jugal bones curved, concave outwards. Temporal fossæ very broad, about equal to the orbits. Beak short, slightly compressed, and rounded at the tip. Length of the premaxillæ to the maxillary suture rather more than one and a quarter times the breadth. Lower mandible strong and nearly straight. Plate XV., fig. 4.

Sternum with well-marked coracoid pits, the length of the body equal to the breadth. Costal processes moderately developed; the lateral processes diverging at an angle of about 20° with the middle line; the posterior median process long. Breadth across the ends of the lateral processes, from 1·2 to 1·4 times the breadth of the body. Three pairs of sternal ribs articulating with the sternum.

Pelvis narrow, like that of *Dinornis;* the greatest breadth at the anti-trochanters is rather less than the length of the pre-acetabular portion of the ilium. The position of the acetabula varies; the length of the ilium being from 2 to 1·8 times the length of the pre-acetabular portion. *Metatarsus* shorter than the femur; its length between 2 and 2·3 times the girth of the shaft. *Tibia* between 2·1 and 2·2 times the length of the metatarsus; its length between 4·2 and 5·1 times the girth. Length of the *femur* 1·25 times that of the metatarsus, and between 2 and 2·5 times the girth of the shaft. A hind-toe was present.

Anomalopteryx didiformis.

Dinornis didiformis, Owen, Trans. Zool. Soc., vol. iii., p. 237 (1843). *Anomalopteryx didiformis*, Reichenbach, Das Nat. Syst. der Vögel. *Dinornis parvus*, Owen, Trans. Zool. Soc., vol. xi., p. 233 (1882), pl. li.–lvii.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xxvii., figs. 3–6; tibia, pl. xxvi., fig. 3, and pl. xxvii., fig. 3; femur, pl. xx.*a*, and pl. xxiv.; pelvis, pl. xix., figs. 1–3.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	7·0	3·25	15·5	4·0	8·1	4·25
No. 1 ! ..	6·25	2·8	14·0	..	8·0	3·1
No. 2 ! ..	6·1	2·8	12·7	3·0	..	..
Max. ..	7·0	3·4	15·5	4·1	8·8	4·25
Min. ..	6·0	2·75	12·7	3·0	7·4	3·1

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	5·5	5·0	3·4	2·6	2·4	1·7
No. 2 ! ..	..	..	..	..	..	..
Max. ..	6·0	5·8	4·0	3·0	2·9	1·7
Min. ..	5·5	5·0	3·4	2·6	2·4	1·6

Breadth of skull at temporal fossæ, 1·7in. to 1·6in.; at post-frontal processes, 3·1in. to 2·9in. Length of scapulo-coracoid, 2in. Length of ilium, 11·5in. to 11in.; breadth of sacrum, 4·25in. to 3·5in.; depth of pelvis, 4·25in. to 4in. Length of middle toe, 4·75in. Total length of skull, 6in. to 5in.; of lower jaw, 5·7in. to 4·7in. Post-frontal process narrow.

Distribution.—Found in both Islands, from Whangarei in the north to Southland. In the North Island the bones were tolerably plentiful in the Te Aute Swamp, while the types came from Poverty Bay. It has also been found in the sand-dunes at Lyall's Bay, and in Maori cooking-places at Pataua, near Whangarei. There is a metatarsus in the Canterbury Museum from Horohoro, near Rotorua. In the South Island the bones have been obtained almost entirely from caves, especially in the Nelson District. A few bones were found at Glenmark, and a single tibia at Hamilton. Probably the bird differed in habits from the other species. No. 1 is the type of *D. parvus*, from Takaka, and No. 2 is a specimen in the Nelson Museum from the same locality. The North Island birds appear to have been, on an average, larger than those of the South Island, and to have had a slightly stouter femur, but there are no differences of specific importance. *D. parvus* is only a small individual of *D. didiformis*.

I have not seen the scapulo-coracoid; but those obtained by Dr. von Hochstetter from the cave at Collingwood, "scarcely 2in. long" ("New Zealand," p. 186), probably belong to this species, bones of which occurred in the cave. Certainly they do not belong to the skeleton on which he has placed them.

Anomalopteryx antiquus.

"Avian Remains," H. O. Forbes, Trans. N.Z. Inst., vol. xxiii., p. 369.

Figures.—Pl. XVII.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	5·5 (?)	(?)	12·0	3·0	..	..

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..

Tibia: Breadth at the proximal end, 3·2in.; at the distal end, 2·5in.; at the middle of the shaft, 1·1in.; antero-posterior thickness of shaft, 0·7in.

Distribution.—Found at Timaru in a bed of clay of Upper Miocene or older Pliocene age. Mr. Stubbs's collection at Timaru contains two broken tibiæ which are sufficiently perfect to allow measurements of the bone to be taken. One (Pl. XVII., *a*), about 6in. long, is the distal end of a right tibia, and shows the lateral position of the groove for the tendon of the extensor muscle of the toes, as well as the anterior prominence of the inner condyle, which are so characteristic of the tibia in the Dinornithidæ. The osseous bridge is broken away. The other specimen (Pl. XVII., *b*), 8½in. long, is the proximal portion of a left tibia which agrees closely in size with the first specimen, so that the total length of the bone can be estimated with considerable accuracy. Both are imbedded in red clay.* I regret that I am unable to give any measurements of the broken metatarsi in Mr. Miller's collection, as these bones are not now in Timaru, and I have not been able to see them. Consequently the length given for the metatarsus is conjectural. However, photographs of the proximal end of a right metatarsus (Pl. XVII., *c*) show distinctly the grooved hypotarsal process, with the outer side more prominent than the inner, which is also a character of the Dinornithidæ.

The species is about the size of *Cela geranoides*, but it is very unlikely that it belonged to *Cela*, because no bones of that genus have ever been found in the South Island. *Anomalopteryx* contains the smallest individuals known in the South Island, and as it is also found in the North Island the genus must have been in existence in the older Pliocene, when the two Islands were joined. This consideration induces me to

* I cannot understand Mr. Forbes's remark, with reference to these fossils, that "the largest, nearly 8in. in length, were undoubtedly portions of *Dinornis* bones of one of the greater forms" (*l.c.*, p. 367).

refer them to *Anomalopteryx.* The species makes a near approach to the specimen No. 2 of *A. didiformis* from Takaka, in the Nelson Museum; but it is smaller, and I think it advisable to keep it separate from that species, partly on this account and partly because of its far greater age. It is, no doubt, the ancestor of *A. didiformis.*

Genus CELA.

Dinornis (part) and *Palapteryx* (part) of Owen; *Cela* of Reichenbach, not of Mœhring (1752), which is a synonym of *Casuarinus.*

Skull convex, the temporal fossæ very large. Breadth at the squamosals, about 1·6 or 1·7 times the height at the basi-temporal. Length from the supra-occipital to the nasals rather less than the breadth at the squamosals; occipital condyle hidden by the supra-occipital. Ridge between temporal fossæ and supra-occipital narrow. Beak short, slightly compressed and rounded at the tip (but more pointed than in *Anomalopteryx*); the length of the premaxillæ to the maxillary suture about one and a half times the breadth. Lower mandible nearly straight, and rather slighter than in *Anomalopteryx.* Plate XVI., fig. 5.

Sternum with the coracoid pits faintly indicated or altogether absent; length of the body less than the breadth; costal processes well developed; lateral processes diverging at different angles.

Pelvis rather broader, in proportion, than in *Dinornis,* and the acetabula set more forward. The greatest breadth at the anti-trochanters is 1·1 times the length of the pre-acetabular portion of the ilia; the length of the ilium is from 2·4 to 2·5 times the length of the pre-acetabular portion. *Metatarsus* shorter than the femur; its length between 1·7 and 2·25 times the girth at the middle of the shaft. *Tibia* about 2·2 times the length of the metatarsus; its length between 3·8 and 4·4 times the girth of the shaft. *Femur* with a length of 1·2 times that of the metatarsus, and between 1·8 and 2·4 times the girth of the shaft. The presence of a hind-toe has not been proved.

This genus contains the smallest species of moa, and is confined to the North Island.

Cela geranoides.

Palapteryx geranoides, Owen, Trans. Zool. Soc., vol. iii., p. 345 (1848); metatarsus and cranium as of *dromioides,* not that of *geranoides.*

Figures.—Metatarsus, Ext. Birds of N.Z., pl. lxx., figs. 5, 6; cranium, pl. xxxi., figs. 4, 5, and pl. xlvi., figs. 1–3.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	6·0	..	..	..	..	..
No. 1 ! ..	5·5	3·0	..	..	7·0	3·5
Max. ..	6·1	3·5	13·1	3·25	7·9	4·0
Min. ..	5·4	2·7	11·7	2·5	6·75	3·0

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	..	4·75	..	..	..	..
Max. ..	5·5	5·6	..	..	2·5	2·2
Min. ..	5·0	4·75	..	..	2·35	1·55

Breadth of skull at temporal fossæ, 1·7in. to 1·65in.; length of ilium, 12·5in. to 12in.; breadth of sacrum, 4·7in. to 4in.; depth of pelvis, 5in. to 4·5in.

Distribution.—This was the commonest species in the Te Aute Swamp; and it was also common in the sand-dunes near Wanganui, but rare at Whangarei. The type came from Waingongoro, near Wanganui. No. 1 are specimens in the Otago Museum collected together at Lyall's Bay, Wellington.

In Mr. Hamilton's collection from Te Aute there is a broken sternum, intermediate in size between those of *C. curtus* and *A. didiformis*, which probably belongs to this species. It is too fragmentary to afford reliable measurements, but it differs from the sterna of both the species just mentioned in having the lateral processes slender, slightly curved, and diverging at a wide angle from the middle line. The cranium, figured on plate xxxi., figs. 4, 5, is from the Bay of Islands; that on plate xlvi., figs. 1–3, is from Wanganui.

Cela curtus.

Dinornis curtus, Owen, Trans. Zool. Soc., vol. iii., p. 325 (1846). *Cela curtus*, Reichenbach, Das Nat. Syst. der Vögel. *Dinornis oweni*, Haast, Trans. Zool. Soc., vol. xii., p. 171 (1886), pl. xxxi., xxxii.*

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xl., fig. 6, and pl. lxxxvii., figs. 7–10; tibia, pl. xxxix., figs. 1–5; femur,

* *Dromornis australis*, Owen, was originally called *Dinornis owenii* by Dr. Krefft, but the name was, I believe, only published in a Sydney newspaper.

pl. lxviii., figs. 5, 6 (as *geranoides*); pelvis, pl. xx.*a* (as *didiformis*).

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	5·0	2·8	11·25	2·75	..	..
No. 1 ! ..	4·4	2·3	9·6	2·4	5·65	2·6
Max. ..	5·25	3·0	11·6	3·1	6·5	3·5
Min. ..	4·4	2·2	9·5	2·25	5·5	2·6

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	4·0	3·5	..	..	2·4	1·4
Max. ..	..	..	2·7	..	..	..
Min. ..	..	..	..	..	..	..

Breadth of skull at temporal fossæ, 1·65in.; at post-frontal processes, 2·65in. The skull is as large as that of *C. geranoides*, but differs from that species in the backward slope of the supra-occipital, the great prominence of the lambdoidal ridge, as well as the greater flattening of the parietals. The sternum has the lateral processes diverging at a small angle, as in *Syornis*.

Distribution.—The type is from Poverty Bay. It was common in the Te Aute Swamp, and the most abundant of all the species at Whangarei; taking the place in the north of *C. geranoides* in the south. No. 1 are the measurements of the type specimen of *D. oweni*, from Whangarei, now in the Auckland Museum.

I regret that I cannot maintain *D. oweni* as a separate species. It is only a small individual of *C. curtus*, with the same proportions and the same geographical distribution. Sir J. von Haast says that the femur is stouter and the metatarsus more slender in *curtus* than in *oweni;* but my measurements do not bear this out, and the supposed anatomical differences between them are only individual variations, which may be found in almost every species of moa. If *oweni* is to be separated from *curtus*, then, for the sake of uniformity, most of the species should be split into two, for they show quite as wide a range of variation.

Genus MESOPTERYX.*

Dinornis (part) of Owen.

Skull convex, angled behind. The vertical ridge of the supra-occipital broadened out into a triangular tuberosity. Breadth at the squamosals one and a half times the height from the basi-temporal. Length from the supra-occipital to the nasals rather greater than the breadth at the squamosals. Temporal fossæ narrow and with a median elevation. Occipital condyle hidden by the supra-occipital, slightly exposed laterally. Orbits small. Beak slender, shorter than the head, much compressed and pointed at the tip. Length of the premaxillæ to the maxillary suture, not quite one and a half times the breadth. Lower mandible slender. Plate XVI., fig. 7.

Sternum without coracoid pits. Length of the body about three quarters of the breadth. Costal processes very large; lateral processes narrow, slightly curved outwards, diverging at an angle of about 20° from the middle line; median process long and not notched. No scapulo-coracoid.

Pelvis moderate; the breadth at the anti-trochanters about 1·2 times the length of the pre-acetabular portion of the ilia; length of the ilium about 2·3 times that of its pre-acetabular portion. *Metatarsus* shorter than the femur; its length between 1·7 and 2 times the girth at the middle of the shaft. *Tibia* about 2·25 times the length of the metatarsus, its length between 3·7 and 4 times the girth of the shaft. *Femur* about 1·35 times the length of the metatarsus; its length between 1·8 and 2·2 times the girth of the shaft. A hind-toe was present, and the legs were feathered down to the toes.

Mesopteryx didinus.

Dinornis didiformis, Haast, Trans. N.Z. Inst., vol. i., p. 83, Nos. 5 and 6. *Dinornis huttonii*, Owen, Ext. Birds of N.Z., p. 430 (1879). *Dinornis didinus*, Owen, Trans. Zool. Soc., vol. xi., p. 257 (1882).

Figures.—Cranium, Ext. Birds of N.Z., pl. lxxviii. (as *casuarinus*). Restoration, pl. cxi. (as *didiformis*).

—	Metatarsus.		Tibia.		Femur	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	6·75	3·9	15·25	..	..	..
Max. ..	7·2	4·0	15·25	4·1	9·2	4·9
Min. ..	6·5	3·25	14·5	3·6	8·9	4·0

* Greek μέσος, middle.

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
Max. ..	6·8	8·0	4·25	2·7	2·5	1·7
Min. ..	6·0	7·25	..	2·7	2·3	1·5

Breadth of the skull at the temporal fossæ, 1·9in. to 1·7in.; at the post-frontal processes, 2·8in. to 2·7in. Length of the lower jaw, 4·25in. to 4in. Total length of the head, about 5in. Length of the ilium, 15·5in. to 14in.; of the ischium, 7·5in. to 6·5in.; breadth of the sacrum, 7in. to 6·2in.; depth of the pelvis, 6in. to 5·5in.

Distribution.—Found in both Islands, but rare in the North. The type is from a cave near Queenstown; and bones have also been found in the peat-beds at Hamilton and Glenmark, and in the caves at Takaka. In the North Island, a few bones have been obtained in the Te Aute Swamp and at Poverty Bay.

This species has been confounded with *A. didiformis*, but is stouter in all bones of the leg. It is also sharply marked off from *S. casuarinus* by the length of the tibia, although no such break exists with the metatarsi. The skull is intermediate between *Cela* and *Syornis*, but stands alone in the slenderness of the beak. Sir R. Owen gave the name *D. huttonii* to this species on the strength of my statement that it was different from *A. didiformis*, but without any description. Afterwards he described it under the name of *D. didinus;* and I think that the name that accompanied the description ought to take precedence.

Genus SYORNIS.

Dinornis (part) of Owen; *Syornis* and *Emeus* of Reichenbach; *Meionornis*, *Palapteryx* (part), and *Euryapteryx* (part) of Haast.

Skull convex, rounded behind, the supra-occipital sloping forward to the lambdoidal ridge. Breadth at the squamosals, from 1·6 to 1·7 times the height from the basi-temporal. Length from the supra-occipital to the nasals equal to, or more than, the breadth of the squamosals. Length of the basi-sphenoid from the basi-occipital to the end of the rostrum three to three and a half times the breadth of the basi-pterygoid processes. Occipital condyle just hidden or slightly exposed both vertically and laterally. Temporal fossæ broad. Beak shorter than the head, moderately curved, much compressed and pointed at the tip; length of the premaxillæ to the maxillary suture about one and three quarter times the breadth. Lower mandible strong. Plate XVI., fig. 6.

Sternum without coracoid pits. Length of the body, from 1·1 to 0·75 times the breadth. Costal processes large; the lateral processes nearly straight, diverging at an angle of about 20° from the middle line; the median posterior process often long, rarely notched at the end. Breadth across the ends of the lateral processes, about 1·1 times the breadth of the body below the costal region. No scapulo-coracoid.

Pelvis moderately broad; the breadth at the anti-trochanters about 1·25 times the length of the pre-acetabular portion of the ilia. Length of the ilium, between 2·2 and 2·5 times that of its pre-acetabular portion. *Metatarsus* shorter than the femur; its length between 1·6 and 2 times the girth at the middle of the shaft. *Tibia* from 2·1 to 2·25 times the length of the metatarsus; its length between 3·7 and 4·4 times the girth of the shaft. *Femur* about 1·25 times the length of the metatarsus; its length between 1·9 and 2·1 times the girth of the shaft.

The presence of a hind-toe has been proved in *S. casuarinus*. The tracheal rings are ossified, thick, circular, deep, and rough. Ext. Birds of N.Z., pl. xciii., figs. 13–32.

Syornis rheides.

Dinornis rheides, Owen, Trans. Zool. Soc., vol. iv., p. 1, (1850), metatarsus only. Not *D. rheides*, Ext. Birds of N.Z., pl. cix.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type	9·0	4·5	..	..	..	..
Max. ..	9·75	6·0	22·5	5·75	12·3	6·5
Min.	8·8	4·5	20·0	4·9	11·5	6·0

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type	..	..	..	..	..	..
Max. ..	9·5	12·0	..	..	..	..
Min.	8·5	10·5	..	..	..	..

Length of ilium, 22·5in. to 19·5in.; of ischium, 9·7in.; breadth of sacrum, 9·7in. to 9in. Length of lower jaw, 6·75in. to 6·2in.

Distribution.—From Motunau and Glenmark, in Canterbury, to Hamilton and Shag Point, in Otago. It was commonest at Hamilton, and rare in the sand-dunes at Shag Point.

This species has been much misunderstood owing to Professor Owen having associated a tibia of *S. crassus* and a femur of *P. plenus* with the metatarsus.* Sir J. von Haast confused it with *E. gravis*, probably on account of the supposed length of the tibia, and the photograph on plate cix. of the "Extinct Birds of New Zealand" represents this mixture. The femur is difficult to distinguish from that of *D. torosus* on one hand and *E. elephantopus* on the other. A complete leg has not yet been found.

Syornis crassus.

Dinornis crassus, Owen, Trans. Zool. Soc., vol. iii., p. 307 (1846), and vol. iv., p. 159, cranium. *Emeus crassus*, Reichenbach, Das Nat. Syst. der Vögel. *Palapteryx crassus*, Haast.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xl., figs. 4, 5; tibia, pl. xxxix., fig. 2 (as *casuarinus*); cranium, pl. lix. and lxxvi. (as *elephantopus*). Restoration, pl. cxii., fig. 2 (as *casuarinus*).

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	8·5	4·7	..	..	..	..
No. 1! ..	8·6	5·2	19·5	4·9	11·6	6·0
No. 2! ..	8·6	4·4	18·6	4·6	10·5	5·6
Max. ..	8·75	5·5	19·9	5·2	11·6	6·0
Min. ..	8·2	4·0	18·5	4·4	10·5	5·6

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1! ..	..	..	..	..	..	..
No. 2! ..	..	..	..	..	..	..
Max. ..	8·5	10·5	6·75	4·0	3·45	2·0
Min. ..	7·75	9·75	6·0	3·7	3·35	2·0

Breadth of skull at temporal fossæ, 2·3in. to 2·2in.; at post-frontal processes, 3·6in. to 3·5in. Length of the lower jaw, 5·8in. to 5·7in. Total length of the head, 6·5in. Post-

* The foot figured by Professor Owen in Ext. Birds of N.Z., pl. l., also appears to be that of *P. plenus*.

frontal process broad; breadth of the temporal fossæ, about two-thirds that of the orbits. The post-axial tarsal bone is about 2in. in length and 1in. in greatest breadth. The length of the ilium is 20·5in. to 18·5in.; of the ischium, 9·5in. to 8·25in.; breadth of the sacrum, 8·75in. to 8·5in.; depth of the pelvis, 8in. to 7in.

Distribution.—Very common in the peat-beds at Hamilton and Glenmark; also found in Maori cooking-places at Awamoa and Shag Point. The femur with fragments of muscle which accompanied the neck with integument, found in Earnscleugh Cave, belongs to this species.* The type is from Waikouaiti. The specimen No. 1 is from Glenmark; No. 2 is from a leg in the Wellington Museum the locality of which is unknown.

This species has, like the last, been misunderstood. Professor Owen gave it its name before he had seen bones of *E. elephantopus;* and the tibia and femur which he associated with the metatarsus belonged to a smaller species. These gave the idea that the bird was very robust; and Sir J. von Haast, as well as myself, placed it close to *E. elephantopus.* The skull ascribed to this species by Sir R. Owen has been proved, by the skeleton in the Otago Museum, to belong to *E. elephantopus,* and consequently the skull placed on that species must come here. The femora are difficult to distinguish from those of *D. struthioides* on the one hand and *E. ponderosus* on the other.

Syornis casuarinus.

Dinornis casuarinus, Owen, Trans. Zool. Soc., vol. iii., p. 307 (1846), metatarsus only; and vol. vii., p. 115, sternum. *Syornis casuarinus,* Reichenbach, Das Nat. Syst. der Vögel (1850). *Meionornis casuarinus,* Haast, Trans. N.Z. Inst., vol. vii., pp. 54, 91 (1874).

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xl., fig. 3; femur, pl. xxiii., fig. 1; cranium, pl. lxxv. (as *rheides*); sternum, pl. xlviii., and pl. lxxiii., lxxiv. (as *rheides*).

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	8·0	4·2	..	..	..	..
No. 1 ! ..	7·9	4·6	18·0	4·2	10·3	5·4
No. 2 ! ..	7·25	4·5	18·0	4·1	10·5	5·2
Max. ..	8·0	5·0	18·25	4·75	10·3	5·75
Min. ..	7·25	3·6	16·0	3·3	9·3	4·25

* Trans. N.Z. Inst., vol. iv., p. 112.

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	6·0	7·75	5·0	..	..	..
No. 2 ! ..	..	..	..	..	..	..
Max. ..	7·0	9·5	5·5	4·0	3·3	2·1
Min. ..	..	8·8	5·0	3·3	3·2	1·9

Breadth of skull at temporal fossæ, 2in. to 1·9in.; at post-frontal processes, 3·75in. to 3·55in.; length of lower jaw, 4·5in.; total length of head, 5in. Temporal fossæ narrow, the breadth about one-third that of the orbits. Length of the ilium, 17·5in. to 16in.; of the ischium, 8·7in. to 7in.; breadth of the sacrum, 8in. to 7in.; depth of the pelvis, 6·2in. to 5·6in. Length of the middle toe, 6in.

Distribution.—Found in both Islands, but rare in the North and common in the South. The type is from Waikouaiti, in Otago. No. 1 is a specimen in the Otago Museum found at Dunedin;* No. 2 is a specimen in the Wellington Museum, the locality unknown. It was very abundant in the peat-beds of Glenmark and Hamilton, and occurs also in the Maori cooking-places at Shag Point. A few bones were found in the Te Aute Swamp, and it also occurs in the Maori cooking-places at Wanganui and Whangarei.

The North Island birds agree with those from Glenmark Swamp in having a rather shorter tibia than the birds from Otago; while the rather older birds from Motunau agree in size with the southern variety. This difference is sufficient to distinguish two varieties, but is not of specific importance. In Otago the length of the tibia is between 18·25in. and 17in., while in Glenmark and the North Island it is between 17·8in. and 16in.

A sternum in the Wellington Museum from Waipawa, Hawke's Bay, enables us to identify the sterna found in the South Island. The cranium figured in Ext. Birds of N.Z., pl. liii., fig. 6, may belong here, but is rather large. The femora are difficult to distinguish from those of *E. gravis*.

Genus EURYAPTERYX.

Dinornis (part) of Owen; *Palapteryx* (part) and *Euryapteryx* (part) of Haast.

* Hector, Proc. Zool. Soc., 1865, p. 749.

Skull rather small, rounded behind, and moderately convex. Breadth at the squamosals from 1·5 to 1·6 times the height at the basi-temporal. Length to the nasals either greater or less than the breadth of the squamosals. Length of the basi-sphenoid from the basi-occipital to the end of the rostrum rather less than three times the breadth of the basi-pterygoid processes. Temporal fossæ narrow and deep. Posterior margin of tympanic cavity straight. Occipital condyle hidden or slightly exposed both vertically and laterally. Beak very short and stout, slightly compressed and rounded at the tip. Length of the premaxillæ to the maxillary suture less than the breadth. Plate XVI., fig. 8.

Sternum without coracoid pits, or sometimes faintly marked. Length of the body about one-half of its breadth. Costal processes small; lateral processes short, nearly straight, diverging at an angle of about 35° from the middle line; median process short, rarely notched. Breadth across the ends of the lateral processes, from 1·8 to 2·1 times the breadth of the body below the costal region. Three pairs of sternal ribs articulating with the sternum. No scapulo-coracoid.

Pelvis very broad, and the acetabula set far forwards. The breadth at the anti-trochanters is one and a half times the length of the pre-acetabular portion of the ilia. Length of the ilium, from 2·7 to 2·9 times the length of the pre-acetabular portion. *Metatarsus* much shorter than the femur; its length between 1·3 and 1·5 times the girth of the shaft in the middle. *Tibia* from 2·2 to 2·4 times the length of the metatarsus; its length between 3 and 3·7 times the girth of the shaft. *Femur* about 1·3 times the length of the metatarsus; its length between 1·8 and 1·5 times the girth of the shaft.

The presence of a hind-toe has been proved in *E. elephantopus* and *E. ponderosus*. The tracheal rings are ossified, elliptical, and smooth. Ext. Birds of N.Z., pl. xciii., figs. 1–12.

This genus contains the most robust of all the moas, and is confined to the South Island.

Euryapteryx elephantopus.

Dinornis elephantopus, Owen, Trans. Zool. Soc., vol. iv., p. 149 (1856), and p. 159; Buller, Birds of N.Z., 2nd ed., vol. i., p. xxxii., and vol. ii., p. 333; Haast, Trans. N.Z. Inst., vol. i., p. 80, No. 12.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. lvii.; tibia, *l.c.*, pl. lvi., fig. 4; femur, pl. lvi., fig. 1; cranium, *l.c.*, pl. lxxvii., and pl. cxiv., fig. 1 (as *crassus*); sternum, pl. lxxii. Restoration, pl. cviii., and pl. cxiii., fig. 2 (as *crassus*).

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	9·25	6·5	24·0	6·4	13·0	7·75
No. 1 ! ..	9·1	6·0	21·1	5·6	11·8	6·8
No. 2 ! ..	9·8	6·8	22·8	6·3	12·8	7·7
No. 3 ! ..	9·5	6·8	23·0	6·5	13·0	7·6
Max. ..	9·9	7·2	24·0	6·5	13·0	8·25
Min. ..	9·0	5·9	20·8	5·7	11·75	6·4

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	7·5	11·5	8·0	..	..	..
No. 2 ! ..	..	..	..	..	..	..
No. 3 ! ..	..	..	..	..	..	..
Max. ..	7·5	12·0	8·8	3·0	3·1	1·9
Min. ..	6·5	11·5	8·0	2·85	2·6	1·8

Breadth of skull at temporal fossæ, 2·2in. to 2·1in.; at post-frontal processes, 3·45in. to 3in. Length of lower jaw, 5·25in. to 4·8in. Total length of the head, about 5·5in. Length of ilium 19in., of ischium 9in.; breadth of the sacrum, 10·25in. to 10in.; depth of pelvis, 7in. to 6in. Post-axial tarsal with a length of from 2·5in. to 2in., and greatest breadth 1·25in. to 1in. Length of middle toe, 8·5in. to 7in.

Distribution.—South Island, from Takaka, near Nelson, to Otago; the type is from Awamoa, near Oamaru. Most abundant in Otago, and comparatively rare at Glenmark. No. 1 is a specimen from a cave in the Waitaki Valley, now in the Otago Museum; Nos. 2 and 3 are from Glenmark. The cranium figured in Ext. Birds of N.Z., pl. cxiv., fig. 1, was obtained by me in the sandhills at the mouth of the Shag River, and sent to the British Museum.

The femur from Waikouaiti ascribed by Professor Owen to *S. crassus* belongs here, as also do the skulls described by him under the same name.

Euryapteryx ponderosus.

Dinornis gravis (?), Hutton, Trans. N.Z. Inst., vol. vii., p. 275.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
No. 1 ! ..	8·25	6·0	18·5	5·25	..	..
No. 2 ! ..	8·0	5·0	18·6	5·4	10·0	5·6
Max. ..	8·9	6·75	20·6	5·9	11·0	6·8
Min. ..	8·0	5·0	18·5	5·2	10·0	5·4

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
No. 1 ! ..	..	..	..	..	..	..
No. 2 ! ..	..	..	..	..	..	..
Max. ..	6·0	10·0	7·5	2·8	2·8	1·85
Min. ..	..	..	7·0	2·5	2·7	1·7

Breadth of the skull at temporal fossæ, 2in. to 1·9in.; at the post-frontal processes, 3·1in. to 2·95in. Length of lower jaw, 4·8in. to 4·5in. Total length of the head, 5·5in. Length of the ilium, 16·5in.; breadth of the sacrum, 8·25in.; depth of the pelvis, 6in. The post-axial tarsal has a length of 2in. to 1·75in., and a greatest breadth of 0·9in. to 0·8in. Length of the middle toe, 6in.

Distribution.—Throughout Otago and Canterbury. Not known from the Nelson District. It was the most abundant species in the Maori cooking-places at Shag Point, where also the skulls were abundant; and it occurs in the Pleistocene deposits at Motunau. No. 1 is from Hamilton; No. 2 is the measurements of a pair of legs in the Wellington Museum, the locality of which is not known.

The skull of this species can be distinguished from that of the last by the processes at the hinder angles of the basi-sphenoid, which are higher and rounder in *ponderosus*, flatter and more elongated in *elephantopus*. From *E. gravis* the skull is distinguished by the parietals which are convex in all directions in *ponderosus*, but concave longitudinally in *gravis*, the post-frontal elevation on the skull being more conspicuous in that species. But there are intermediate forms. The tibia and femur appear to be well marked off from those of *E. gravis*, but all the bones pass into those of *E. elephantopus*. I have separated it from this last species partly on account of its geographical distribution, and partly because a range of variation of two inches in the metatarsus is much more than what has been allowed for the species of *Syornis* and *Cela.* It will be seen also that there are three types of skull in *Euryapteryx.*

Euryapteryx gravis.

Dinornis gravis, Owen, Trans. Zool. Soc., vol. viii., p. 361, 1872 (metatarsus and tibia only). *D.* sp., Haast, Trans. N.Z. Inst., vol. i., No. 17.

Figures.—Metatarsus, Ext. Birds of N.Z., pl. xlii.*a*; tibia, *l.c.*, pl. xlii., figs. 1–3; cranium, *l.c.*, pl. lxxxi. (not fig. 5). Restoration, pl. cx.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	7·75	5·0	16·6	5·0	..	..
No. 1 ! ..	7·75	5·0	15·75	4·75	..	..
Max. ..	7·8	5·5	17·75	5·1	9·5	5·3
Min. ..	7·0	4·5	15·7	3·3	9·0	4·7

—	Pelvis.		Sternum.	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..
No. 1 ! ..	..	..	..	..	..	..
Max. ..	4·5	7·0	6·5	2·5	2·7	1·7
Min. ..	..	..	..	2·25	2·5	1·6

Breadth of the skull at temporal fossæ, 1·85in. to 1·75in.; at post-frontal processes, 4·1in. to 3·1in. Length of lower jaw, 4·4in. to 4·3in. Total length of the head, 5in. The temporal fossæ are broader than in the other species, being about one-half of that of the orbits. Length of the ilium, 12in.; breadth of the sacrum, 6in.; depth of the pelvis, 5in.

Distribution.—The type is from Kakanui, near Oamaru. It was common in the peat-beds at Hamilton and Glenmark, and in the Pleistocene deposits at Motunau. It also occurs at the Maori cooking-places at Shag Point. No. 1 is from Hamilton.

Euryapteryx pygmæus.

—	Metatarsus.		Tibia.		Femur.	
	Length.	Girth.	Length.	Girth.	Length.	Girth.
Type ..	6·0	4·0	13·5	5·0	7·5	4·5

—	Pelvis.		Sternum	Skull.		
	Length.	Breadth.	Breadth.	Length.	Breadth.	Height.
Type ..	..	..	..	..	..	..

Metatarsus: Breadth at proximal end, 2·65in.; at middle of shaft, 1·55in.; at distal end, 3·4in.; antero-posterior thickness of shaft, 0·9in.

Distribution.—This species is founded on a pair of metatarsi in the Nelson Museum from Takaka. With them I have associated a tibia and a femur from Otago, which were exhibited at the Dunedin Exhibition in 1865, the measurements of which are given by Sir James Hector in Proc. Zool. Soc., 1865. It appears to have been a very rare species.

History of the Moas.

The history of the moas presents several interesting problems not yet completely solved, prominent among which are their origin, their advent in New Zealand, their development, and the date of their extinction.

Origin of the Moas.

The moas belong to that group of birds called "Ratitæ" by Merrem (1813), to which also belong the ostrich, the rhea, the emu, the cassowary, and the kiwi. All of these have small, or even rudimentary, wings, and loosely-arranged feathers; while all but the kiwi are birds of large size. Whether the Ratitæ—or struthious birds—form an offshoot from the Carinatæ—or flying birds—or whether the Carinatæ are descended from the Ratitæ, is a question which has been much discussed. But the writings of Professor T. J. Parker on *Notornis* and on *Apteryx** have, I think, conclusively settled it in favour of the first view. Indeed, the structure of the rudimentary wings, and the cellular texture of some of the

* Trans. N.Z. Inst., vol. xiv., p. 254; N.Z. Journal of Science, 1891, pp. 3 and 66; Phil. Trans., vol. clxxxii., p. 25.

bones, are by themselves sufficient evidence to show that the remote ancestors of the Ratitæ could fly. Palæontology confirms this opinion, because the oldest known bird—*Archæopteryx*, of the Jurassic period—had well-developed wings.

With the exception of some peculiarities in the base of the skull, all the other characters which unite the Ratitæ into one group, including their great size, are merely adaptations to a terrestrial life, and are of little value as evidence of affinity. Even the characters of the skull are not confined to the Ratitæ, but are also found in the tinamous and *Opisthocomus*, which are carinate birds.

The living Ratitæ form four well-defined families—

1. *Struthionidæ*, containing the two-toed ostrich of Africa.
2. *Rheidæ*, containing the rhea of South America.
3. *Casuaridæ*, including the emu and cassowary of Australia and Melanesia.
4. *Apterygidæ*, containing the kiwi of New Zealand.

The moas— Dinornithidæ—come between the Casuaridæ and the Apterygidæ, connecting them together. Contemporaneous with the moas were *Dromornis* and an extinct species of emu in Australia, a large extinct species of rhea in Brazil, and *Æpyornis* in Madagascar. The last of these was a struthious bird, but it is doubtful where it should be placed. Certainly it was not closely allied to the moas, although it resembled some of them in its gigantic size, and in having a hind-toe. In the early part of the Pliocene period an ostrich lived in northern India, as also did another with three toes, perhaps allied to the rhea; and here we come to the earliest certain traces of struthious birds outside of New Zealand. In the Lower Eocene, *Dasornis*, *Megalornis*, and *Macroornis*, of Europe,* as well as *Diatryma*, of Mexico, are thought by some to belong to the Ratitæ. The fragment of the skull of *Dasornis* is said by Professor Owen to resemble the skulls of *Rhea* and *Struthio* more than that of *Dinornis*. The fragmentary shaft of the tibia of *Megalornis* is compared to that of the emu by Professor Seeley.† Professor Cope thinks that *Diatryma* was allied to the rhea, while Mr. Lydekker thinks it may be identical with *Gastornis*. Great size may go either with aquatic or with terrestrial habits, and there is as yet no conclusive proof that any of these birds belong to the Ratitæ; and certainly there

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* *Gastornis* is said both by A. Milne-Edwards and E. T. Newton to be related to the Anatidæ (Trans. Zool. Soc., vol. xii., p. 143); but Mr. Lydekker places it doubtfully in the Ratitæ (*Knowledge*, 1891, and Nicholson's "Palæontology," vol. ii.).

† Quar. Jour. Geol. Soc., vol. xxx., p. 708.

is no evidence for supposing any of them to be the ancestors of the moas. *Mesembriornis*, of South America, appears to be related to the Anatidæ.

In the Cretaceous period all the birds were very different from living ones, and, although flying birds and flightless birds existed even then, the flightless birds were adapted for swimming, while the Ratitæ are a group specially adapted for terrestrial life. It is true that the Cretaceous birds had skulls, so far as we know, on the present Ratite type; but that pattern appears to have been at the time common to all birds. There were no distinct Carinatæ and Ratitæ, only the Proto-carinatæ of Professor T. J. Parker. The Ratitæ must have branched off from the Proto-carinatæ at an early date, but probably not before the close of the Cretaceous period. The Grallæ of Bonaparte, together with the bustards, form another group, also adapted for terrestrial life, which branched off from the Carinatæ at a later period.

Advent of the Moa in New Zealand.

That the moas have been a long time in New Zealand is evident. Numbers of bones have been obtained from old Maori cooking-places,* which are, of course, recent; and still greater numbers have been found in swamps and caves, some of which are of Pleistocene age. At the Patangata Swamp, Te Aute, near Napier, the bones were partly in a stiff blue clay and partly in an old forest-bed lying on the clay, and were covered by 8ft. or 10ft. of silt;† while others occurred lying on the surface of the drained lagoon, and may have been younger. The swamp at Glenmark, which had to be drained, may possibly belong to the Recent period, but below the swamp there is a series of beds of river-shingle, peat, and silt, covered by the loess deposit so common in Canterbury, which is no doubt Pleistocene, and from this peat-bed a large number of moa-bones have been obtained.‡ At Hamilton, in central Otago, the principal deposit of bones was a small dry peat basin excavated out of a bed of clay, and below the clay, which was 6ft. thick, there was another small peat basin, also full of moa-bones.§ Considerable changes have taken place in the physical geography of the country since these peat basins were

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* Murison, Trans. N.Z. Inst., vol. iv., p. 122; Haast, *l.c.*, vol. vii., pp. 86 and 91; Thorne, *l.c.*, vol. viii., p. 83; Hutton, *l.c.*, vol. viii., p. 103; Robson, *l.c.*, vol. viii., p. 95, and vol. ix., p. 279; Mantell, *l.c.*, vol. xxi., p. 440; G. A. Mantell, "Petrifactions and their Teachings," p. 101.

† Hamilton, Trans. N.Z. Inst., vol. xxi., p. 314; Park, Rep. Geol. Expl., 1887–88, p. 88.

‡ Haast, "Geology of Canterbury," p. 442.

§ Booth, Trans. N.Z. Inst., vol. vii., p. 123, and vol. ix., p. 365; Hutton, Quar. Jour. Geol. Soc., vol. xli., p. 213.

formed, and undoubtedly they must be referred to the Pleistocene. Bones have been found at Motunau, in clay and lignite, which Sir J. Hector and Mr. A. McKay consider to be early Pleistocene, and of the same age as the oldest bones at Glenmark. These beds were covered by 10ft. to 60ft. of alluvial deposits. Mr. McKay has also collected broken moa-bones and fragments of moa egg-shell from the Pleistocene beds at Gore Bay. These beds form a series of angular gravels and silts, with marine shells in the lower portion, passing upwards into rounded gravels, clays, and loam. The moa-bones were obtained from about the middle of the formation.* Moa-bones also occur in the loess which wraps round Banks Peninsula and covers the low hills at Timaru and Oamaru,† as well as in the higher alluvia of the rivers.

A few bones are reported by Dr. Haast from the ancient moraines in Canterbury and Otago,‡ which are probably of Pliocene age. Near Napier moa-bones have been found by Mr. Aug. Hamilton associated with newer Pliocene marine shells;§ and the footprints discovered by Mr. D. Millar in the sandstone at Gisborne‖ are also probably newer Pliocene. Mr. S. H. Drew has found bird-bones, probably belonging to the moa, in the Pliocene brown sands near Kai-iwi, between Wanganui and the mouth of the Waitotara.¶ Undoubted moa remains have been found by Mr. F. W. Stubbs and Mr. Miller in a bed of clay at Timaru, which overlies gravel and underlies a lava-stream; and with them was associated a femur supposed by Mr. H. O. Forbes to belong to the living *Apteryx australis*.** These lavas have hitherto been considered as Miocene, or even Eocene, in age. They can be traced for about twelve miles in a westerly direction, gradually rising until they form the summit of Mount Horrible (1,138ft.); and here they end abruptly in a precipice overlooking the valley of the Pareora River. Below the lava-streams, and separated from them by a thickness of 300ft. or 400ft. of sandy and tufaceous beds, are older lava-streams, which on the south-west side of Mount Horrible lie on limestone of Oligocene age. In 1865 Sir J. von Haast thought that certain beds, with marine fossils belonging to the Pareora series

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* Trans. N.Z. Inst., vol. xiv., pp. 410 and 540; Rep. Geol. Expl., 1882, p. 74.

† Hutton, "Geology of Otago" (1875), pp. 71, 72.

‡ Quar. Jour. Geol. Soc., vol. xxi., p. 134; Trans. N.Z. Inst., vol. iv., p. 68; Geol. Canterbury, pp. 380 and 437.

§ Trans. N.Z. Inst., vol. xxi., p. 312.

‖ Williams, Trans. N.Z. Inst., vol. iv., p. 122; Gillies, *l.c.*, p. 127; Owen, Ext. Birds of N.Z., p. 451, pl. cxvi.

¶ Park, Rep. Geol. Expl., 1886–87, p. 63.

** Trans. N.Z. Inst., vol. xxiii., p. 367.

(Miocene), found in the immediate neighbourhood, were the equivalents of the tufaceous beds, although he did not succeed in finding the fossiliferous beds actually cropping out between the lava-streams.* But in 1872 he says that the limestone at Mount Horrible (Weka Pass limestone) is "subdivided by several coulées of the anamesites;"† and in his "Geology of Canterbury" (1879) he refers the Timaru volcanic rocks to the Oamaru (Eocene) formation. Writing of the section at Mount Horrible, he omits his former statement that lavas are interbedded with the limestone, and says, "Upon the calcareous greensands forming the upper bed of the Oamaru formation, and which is often so rich in carbonate of lime that it can be used for the lime-kiln, a bed of volcanic tufa reposes, sometimes changed into an agglomerate, after which the first lava-stream appears. Then follow a number of tufaceous beds with some smaller lava-streams between them, till the uppermost coulée is reached, having, like the lowest one also, a thickness of about 50ft. The anamesitic rock is extensively quarried near Timaru, and forms a valuable building-stone for that town" (*l.c.*, p. 314).

In 1876 Mr. A. McKay, of the Geological Survey, found in this locality blue sandy beds with Miocene marine fossils, overlain conformably by grey sands, lignite, and gravels; and he says that the volcanic rocks of Timaru are associated with the Pareora (Miocene) beds.‡ A few years later, relying on Dr. von Haast's statement that lavas were actually interstratified with the calcareous rocks, he considered that these must be older than the lavas of Mount Horrible and Timaru, which, he says again, belong to the Pareora formation,§ and form part of the latest display of volcanic energy in this Island. But, as Dr. Haast does not mention this supposed intercalation of calcareous rocks and lava-streams in his "Geology of Canterbury," we must suppose it to have been a mistake, and consequently there is no reason to regard any of the volcanic rocks near Timaru as of Eocene age.

That these lavas were not younger than Miocene was therefore the opinion of the only two geologists who had examined the locality. But last year Mr. H. O. Forbes published his opinion that they were probably of "newer Pliocene or even Pleistocene age."‖ This conclusion was not arrived at by a re-examination of the sections at Mount Horrible and the Pareora. Mr. Forbes merely went to a quarry near

* "Report on the Geological Formation of the Timaru District," pp. 10 and 12.

† Rep. Geol. Expl., 1871–72, p. 25.

‡ Rep. Geol. Expl., 1876–77, pp. 54 and 66.

§ Rep. Geol. Expl., 1879–80, p. 78.

‖ Trans. N.Z. Inst., vol. xxiii., p. 372.

Timaru and, "with little doubt," identified a "rough red shingle," which he did not even see *in sitû*, with the gravels of the "alluvial fans" of the Canterbury Plains. He also identified the bone-bed itself, which lies above the "rough red shingle" and below the lava-stream, with the silt or loess which lies on the top of the lava-stream. Mr. Forbes's opinion on the subject cannot therefore carry any weight; it is merely another instance of the mistake, so often made, of correlating rocks by lithological resemblances, and overlooking the far more important evidence to be derived from the changes which took place between the deposition of the two beds.

The moa-remains belong to a species (*A. antiquus*) which has not been found elsewhere, but if it had been correct that bones of a living species of kiwi occurred with them it would have been strong evidence in favour of the bed being younger than Miocene. A broken femur, only partially cleared from the matrix in which it is imbedded, cannot furnish very conclusive evidence; and Mr. Forbes gives no description of the bone, neither does he say on what characters he relies as proving it to be the femur of *Apteryx*. Certainly his drawings do not bear out his statement, for they show a bone differing materially from the femur of *Apteryx australis*. The shaft is too straight and too stout; the head too convex; the neck too transverse to the axis of the bone, and far too much constricted. At the distal end the inner condyle projects inward too much, and the outer one too much downward, thus making the articular surface too oblique to the shaft. In several characters the drawings resemble the femur of *Aptornis* more than that of *Apteryx*, and I cannot accept Mr. Forbes's drawings, unaccompanied as they are by any description, as a proof that the bone belongs to *Apteryx* at all, much less to *A. australis*. The gravels under the bone-bed belong, no doubt, to the series of sands and gravels which Mr. McKay has shown to lie conformably on beds with marine Miocene fossils. Whether these gravels are Upper Miocene or older Pliocene it is at present impossible to say; but we may safely assume that the lavas are much older than Pleistocene, because since they were erupted the amount of denudation has been enormous, and all traces of the place from whence they came have been swept away.

Lastly, the Hon. W. Mantell, in 1849, found in a septarium near Hampden, Otago, a fragment of a large bone 1½in. in diameter, which was said by high authorities in England to belong to a bird.* These septaria are, I think, of Lower Miocene age, as they occur in sandy clays containing in the close neighbourhood *Aturia zic-zac*, *Ancillaria*, *Cominella*, as

* Quar. Jour. Geol. Soc., vol. vi., p. 326.

well as other fossils, including at least three living species of Mollusca,* and, if this fragment is part of a moa-bone, it is the oldest at present known. Doubts have been expressed as to the ornithic nature of this fragment, and it has been suggested that it may be reptilian. Mr. H. O. Forbes has even gone so far as to say that, "as reptilian bones have since been obtained from the same horizon, it was probably of this nature."† But no second examination of the fragment has been made, and it is not probable that the English authorities mistook reptilian for bird bones. Also no other reptilian bones have been found in these septaria, nor are reptilian bones known to occur in any other part of New Zealand associated with the species of shells found at Hampden in the beds containing the septaria: consequently, whatever age these beds may be, Mr. Forbes cannot be correct in saying that reptilian bones have been found on the same horizon; for geological horizons are determined by a similarity of fossils. Omitting this fragment as uncertain, we have undoubted traces of the moas in New Zealand in early Pliocene, or perhaps in Upper Miocene, times.

Now comes the question, How came the moas to be in New Zealand? Mr. A. R. Wallace supposes that the moas are descended from Ratite ancestors of the Northern Hemisphere, and have spread southwards through New Guinea into Australia and New Zealand. If this be so the migration into New Zealand must have taken place a very long time ago. In the Miocene and Oligocene periods New Zealand was of much smaller dimensions than at present; but in the Eocene, and again, probably, in the older Pliocene, it was much larger, and stretched in a north-west direction towards New Guinea. But, as I have pointed out in former addresses to this Institute,‡ biological evidence assures us that New Zealand has never been joined to Australia or to New Guinea since the Cretaceous period, a time when there were no struthious birds in existence; and it is difficult to explain how these birds, if they migrated from the Northern Hemisphere, entered Australia and New Zealand without being accompanied by placental mammals. Mr. Wallace supposes that they either flew or swam across a strait which was impassable to the mammalia.§ That they flew across is, on this hypothesis, impossible, because the special characters of the Ratitæ are

* Trans. N.Z. Inst., vol. xix., p. 426.

† Trans. N.Z. Inst., vol. xxiii., p. 372.

‡ Ann. and Mag. Nat. Hist., ser. 4, vol. xiii., p. 25; ser. 5, vol. xiii., p. 425; and vol. xv., p. 77. N.Z. Journal of Science, 1884–85, pp. 1 and 249.

§ "Island Life," p. 450. See also Owen, Ext. Birds of N.Z., p. 136.

due to their being unable to fly; and the only alternative is that they crossed by swimming. But, although the emu and the rhea are both said to take readily to water, many placental mammals do the same, and it is very unlikely that the struthious birds should twice have swum across straits—once from the Oriental to the Australian region, and again from the Australian region to New Zealand—which were impassable to mammals. There are also other reasons for doubting the northern origin of the Australasian Ratitæ. The struthious birds of New Zealand, notwithstanding the almost complete absence of wings, make a nearer approach to the original stock—that is, are less modified—than any of the other families. This is shown by the long lateral processes of the sternum, by the smaller coraco-scapular angle in the smaller species, by the broad sacrum and free ischia and pubes, as well as by the hind-toe. Again, the only small Ratitæ are from New Zealand; and, if the group is descended from flying birds, the smaller forms must have preceded the larger ones. We should expect to find the least altered forms near the place of origin; and, if the New Zealand Ratitæ have migrated from Europe or Asia, how comes it that the least-modified forms have been gathered together in these Islands? Flightless birds are generally developed on islands where there are no mammals, and not on large continents.

The common ancestors of the Australian and New Zealand Ratitæ must have had both wings and hind-toes, like the kiwi and *Palapteryx*. Probably they also had, like the moas, feathers sometimes with one, sometimes with two, shafts to a quill. *Palapteryx* makes the nearest approach to the common ancestor of the Australasian Ratitæ of any bird we know; but no doubt these common ancestors had much larger wings than *Palapteryx*, and they must have possessed clavicles. The late Professor W. K. Parker long ago pointed out the struthious affinities of the tinamous,* and lately he has proposed to place the Ratitæ, and perhaps *Opisthocomus*, with the Tinamidæ in the group Dromæomorphæ of Huxley.† The tinamous are birds about the size of kiwis, living in Central and South America, and they show in the free ischia and pubes, as well as in having a free post-axial tarsal bone, a decided approach to the Dinornithidæ. Probably, therefore, the Australasian Ratitæ are descended from birds allied to the tinamous, which, being carinate and with large wings, found their way to New Zealand by flight, like all the other birds.

There are no great difficulties in accounting for a migration by land of these birds from New Zealand into Australia, while

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* Trans. Zool. Soc., vol. v., p. 149 (1866).
† Trans. Zool. Soc., vol. xiii., p. 80 (1891).

a counter-migration of Australian mammals into New Zealand was prevented. At some former period, when New Zealand stretched towards North Australia, a portion of land—including, perhaps, Norfolk Island—inhabited by Ratitæ may have been detached from New Zealand, and subsequently united to North Australia, when the Ratitæ would spread into Australia and New Guinea. If this supposition is a correct one the great differentiation that has taken place in the birds since their migration shows that it must have been not later than the Eocene period. According to Mr. De Vis a femur belonging to one of the Dinornithidæ has been lately found on the Darling Downs, in Queensland;* and if this is correct it would imply that there had also been a second migration into Australia from New Zealand in the older Pliocene. But I cannot agree with Mr. De Vis that *Dromornis* was more closely related to the moas than to the emu. This question has been settled by Sir R. Owen from an examination not only of the femur, but also of the tibia and pelvis. The points of resemblance between *Dromornis* and *Dinornis* are adaptive only, and cannot be taken to prove affinity. If the absence of a pneumatic foramen in the femur shows relationship more strongly than other points, we should have to class the owls with the kiwis instead of with the hawks.

We may conclude, therefore, that the ancestors of the moas originated in New Zealand in the Eocene period, although we have as yet no certain evidence of them before the older Pliocene or Upper Miocene. Probably the Ratitæ of America, Asia, and Africa, including *Æpyornis*, have had a separate origin from those of Australasia. The ancestors of *Æpyornis* must have passed into Madagascar in the Eocene period, for no Miocene mammals are found there, and it is possible that they may be descended from swimming-birds through *Gastornis, Dasornis, Megalornis*, and *Diatryma*.

Development of the Moas in New Zealand.

In whatever way the moas originated in New Zealand, it is evident that the land was a favourable one, for they multiplied enormously, and spread from one end to the other, no doubt during a time when both Islands were connected. Bones have been found from the Bay of Islands in the north to Waipapa Point in Southland, and from sea-level to an altitude of 5,250ft. in the mountains of Otago.† The number of indivi-

* N.Z. Journal of Science, 1891, p. 97; and Etheridge, Records of Geol. Surv., N.S. Wales, vol. i., p. 128.

† N.Z. Journal of Science, 1885, p. 394. The moa-bones found on the Great Barrier Island by Mr. Weetman (Trans. N.Z. Inst., vol xix., p. 193, and vol. xxii., p. 84) belong to a young chick of a species of *Dinornis*, and

duals living together must have been very great, if we may judge by the number of bones found in the swamps and in the alluvial deposits of rivers. Writing in 1871, Sir James Hector says, "It is impossible to convey an idea of the profusion of bones which, only a few years ago, were found in this district [central Otago], scattered on the surface of the ground, or buried in the alluvial soil in the neighbourhood of streams and rivers."* Sir Julius von Haast estimated that there were the remains of more than a thousand birds, belonging to fourteen different species, in the Glenmark Swamp. At Hamilton I obtained from a small basin, about 50ft. in diameter and 4ft. in depth, bones of at least four hundred birds, belonging to eleven species; and Mr. Forbes estimates that at Enfield the remains of more than three hundred birds were crowded together into a small space not more than 3ft. deep.

The great number of different species of struthious birds lately living together in New Zealand is a remarkable fact, unparalleled in any other part of the world.† The Continent of Africa, together with Arabia and, formerly, central Asia, contains but three species of ostrich, differing in the colour of the skin of the neck. South America, from the Straits of Magellan to Peru, has but three species of rhea. Australia possesses two species of emu and one species of cassowary; while eight other species of cassowary inhabit detached islands from New Britain and New Guinea to the Aru Islands and Ceram. Outside of New Zealand two species of struthious birds are hardly ever found living in the same district; while a few hundred years ago there were in New Zealand, besides several kinds of kiwis, twelve species of moas in the North Island and seventeen species in the South Island. Many years ago I found, as I thought, a solution for this problem by examining the present distribution of the cassowaries.‡ Here we have eight species, inhabiting five different islands, and if this region of the earth were to be elevated and the islands joined these eight species might mingle together. If the region were to sink again all would undoubtedly be driven to the highest land, and we might have a single island inhabited by eight species of cassowaries. Now, we know that New Zealand has actually gone through a series of changes in level similar to those just mentioned. In the Oligocene and Miocene periods it consisted of a cluster of several islands,

possibly the bird was taken there by the Maoris. No moa-bones have been found on the Chatham Islands by Europeans, but the Maorioris have a tradition of a large bird which was called puoa (Trans. N.Z. Inst., vol. vii., p. 117, footnote).

* Trans. N.Z. Inst., vol. iv., p. 115.

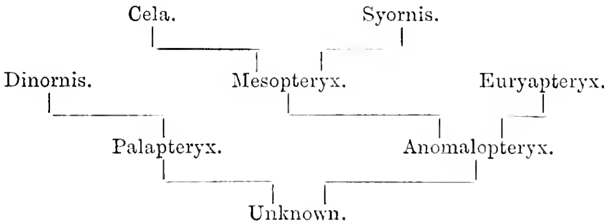
† Owen, Ext. Birds of N.Z., p. 106.

‡ Trans. N.Z. Inst., vol. v., p. 233.

which were united in the older Pliocene, and ultimately it divided into the two islands which we have now. If the ancestors of the moas inhabited New Zealand during the Eocene period—as we have seen was most probably the case —each island in the Miocene may have contained a different kind of moa, all of which would mingle together when the land rose in early Pliocene times. In the newer Pliocene the birds must have been again separated by the formation of Cook Strait, and the species in each island would again be isolated from each other.

I still think that isolation during Miocene times gave origin to the genera; but variations of specific importance have in several cases taken place since the formation of Cook Strait, and most of the species must be due solely to variation without isolation. As is the case with most common species, the moas varied greatly, and, there being no carnivorous mammals or other powerful enemy to hold them in check, while vegetable food abounded in all directions, natural selection did not come into play, the intermediate forms were not strictly eliminated, and, consequently, the different species were not distinctly marked off, but one merged into the other. Under such favourable circumstances the conditions of life were very easy, and the birds got larger and fatter, more sluggish and more stupid.

If the moas are descended from flying birds, which we cannot doubt, it is evident that the smaller species must have preceded the large ones; and this is borne out by the facts of geographical distribution. For it is only the smaller species of *Anomalopteryx*, *Mesopteryx*, *Syornis*, and *Dinornis* which are found in both Islands, the larger forms in *Syornis* and in *Dinornis* having been developed since the Islands were separated. Whether the apparently allied species of *Dinornis* are really geographical representatives of each other, due to isolation, or whether they form two separate lines, one in each Island, diverging from *D. struthioides*, we cannot say until the skulls and sterna of the North Island species are known; but the latter hypothesis seems to me to be the more probable, as it accounts for all the species of the South Island being more robust than those from the North Island. When we try by morphological evidence to reconstruct the genealogy of the moas we see that *Mesopteryx* connects *Cela* with *Syornis*, that it is itself connected with *Euryapteryx* by *Anomalopteryx*, and that this last genus is connected with *Dinornis* by *Palapteryx*. Evidently *Anomalopteryx* and *Palapteryx* are the oldest forms: but, if *Palapteryx* had wings, it could not have been derived from the wingless *Anomalopteryx;* and, if the birds were increasing in size, *Anomalopteryx* could not have been derived from *Palapteryx*. Both must have had a common ancestor as yet unknown, and we thus get the following classificatory diagram :—



Palæontology throws very little light on the subject. All the species—except *A. antiquus*, which is Pliocene only—have been found in the Pleistocene peat deposits, and all of them except six—*D. altus*, *D. maximus*, *D. excelsus*, *D. validus*, *D. torosus*, and *P. plenus*—have been found in recent Maori cooking-places.

The following species from the older Pleistocene beds at Motunau are represented in the Wellington Museum : *D. potens*, *D. torosus*, *S. rheides*, *S. crassus*, *S. casuarinus*, *E. elephantopus*, *E. ponderosus*, and *E. gravis* ; and the bones of the three species of *Euryapteryx* have the proportions of the most robust specimens found in younger deposits. Of the Pliocene species we know but little. Professor Owen has referred the footprints sent to him, in the sandstone from Poverty Bay, to *D. ingens*, *D. struthioides*, and *P. dromioides*. Those described by Archdeacon Williams and Mr. Justice Gillies were made by a bird not larger than *A. didiformis*, which had a foot about 8in. in length. The bones of *A. antiquus* found by Mr. Stubbs under the lava-stream at Timaru are the oldest known moa-bones, and they belong to a species which was smaller than any which lived subsequently in the South Island.*

It seems, therefore, that very little change took place in the moas subsequent to the date of the oldest beds at Glenmark and Motunau. No new species, or even varieties, were formed, but possibly some of the larger forms of *Dinornis* may have died out. But even this is not certain, for the large species of *Dinornis* are rare everywhere, and it is possible that they may have lived away from the coast, in which case we can easily explain the absence of their bones in the Maori cooking-places, for, except in central Otago, it is only the sand-dunes along

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* Mr. Forbes is mistaken in saying of these bones that "the largest, nearly 8in. in length, were undoubtedly portions of *Dinornis* bones of one of the greater forms" (Trans. N.Z. Inst., vol. xxiii., p. 367). I have examined Mr. Stubbs's collection, and there is in it no evidence of a moa larger than *A. antiquus*.

the coast which have preserved to us the relics of the ancient moa-hunters. But considerable change must have taken place in the moas between the time of the formation of Cook Strait and the deposition of the Motunau beds, because out of the eight species obtained from there only one is found in the North Island, and out of the whole twenty-five Pleistocene species only four are common to both Islands. We must therefore suppose that the other twenty-one species are of later origin. If, then, the Motunau beds are Pleistocene, we must put the formation of Cook Strait back into the Pliocene. It is also evident that the genera *Dinornis, Tylopteryx, Palapteryx, Anomalopteryx, Mesopteryx,* and *Syornis* had all been differentiated before the formation of Cook Strait, for their remains are found in both Islands, while the genera *Cela* and *Euryapteryx* may have come into existence at a later date. This great differentiation implies a long interval of time, and it probably took place during the isolation of the species in the Oligocene and Miocene periods, so that we again arrive at the conclusion that the ancestors of the moas inhabited New Zealand during the Eocene period. It should be remembered that the Eocene includes a duration of time probably equal to the Oligocene, Miocene, and Pliocene together.

In the Pliocene period the moas must have flourished greatly and covered the land. *Euryapteryx* had its headquarters in Otago, *Syornis* in Canterbury, *Mesopteryx* in both Otago and Canterbury. *Anomalopteryx* and *Palapteryx* were most common in Nelson and Wellington, *Dinornis* in Hawke's Bay, and *Cela* in Hawke's Bay and in Auckland.

But it would seem that in the Pleistocene period the moas suffered great mortality in the South Island, for how else could such great quantities of bones, of both young and old birds, have got together in the swamps at Hamilton and Glenmark? It has often been suggested that flocks of the birds, attempting to escape from fires, rushed into the swamps and perished; but when we remember that these moas died thousands of years ago, long before there were any human inhabitants to light the fires, it will be seen that this surmise is quite out of the question. Only two hypotheses, or a combination of them, appear possible to account for the facts. Either the birds walked into the swamp and there perished, or their dead bodies were washed in. If we suppose that a swamp acted as a trap for birds trying to cross it, we can conceive that in time a great number of birds may have been trapped in the same hole. According to Maori tradition the moas frequented wet places; and the fact that these swamps always contain the remains of a large number of young birds is also favourable to the idea. This theory, originated by Mr. Mantell, is thought by both Mr. A. Hamilton and Mr. Park to account for the bones in the Te Aute Swamp, because most of the larger leg-bones were found in a vertical position, the tibia and metatarsus often in their relative places; and the same, to some extent, was the case at Waikouaiti.* But the position of the bones at Glenmark and Hamilton was very different, the leg-bones lying in all directions, and just as often upside down as in any other position.† It is also difficult to account by this theory for the swamping of tuataras, *Cnemiornis*, *Harpagornis*, the kiwi, and still smaller flying birds, which have been found in the swamps with the moa-bones. Sir J. von Haast thought that the first hypothesis might account for the occurrence of bones in the main swamp at Glenmark; but the older peat-beds, like those at Hamilton, are not deep enough to swamp a moa, and the bones go to the very top of the bed.

At Hamilton, and also at Glenmark, there is a considerable amount of evidence in favour of the second hypothesis, that the bones were washed in by floods; but, as none of the bones are waterworn, and the peat always contains a large number of moa-stones, whole birds in the flesh must have been washed in, and not single bones. At Glenmark, wherever a small watercourse came in from the surrounding hills, a network of drift timber, often of large size, with numerous moa-bones, was always found round its mouth. In the swamp the bones occurred in "nests" near clay banks, while in other places there were no bones. Dr. Haast remarks that "the carcases or portions of birds had evidently been washed here against the banks, and deposited in considerable quantities."‡ At Hamilton very little timber was found, probably because it had all decayed into peat, but stones up to 1lb. and 2lb. occurred, and one piece of rock weighing between 10lb. and 12lb. was found in the clay near the bones. As the heaviest moa-stone does not weigh much more than 2oz., these large stones must have been entangled in tree-roots which had been washed into the swamp by floods.§ The peat-bed at Hamilton contained numbers of fresh-water shells, and it probably formed the lowest portion of a former lake, into which the materials brought down by floods from the surrounding hills collected.

We find corroborative evidence of this in the alluvial or old lacustrine deposits all round the plains of central Otago, for these always contain numerous bones wherever a stream enters them from the hills. Mr. Vincent Pyke—a very early

* Mantell, "Petrifactions and their Teachings," p. 98.

† Booth, Trans. N.Z. Inst., vol. vii., p. 128.

‡ "Geology of Canterbury and Westland," p. 446.

§ Quar. Jour. Geol. Soc., vol. xli., p. 213.

colonist, and acute observer—says that at Moa Flat, in Otago, the bones were scattered *around* the plains on the old lake-terraces, or in shallow ravines washed out by the floods and rain. "Around these ancient lake-beds the remains of the moa were most commonly found in heaps, in piles, in layers, and so found in a state of what may fairly be termed perfect preservation, with moa-stones underneath each skeleton. . . . . they were simply lying on the surface." He also "observed the same thing on the terraces, and in shallow gullies evidently washed out by rain, but always at a certain elevation—at Hamilton and other parts of the Maniototo Plains—but never *on* the plains."* Sir James Hector also says, "The greatest number of moa-bones were found where the rivers debouch on the plains."† Mr. Booth says, "I find below a certain level that would leave the whole Maniototo Plain under water there are no moa-bones to be found with the exception of near the mouths of the burns coming in from the hill, where the bones have been brought down by freshets. . . . . I have crossed these plains in several places, and do not recollect ever having seen a moa-bone below the level spoken of. I have also inquired of several shepherds who live on the plain, and who have walked over every acre of it, and none of them recollect having seen a moa-bone below the level I have mentioned."‡

This evidence seems to be sufficient. But how are we to account for the number of dead birds washed down by the floods? It is a remarkable fact that, while the bones of young moas are rare in Maori cooking-places and in caves, they formed a very large proportion of the bones at Glenmark and at Hamilton: indeed, in the older peat-bed at Hamilton, under the clay, the bones of young birds were as numerous as those of adults. Most of these young birds are from one-half to three-quarters grown, mixed with a few others. Another interesting fact is that neither at Hamilton nor at Glenmark was a single fragment of moa-eggshell found.§ We cannot suppose that all the eggshell has been dissolved, because at Hamilton I collected from the peat many delicate land and fresh-water shells, and in the swamps of Madagascar fragments of eggshell of *Æpyornis* are said to be not uncommon. We must conclude that the female birds died at a time of the year when they contained no hardened eggs; and this, together with the large number of young birds, points to the autumn or winter as the time when the moas died. It is also evident

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* "The Moa," Wellington, 1890.

† Trans. N.Z. Inst., vol. iv., p. 115.

‡ Trans. N.Z. Inst., vol. vii., pp. 132, 133.

§ A piece of eggshell is reported as having been found at Enfield.

that the dead moas could not be washed into swamps under the present climatic conditions, and the solution of the problem is to be found in the fact that in Pleistocene times, when these deposits of bones were formed, the climate was very different from what it is now. At that time the eccentricity of the earth's orbit was very great, and, when winter in the Southern Hemisphere happened in aphelion, long cold winters were followed by short and very hot summers, which would produce what has been called a pluvial, or, better, diluvial period.* The snows of the early winters would kill large numbers of moas and other birds on the hills, and the summer floods and avalanches would deposit their bodies in hollows, or on the low ground at the foot of the hills. As the Pleistocene period passed away the climate no doubt got more equable, and the surviving moas once more increased and multiplied. Some, perhaps, of the larger forms had succumbed altogether before human beings visited the islands, but most of the species were still living at that time, and were subsequently exterminated by the hand of man.

Extinction of the Moas.

The first collection of moa-bones, made by Mr. Colenso, Mr. Williams, and Mr. Cotton, was obtained by Maoris chiefly from the river-beds in the Waiapu and Poverty Bay districts. In 1842 Mr. Colenso said that, although the true age of the bones was not certainly known, he thought that "they will be found lying in the upper stratum of the Secondary [Tertiary] or the lower strata of the Tertiary [alluvial] formation," and probably "in beds of shingle, the detritus of the deluge."† "From native tradition," he said, "we gain nothing to aid us in our inquiries after the probable age in which the animals lived; for, although the New-Zealander abounds in traditionary lore, both natural and supernatural, he appears to be totally ignorant of anything concerning the moa save the fabulous stories already referred to." The collections also of Mr. Percy Earl and Dr. Mackellar, in 1846, were from an old turbary deposit at Island Point, Waikouaiti, of Pleistocene age.‡

In 1847 the Hon. W. Mantell collected from the old Maori cooking-places at Waingongoro, near Wanganui, and he was

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* For proofs of a pluvial Pleistocene period in Australia see Wilkinson, Proc. Linn. Soc. N.S. Wales, vol. ix., p. 1227 (1884). For New Zealand, see Quar. Jour. Geol. Soc., vol. xli., p. 213 (1885).

† Tasmanian Jour. Science, 1843, vol. ii., p. 87; and Trans. N.Z. Inst., vol. xii., p. 72.

‡ Mantell, Quar. Jour. Geol. Soc., vol. iv., p. 238; and Amer. Assoc. Proc., 1850, p. 252.

the first to recognise that the moa had been killed and eaten by man. In 1852 he obtained more proofs of this at Awamoa, near Oamaru,* and he further ascertained that the Maoris had "traditions concerning the existence of the moa and the use of it by them for food, of its bones for implements, and its feathers for ornaments."† In 1851 he read a paper on the subject to the New Zealand Society which, I believe, was never published; and in the discussion that followed the reading to the Zoological Society of London, in 1856, of Professor Owen's paper on the Awamoa Collection, Mr. Mantell, who was present, successfully combated the then prevailing idea in England that the moa was Pleistocene only. In 1864 Sir W. Buller published a letter in the *Zoologist*, in which he said that the moa is now extinct, but was contemporaneous with the Maoris, as is proved by the broken and calcined bones in the refuse of their feasts, and by "the rude history of the bird preserved in Maori tradition." In the same year the skeleton of *D. potens*, which is now in the York Museum, was found at Tiger Hill; and, as this skeleton had portions of the skin and ligaments attached, it completed the reversal of opinion among English naturalists. In June of that year Mr. Allis read a paper about it to the Linnean Society, when the general opinion of the meeting was that probably the bird had been living within ten years;‡ and in 1868 Mr. E. Newman concluded that the last moa died in about the year 1800 or, perhaps, later.§

But in the same year the Hon. W. Mantell, in a lecture to the New Zealand Institute, pointed out that the extermination of the moa must have taken place within a very short period after the appearance of man on these Islands, as the allusions to the bird in the most ancient Maori traditions are very slight and obscure. He also said that nephrite appears to have been discovered at a later date than the extinction of the moas, because it was never found in the Maori cooking-places with moa-bones.‖

Three years later Sir J. von Haast published his papers on "Moas and Moa-hunters,"¶ in which he denied the existence of any Maori traditions about the moa, and held that the birds had been exterminated by men "most probably belonging to a different race from the present native inhabitants of the Islands" (p. 68)—a race to whom not only was greenstone unknown, but who had not even acquired the art of grinding

* Trans. N.Z. Inst., vol. xxi., p. 440.
† Trans. N.Z. Inst., vol. v., p. 95.
‡ *Zoologist*, 1864, p. 9195.
§ *Zoologist*, 1868, p. 1354.
‖ Trans. N.Z. Inst., vol. i., p. 18.
¶ Trans. N.Z. Inst., vol. iv., p. 66.

stone adzes, and who had no domesticated dog—a race which had passed away "long before the Maoris settled here" (p. 68). In fact, he said "he might even assume that the human race [*i.e.*, the moa-hunters] made its appearance when this [land] communication existed" between the two Islands (p. 84); for, he said, so rude a people could hardly have built canoes. But a little further on he thinks that possibly the moa-hunters were identical with a race which, according to Mr. A. Mackay, formerly existed in the interior forests of the North Island, and were called "Maeros" by the Maoris; and in his "Geology of Canterbury and Westland" (1879) he calls them "an autochthonic race having affinities with the Melanesian type" (p. 430).

Six months after the reading of Dr. Haast's first paper Mr. Murison stated that he had found in central Otago polished stone implements with moa-bones;* and in 1874 Dr. Haast himself found ground stone implements with moa-bones in a cave near Sumner. Consequently he withdrew his former opinion on this point,† and said that the moa-hunters "had reached already a certain stage of civilisation, which in many respects seems to have been not inferior to that possessed by the Maoris when New Zealand was first inhabited by Europeans" (*l.c.*, p. 80).

The only other reasons advanced by Dr. Haast for disassociating the moa-hunters from the Maoris were that the moa-hunters were not cannibals, and that they did not possess a domesticated dog. The first of these reasons, although correct for the South Island, is not correct for the North Island. It was opposed to the evidence of Mr. Mantell,‡ and was subsequently disproved by Mr. Thorne;§ while the negative evidence on which the absence of a domesticated dog was inferred was disposed of by Mr. Booth, who found two moa-bones marked by the teeth of dogs in the old Maori cooking-places at the mouth of the Shag River.‖ In 1883 M. de Quatrefages summed up the published evidence, and came to the conclusion that the moa had probably lived to about the year 1770 or 1780.¶ So far there had been no distinct proof of nephrite having been used by the moa-hunters;** but in 1889 Monck's Cave was discovered, near

* Trans. N.Z. Inst., vol. iv., p. 122.

† Trans. N.Z. Inst., vol. vii., p. 72.

‡ Trans. N.Z. Inst., vol. i., p. 18.

§ Trans. N.Z. Inst., vol. viii., p. 88.

‖ Trans. N.Z. Inst., vol. viii., p. 106.

¶ Ann. and Mag. of Nat. History, ser. 5, vol. xiv., pp. 124 and 159.

** Sir James Hector says that Mr. Murison "found polished adzes of aphanite, and even jade," in the cooking-places of the Maoris (Trans. N.Z. Inst., vol. iv., p. 117); but Mr. Murison makes no mention in his own paper of jade implements having been found.

Sumner, in which polished nephrite and other stone implements, as well as wood carvings of Maori pattern, were found, with moa-bones, and fragments of moa-eggshell still retaining the shell-membrane.* There can therefore be no longer any doubt that the moas were exterminated by men of the Maori race; and the only question remaining is, How long was that ago?

In the North Island we have to trust almost entirely to traditional evidence. Mr. J. S. Polack, in his book, "New Zealand," published in 1838, says that "the natives [of the East Cape district] added that *in times long past* they received the tradition that very large birds had existed [in New Zealand]; but the scarcity of animal food, as well as the easy method of entrapping them, had caused their extermination."† He adds, "I feel assured, from many reports I received from the natives, that a species of *Struthio* still exists in that interesting [South] Island, in parts which perhaps have never yet been trodden by man. Traditions are current among the elder natives of *atuas*, covered with hair, in the form of birds, having waylaid former native travellers among the forest wilds, vanquishing them with an overpowering strength, killing and devouring, &c." Mr. Polack gives no name to these birds, but Mr. W. Colenso says that in 1838 the Maoris of the same district had fabulous traditions of a large bird, which they called moa.‡ Mr. Rule, who brought the first bone to Professor Owen in 1839, told him that the Maoris had a tradition that this bone belonged to an extinct hawk, which they called "movie."§ In the same year the Rev. W. Williams and the Rev. R. Taylor found bones of a large bird near Waiapu, which Mr. Williams says the Maoris called "moa," while Mr. Taylor says that they called

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* Trans. N.Z. Inst., vol. xxii., p. 64, and vol. xxiii., p. 373.

† Vol. i., p. 303. Quoted by Hector, Trans. N.Z. Inst., vol. v., p. 413, footnote.

‡ Trans. N.Z. Inst., vol. xii., p. 64. "Moa" is the native name for the domestic fowl in Polynesia; but, as the Maoris do not appear to have brought the fowl with them to New Zealand—along with the dog, the kumara (*Convolvulus batata*), and the taro (*Colocasia antiquorum*)—it seems possible that it was not known in Polynesia at the date of the Maori migration. If this conjecture be correct, the word "moa" must have been used for some other bird, and it has been suggested that it meant the cassowary. This, however, is hardly possible, because the cassowary is not found on any of the islands from whence the Maoris are supposed to have come, but is confined to Melanesia and the Molucca Islands. It is called "mooruk" in New Britain.

§ The extinct eagle, *Harpagornis*, appears to be known in Maori tradition as the hokioi (see Trans. N.Z. Inst., vol. v., p. 435, and vol. xii., p. 99). In the South Island the same bird, or an ally, was called "pouakai" (*l.c.*, vol. x., p. 63).

it "tarepo."* Three years later (1842) he says that the Maoris of Waingongoro, near Wanganui, called the bird "moa." Mr. J. W. Hamilton says that in 1844 the Europeans knew very little about the existence of moa-bones, and very few had at that time been found; but the Maoris always knew them when they saw them.† It is evident, therefore, that the Maoris had a tradition that these bones, which they used for fish-hooks, had belonged to birds which they called "moas."

Mr. W. Colenso, in a very valuable and thoroughly scientific paper on the subject,‡ distinctly recognises that the ancestors of the Maoris knew the moa, but says that this knowledge dates from "very long ago, in almost prehistoric times, long before the beginning of the genealogical descent of the tribes, which, as we know, extended back for more than twenty-five generations;" for the moa is rarely mentioned in their poetry or proverbs, and even then the allusions are largely mythical. But the name "moa," he says, is incorporated in many words handed down from early ancestors—firstly, as names of places, such as Moawhiti (startled moa), Moakura (red or brownish moa), Moarahi (big moa), Otamoa (moa eaten raw), Moawhango (hoarse-sounding moa), and others: secondly, in names of persons, as Hinemoa, "hine" meaning daughter of rank, or young lady: and, thirdly, as ordinary words—for example, Maimoa (Come-hither moa), used as the name for a decoy-bird; Moamoa (small round stones the size of marbles), perhaps a reminiscence of moa gizzard-stones. There is also a tradition among the Maoris of the East Cape district that the moas were exterminated by a fire known as the fire of Tamatea; and Mr. Colenso remarks that Tamatea is a very ancient name in New Zealand mythological history. He was a descendant of Toto, and, with his children, came to New Zealand in the canoe Takitumu.

Mr. Mantell says that "the extermination of the moas must have taken place within a very short period after the Maoris reached the Islands, as the allusions to the birds in their most ancient traditions are very slight and obscure."§ Major W. G. Mair, who takes great interest in science, has a thorough knowledge of the Maori language, and has been for many years collecting Maori tales, says, "In all these thousands of pages of Maori lore which I have written from the mouths of

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* Trans. N.Z. Inst., vol. v., p. 97. In a letter to Sir E. Home in 1844 he says, "kakapo or tarepo" (Trans. Zool. Soc., vol. iii., p. 32). Mr. W. Travers says that "tarepo" was the native name for the extinct goose *Cnemiornis* (Trans. N.Z. Inst., vol. viii., p. 75, footnote).

† Trans. N.Z. Inst., vol. vii., p. 122.

‡ Trans. N.Z. Inst., vol. xii., p. 63.

§ Trans. N.Z. Inst., vol. i., p. 18.

[Maori] witnesses in Waikato, at Rotorua, in the Bay of Plenty, Hawke's Bay, Manawatu, Wanganui, and Taupo, there is not one word about the moa."* The Rev. J. W. Stack says the same; and he has pointed out that the saying, "Ka ngaro i te ngaro a te moa" ("Lost as the moa is lost"), or, as Mr. Colenso translates it, "All have perished just as the moas have perished," which occurs in the very ancient Maori poem called the "Lament of Ikaherengatu," shows that the moa was not in existence at the time when it was composed.†

On the other hand, the Rev. R. Taylor,‡ Judge Maning,§ Mr. John White,|| Sir George Grey,¶ Sir W. Buller,** Lieut.-Colonel McDonnell,†† and Judge Monro‡‡ all agree that the present Maoris have plenty of traditions about the moas. Sir G. Grey says that when he came to New Zealand, in 1845, the Maoris invariably spoke to him of the moa as a bird well known to their ancestors; and Sir Walter Buller says that their "ancient folk-lore, their historical songs, and their proverbial sayings are full of allusions, more or less direct, to the bird." Colonel McDonnell was told that the moa was of a brown colour, with feathers longer and coarser than those of the kiwi; that it fought fiercely when brought to bay, and struck out with its feet, but was easily killed with clubs.§§ According to Judge Maning they were stupid and sluggish birds, and were killed in great numbers by fires. Periodically they fought with great fierceness. According to Mr. John White the moas did not go in flocks, but lived in pairs with their young. The same writer says that the nest was merely a heap of grass, on the top of which they laid their eggs; while the Rev. R. Taylor says that the nests were made of refuse fern-root on which they fed. Mr. White says that they lived principally on the young shoots and roots of fern and grass, as well as on the shoots of a shrub with yellow flowers, called korokia (*Corokia buddleoides*), which grows on the margins of the bush. They haunted chiefly the edges of the forest, but often visited lakes and water-pools to feed on water-plants. The Maoris used to lie in wait for them near the tracks by which they went to the water, and strike them

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* Trans. N.Z. Inst., vol. xxii., p. 74.
† Trans. N.Z. Inst., vol. vii., App., p. xxviii.
‡ Trans. N.Z. Inst., vol. v., p. 100.
§ Trans. N.Z. Inst., vol. viii., p. 102.
|| Trans. N.Z. Inst., vol. viii., p. 79.
¶ Proc. Zool. Soc., 1870; *Zoologist*, 1870, p. 2104.
** Birds of N.Z., 2nd ed., vol. i., p. xxxiii.
†† Trans. N.Z. Inst., vol. xxi., p. 438.
‡‡ Trans. N.Z. Inst., vol. viii., p. 427.
§§ None of the skulls found in Maori cooking-places have been broken with clubs. Kawana Paipai's statement that he had himself hunted the moa on the Waimate Plains, Taranaki, is no doubt a romance.

with spears, which were so cut that they broke off and left about 6in. or 8in. of spear in the bird. The birds were driven from the water by one party of men, while another party lay in ambush to spear them.

Mr. Taylor gives a slightly different account of a moa-hunt. He says that notice was given to neighbouring settlements that a hunt was to take place. A large party spread out to drive the birds from their haunts towards a lake or swamp. As they approached the water the line of beaters was gradually contracted, until at last a rush was made with loud yells, and the frightened birds were driven into the water, where they could be easily approached in canoes and despatched without their being able to make any resistance. According to Sir G. Grey, Mr. Stack, and Mr. White, the Maoris always used koromiko (*Veronica salicifolia*) for cooking the flesh. They have a saying, "The koromiko is the tree which roasted the moa." But Mr. Colenso has pointed out that the wood of the koromiko is too small to heat a Maori oven, and he suggests that the saying should perhaps be translated "which burnt the moa."

At first sight all this seems to be in direct conflict with the opinions of Mr. Colenso, Mr. Mantell, and Major Mair; but we must remember that none of these traditions have been published in Maori, and many of them may be nothing but late deductions from the words and proverbial sayings mentioned by Mr. Colenso, for it is evident that they were not generally known among the Maoris. At any rate, it is quite time that the evidence for these being ancient Maori traditions should be put upon record.

But Sir Walter Buller has given a story of the pet moa of the Ngatituwharetoa which cannot have been so derived. He says that this bird was stolen by a man named Apa-hapai-taketake, an ancestor of the Ngatiapa Tribe. A series of fights ensued, in which the Ngatiapa came off worst, and were driven south from the Bay of Plenty to Lake Taupo.* I have not been able to ascertain the probable time of this migration, but I judge from the context that the Ngatiapa took up unoccupied ground near Taupo, and if this be so Apa-hapai-taketake must have been a very early ancestor. At the present time the tribe lives on the West Coast, between Wanganui and Otaki. In Mr. White's large work on the "Ancient History of the Maori," I can only find two allusions to the moa. One is about its extinction by fire in the South Island, which is copied from Mr. Stack; the other relates to its first discovery. "Nga-hue was the first man who came to these Islands, who at Te-wai-rere saw the bird moa, and

* Birds of N.Z., 2nd ed., vol. i., p. xxviii.

killed one, and went back to Hawa-iki and told the inhabitants of that land that he had discovered a country without human inhabitants, but where there was greenstone to be found."* A little further on the moa is said to have been killed near the Wai-rere waterfall at Arahura [near Hokitika], and that Ngahue carried it away in a calabash. Major Mair gives another story about a man named Hape, who pursued a moa to the top of a hill in the Rotorua district. When trying to catch it the moa struck out and hurled him back into the valley. But, being a "tangata atua" [god-man], he was not killed, and his heel, striking against a rock, split it, and caused the water of the Tarawera River to flow in its present subterranean channel at Te Tatau-a-Hape.† The only other published story about the moa is the well-known one of the bird supposed to be living in a cave on Whakapunake Mountain, guarded by a dragon, but seen by none.‡

In discussions on this subject much has been said about positive and negative evidence. It has been even affirmed that "the testimony of a man who had actually seen and eaten the moa was worth ten thousand legends and traditions." But there is here, I think, a misconception, for the relative value of the two kinds of evidence depends altogether on the application. We believe implicitly many things on negative evidence alone. For instance, we believe that there are no snakes in New Zealand entirely on negative evidence. We believe this because we feel sure that if there were snakes in New Zealand some would have been found before now. And, so far as the North Island is concerned, I am compelled to believe that the moas were exterminated many years ago, because I feel sure that if it were not so we should find as many allusions to it in Maori tales and poetry as we do to all the other birds, beasts, and fishes that were of interest to the natives. The question really hinges on the reliability of the evidence, and not whether it is negative or positive. In this case the negative evidence is the more reliable, for it is unbiassed, and existed before the question was raised. But the positive evidence is not all on one side. The very earliest statement of the Maoris to Mr. Polack was that "in times long past they received the tradition that very large birds had existed;" and the saying, "Ka ngaro i te ngaro a te moa," is positive evidence that the Maoris who recited it believed the moa to have been lost or exterminated when this very ancient poem was composed. This appears to me to be conclusive proof that the moa was exterminated rapidly, soon after the arrival

* Anc. Hist. of the Maori, vol. ii., p. 187.

† Trans. N.Z. Inst., vol. xxii., p. 72.

‡ Trans. N.Z. Inst., vol. xii., p. 67, and vol. xxii., p. 72.

of the Maoris in New Zealand. The dodo of Mauritius existed for seventy-three years only after the island was discovered; and the sea-cow of Behring Strait, which was living in immense numbers in 1741, succumbed entirely in twenty-seven years. The Maoris are supposed to have inhabited New Zealand for about six hundred years,* so that we must put the probable extinction of the moa in the North Island at four or five hundred years ago.

In the South Island there are no Maori names of places containing the word moa;† and Mr. A. Mackay, the Rev. J. F. H. Wohlers, and the Rev. J. W. Stack all agree that the natives have no traditions of the moas further than that they were destroyed by a fire, called the fire of Tamatea, which swept over the Canterbury Plains some five hundred years ago—evidently an echo of the legend of the North Island already mentioned. According to Mr. Stack tradition states that the first occupants of the South Island were the Kahui-tipua, a fabulous race of giants who ate men. They were destroyed by Te Rapu-wai, who were soon followed, from the North Island, by the Wai-taha.

These two belonged probably to the same tribe; at any rate, they were contemporaries, intermarried freely, were not warlike, became numerous, and "covered the land like ants." The Waitaha were exterminated by the Nga-ti-mamoe, who crossed Cook Strait into the South Island about three hundred years ago; and the Ngatimamoe were, in their turn, destroyed by the ancestors of the present natives—the Nga-i-tahu—about two hundred or two hundred and fifty years ago. Very little is known about Te Rapu-wai and Waitaha. Their traditions perished with the extinction of their conquerors, the Ngatimamoe, but the extinction of the moa, as well as the formation of the shell-heaps on the coast, are attributed sometimes to one, sometimes to the other.‡ It is evident that Haumatangi, who told Mr. J. W. Hamilton that he had himself seen the last moa, and the Rapaki (Lyttelton) Maori who told him that his father had hunted the moa,§ were romancing. As also was the sealer Meurant, who said that he had seen and eaten moa's flesh at Port Molyneux as late as 1823.‖ We must also consider as fabulous the Maori statements made to Mr.

* Writers are of opinion that the ancestral records of the Maoris of the North Island prove from eighteen (Shortland) or twenty-five (Colenso) to forty-six (J. White) generations since their first arrival.

† Awamoa, near Oamaru, was so named by the Hon. W. Mantell.

‡ Stack, Trans. N.Z. Inst., vol. x., p. 60, &c. Copied by Mr. White in his "Ancient History of the Maori," vol. iii., p. 191. See, also, Mantell, Trans. N.Z. Inst., vol. xxi., p. 440.

§ Trans. N.Z. Inst., vol. vii., p. 121.

‖ Trans. N.Z. Inst., vol. vii., p. 121.

W. H. Roberts that the moa was "a very swift bird on foot, and could outrun a horse easily, its miniature wings helping it considerably;" and that they used to steal children.* Also the story of the man-eating bird of the forests of the South Island mentioned by Mr. Polack.

No one knows the Maoris of the South Island better than the Rev. J. W. Stack and the Rev. J. F. Wohlers, and yet neither of them ever heard of these legends. Mr. Stack says, "The Ngaitahu have occupied this [South] Island for about ten generations. Allowing twenty-five years for a generation, their occupation dates back two hundred and fifty years. In none of the traditions relating to this period, though numerous and detailed, are there any allusions to the moa."† Mr. Wohlers has published a number of southern Maori tales,‡ collected more than forty years ago, "when there were still a few Maoris alive who were acquainted with their ancient lore;" and, although whales, seals, dogs, rats, owls, tuis, pigeons, herons, eels, and other animals are mentioned, the word "moa" does not once occur. However, we find here the legend of the man-eating bird. Two strangers arrived from Hawaiki and taught the natives how to make fire and cook their food. The natives told the strangers that they were suffering from a monstrous bird which ate people. "The strangers asked if the direction 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 blockhouse, 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 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."§ Every one will, I think, allow that this very ancient legend was not recited or even composed by men who had a personal knowledge of the moa. There is also a story of catching a bird by putting a rope over the entrance to the cave in which the bird was living.‖ This may be the origin of Whera's

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* Trans. N.Z. Inst., vol. vii. p. 548.

† Trans. N.Z. Inst., vol. iv., p. 107.

‡ Trans. N.Z. Inst., vol. vii., p. 3, and vol. viii., p. 108.

§ Trans. N.Z. Inst., vol. viii., p. 109.

‖ *L.c.*, vol. vii., p. 22.

statement to Mr. J. W. Hamilton about catching moas with a rope;* but in the ancient tale the bird is said to have been the blue heron, and not the moa.

Lastly, we must consider the evidence afforded by the finding of nephrite with moa-hunter remains in Monck's Cave, near Sumner. The Ngaitahu have a tradition that their ancestors knew nothing of nephrite until a piece was brought over from Hokitika, in about the year 1700, by a woman named Raureka.† But, allowing this to be correct, it does not follow that Te Rapu-wai and Waitaha were ignorant of it. The knowledge of the places where nephrite was found might easily have perished with them, or with the Ngatimamoe; and another tradition that the Ngaitahu came to the South Island in order to find nephrite is quite in accordance with this idea. Indeed, tradition says that nephrite was found by the very first Maoris who came to the Island, and it was certainly known in the North Island before the year 1700.

We come now to the observational evidence which has been collected during the last forty years. Sir Julius von Haast formed his opinion of the great antiquity of the moa-hunters largely on evidence obtained in the South Island. He ascertained that at the old native cooking-places at the mouth of the Rakaia the ovens of the moa-hunters were only on the higher ground, some 10ft. or 12ft. above the sea, while the Maori ovens which occurred on the lower terraces, about 8ft. and 4ft. above the sea, never contained moa-bones.‡ Again, he showed that the encampments of the moa-hunters east of Christchurch were confined to the inner line of sand-dunes, and that only ovens without moa-bones were found on the lower ground north of the Heathcote Estuary, between the sand-dunes and Brighton. Also, at Moa-bone Point Cave, near Sumner, the floor of which was 13½ft. above high-water mark, the upper deposits, between 3½ft. and 4ft. thick, contained no moa-bones, but only estuarine shells (*Venus stutchburyi*, *Paphia neozelanica*, and *Amphibola avellana*) and *Mytilus*, while the lower 6in. or 12in. contained moa-bones without estuarine shells. He also showed that these moa-bone beds rested on marine sands, which reached a level of 8½ft. to 9ft. above high-water mark, and which contained human remains,§ as well as bones of seals, and shells of *Mactra discors*, *Paphia spissa*, *Dosinia australis*, and *Turritella rosea*, all of which are distinctly marine. He also stated that outside the cave, among the old sand-dunes, the shell-fish-eaters lived after the

* Trans. N.Z. Inst., vol. vii., p. 121.
† Stack, Trans. N.Z. Inst., vol. x., p. 86.
‡ Trans. N.Z. Inst., vol. iv., p. 96.
§ Trans. N.Z. Inst., vol. vii., p. 74; and McKay, vol. vii., p. 99.

moa-hunters. All this may be quite true; and yet it does not follow that the moa-hunters were a very ancient race. The explanation is that the land in the neighbourhood of Sumner has been elevated at least 9ft. since the earliest of the moa-hunters lived there. These earliest moa-hunters did not eat shell-fish, because there were none there at that time, the present estuary not being formed until the land rose; and this also accounts for there being no moa-hunter encampments on the flat east of the sand-dunes, this flat being at the time under the sea, and the line of sand-dunes forming the shore. If, also, we suppose that this elevation of the land extended southwards to the mouth of the Rakaia, we get an explanation of the fact that the moa-hunters' ovens only occur on terraces 10ft. or 12ft. above the sea. But Sir Julius von Haast was wrong when, for this reason, he referred these moa-hunters back to Pleistocene times. The elevation of the land 4ft. at Wellington, and 9ft. at the Rimutaka Mountains, on the 23rd January, 1855, is sufficient to show us that we cannot take an elevation of 9ft. as a proof of any great lapse of time. I have elsewhere shown* that I consider Dr. Haast to have been mistaken when he thought that he had found at the mouth of the Shag River the same difference between moa-eaters and shell-fish-eaters† as he did at Sumner; for at the Shag River the moa-hunters ate both moas and estuarine shell-fish. Indeed, the recent exploration of Monck's Cave by Mr. H. O. Forbes‡ has proved that the moa still lived near Sumner after the estuary had been formed, for the moa-eggshell, with shell-membrane attached, was associated with estuarine shells and *Mytilus*, and not with ocean shells as at Moa-bone Point Cave.§

The evidence relied upon by Sir J. von Haast to prove the very great antiquity of the moa-hunters no doubt fails; but, on the other hand, are those reasons valid which have been advanced for supposing that the moas lived in the South Island long after they had been exterminated in the North Island? These are, first, the former occurrence of bones lying on the surface of the ground; and, secondly, the discovery of bones with dried skin, ligaments, flesh, and feathers.

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* Trans. N.Z. Inst., vol. viii., p. 103. Fragments of the skull of the sea-elephant (*Morunga*) were found with the moa-bones.

† Trans. N.Z. Inst., vol. vii., p. 91.

‡ Trans. N.Z. Inst., vol. xxiii., p. 373.

§ Inside Monck's Cave, as well as just outside, the shells were principally *Venus stutchburyi*, *Mytilus*, and *Amphibola avellana*. *Paphia neozelanica* also occurred, but not so commonly as the others. The following marine shells are also in the collection from the cave, but I do not know under what conditions they were found: *Voluta pacifica*, *Turbo smaragdus*, *Haliotis iris*, and *Pecten laticostatus*.

With reference to the first: Mr. J. Buchanan, who accompanied the first surveying-party into the interior of Otago, in 1856, says that in the upland district east of the Lammerlaw Range, between 2,000ft. and 4,000ft. above the sea, large leg-bones of moas were strewn on the surface in great profusion, and they were in very perfect preservation, most of them being quite hard, except where they had been roasted by grass-fires. In the Manuherikia Valley no bones were found on the level terraces, perhaps on account of the late fires; but they were abundant in the scrub on the flats which were liable to be flooded by the rivers.* The observations of Mr. Vincent Pyke (1861) and of Sir James Hector (1862) I have already quoted, but I may here add that Sir James Hector says that at the south-west extremity of a triangular plain by the side of Lake Wakatipu, in 1862, he counted thirty-seven of such distinct skeleton-heaps.† Mr. Murison (1861) does not mention surface bones. He says, "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 eggshells in great number were laid bare by the plough."‡ The Maori cooking-places were also covered by 6in. of silt, and were not discovered until 1865. But all these bones disappeared very rapidly. During the summers of 1873–74 and 1874–75 I rode over the whole of the interior of Otago, making a geological survey, and I never saw moa-bones lying on the surface, except where they had been ploughed or dug up, although they were not uncommon in the river alluvia. The same has apparently occurred in Canterbury. Mr. Boys says that he has seen (date unknown) quantities of moa-bones lying on the surface of the ground on the Waipara Plains.§ While Sir Julius von Haast, who commenced his explorations in Canterbury in 1861, and visited the Waipara in 1866–67, says, "I must confess that I have never observed any [moa-bones] in such positions [*i.e.*, on the ground among the grass on the plains, or between rocks and *débris* in the mountains], except when it could be easily proved that they had been washed out either by heavy freshes from older deposits in cliffs along river-beds, or by the disappearance of the luxuriant virgin vegetation, consisting of high grass or bushes, the soil having been laid bare, so that its upper portion would speedily be washed away by rain-water."|| And a little further on he says that none are found on the surface now

* Trans. N.Z. Inst., vol. v., pp. 416 and 417.

† Trans. N.Z. Inst., vol. iv., p. 118.

‡ Trans. N.Z. Inst., vol. iv., p. 121.

§ Trans. N.Z. Inst., vol. iv., p. 400.

|| Trans. N.Z. Inst., vol. iv., p. 70.

(1871). In 1884 Mr. F. R. Chapman found the remains of nine birds lying on the surface near Lake Tekapo, each with its gizzard-stones, and one with tracheal rings; but he says that these skeletons had been covered with sand, and lately exposed by the wind.* But bones lying on the surface are not confined to the South Island. According to Dr. von Hochstetter, many years ago numbers of moa-bones were found on the surface near Lake Tarawera, after the forest had been burnt.† Sir James Hector found bones on the surface in the Raukawa Bush, Hawke's Bay,‡ and gizzard-stones have been found with bones in the same district.§

No doubt many of the surface bones seen by the earlier settlers had been washed out of alluvial beds and brought down to the plains by floods; but this will not account for the more or less complete skeletons, which must have decayed where they were found. Some of these may have been buried in sand for many years and afterwards exposed by the wind, as was the case with those seen by Mr. Chapman. Others may have been covered by dense vegetation, and so protected from the sun, which destroys bones rapidly when they are exposed to its direct rays. But it is, no doubt, difficult to account satisfactorily for all the statements made. One thing however, is clear. If all the bones that were lying on the surface in Otago in 1861 disappeared in fifteen years, either some great change must have taken place in the district during the interval, or else none of the surface bones of 1861 were more than fifteen years old. In the latter case we must suppose that moas were living in large numbers in that district in 1846, three years before the settlement of Otago, although not a single bird was found alive by the first explorers. This is incredible, and we must necessarily fall back on the first suggestion, and account for the disappearance of the bones by the constant burning of the scrub by Europeans, in which case the surface bones do not prove the late existence of the moa in the district where they were found.

But it is in the South Island only that bones with dried skin and ligaments have been found. In January, 1864, the specimen of *D. potens* now in the York Museum was found at Tiger Hill, in the Manuherikia Valley; and, although buried under 14ft. of sand, some portions of the skin and ligaments still remained.‖ In 1871 Mr. W. A. Low found a piece of

* Trans. N.Z. Inst., vol. xvii., p. 175.

† "New Zealand," p. 64.

‡ Trans. N.Z. Inst., vol. xxi., p. 318.

§ Hamilton, *l.c.*, vol. xxi., p. 319.

‖ Hector, Proc. Zool. Soc., 1865, p. 751; Allis, Proc. Linn. Soc., 1864, p. 50; Owen, Ext. Birds of N.Z., p. 248, as *D. robustus*.

dried skin, with feathers, in the Dunstan district;* and in the same year the neck of *S. crassus* now in the Otago University Museum was found in Earnscleugh Cave, near Alexandra.† In 1874 the leg of *D. potens*, also in the Otago Museum, was found by Mr. Allen in the Knobby Ranges.‡ In 1878 Mr. Squires found near Queenstown the leg, head, and neck of *M. didinus*, now in the British Museum;§ and in 1884 Mr. Brandford discovered the leg of *E. elephantopus* which is now in the Cambridge University Museum, in a cave in the Remarkable Mountains, near Queenstown.||

Certainly it does not seem probable, at first sight, that these remains can be very old; but, under exceptional circumstances, skin, cartilage, and tendon are known to have been preserved in other places for many hundreds of years.** Now, it must be noticed that all the specimens just mentioned have been found in a limited district in central Otago, about sixty miles long and forty miles broad, which lies between Lake Wakatipu and the Lammerlaw Range. So that either the birds survived much longer in this district than in other places,†† or the remains have been better preserved here than elsewhere. The fact that those bones of the Knobby Range specimen which were exposed to the sun were as much decayed as ordinary moa-bones found on the surface, makes the latter supposition the more probable one; and there are other reasons for coming to the same conclusion. If these remains have not been preserved under special circumstances the birds cannot have been dead more than a few score years at the most: but if they had been alive fifty years before they were found it is certain that the Maoris of Canterbury and Otago would have known that the moas survived longer in central Otago than elsewhere; and yet there is no tradition to that effect. On the other hand, the district in which all these

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* Trans. N.Z. Inst., vol. iv., p. 114.

† Trans. N.Z. Inst., vol. iv., p. 115. With the moa-remains were found remains of an extinct duck (*Anas finschi*), also with dried ligaments; *Cnemiornis;* and the remains of an extinct lizard, about the size of the tuatara, but with pleurodont teeth (*l.c.*, vol. vii., p. 139)—perhaps one of the lizards mentioned by Mr. Stack (*l.c.*, vol. vii., p. 295).

‡ Trans. N.Z. Inst., vol. vii., p. 266; *Nature*, Feb. 11, 1875; Buller, Birds of New Zealand, 2nd ed., vol. i., p. xxxi., and woodcut from 'La Nature.'

§ Trans. Zool. Soc., vol. xi., p. 257.

|| Buller, Birds of N.Z., 2nd ed., vol. i., p. xxxii.

** See Haast, Trans. N.Z. Inst., vol. vii., p. 97, and "Geology of Canterbury," p. 442.

†† The supposed footprints referred to by Hochstetter in "New Zealand," p. 191, footnote, was a joke perpetrated by Mr. Maling, a surveyor, who had assisted Dr. Haast in digging out the caves near Collingwood.

remains have been found is shut in from the sea on all sides by ranges of mountains, and is, in consequence, by far the driest in New Zealand. Mr. Vincent Pyke, who was Secretary for the Otago Goldfields in 1863, speaking of the remarkable preservative powers of the dry air in this district, says, "On one occasion I was called upon to hold an inquest on the body of a child which was identified as having been the subject of a previous inquest before myself some weeks previously. It had been exhumed from the grave, and appeared slightly mummified, but was otherwise as sound as the day it was buried. On another occasion a boy drowned in the Clutha River on the 1st January was picked up in the following March on a sandy beach 12ft. above the then level of the river, slightly covered with drift sand, but quite fresh and undecomposed, although it had for so long a period been lying exposed to the fierce sun of an extremely hot Dunstan summer."* Also, in about 1869 the remains of a Maori baby were found in a rock shelter in the same district. It was shown to me in Dunedin in 1872. The skin, hair, ligaments, and some dried-up flesh still remained on the bones. This baby must have died previous to the breaking-out of the diggings in 1861, and probably much before that, for no Maoris are known to have lived in the district or to have visited it since the colony was founded. Skin and ligament, once dried, and protected from the sun, might easily, in this district, be preserved for centuries; so that these remains prove nothing.

CONCLUSION.

The case seems to me to stand thus: In the North Island we have, at Wanganui and near Whangarei, undoubted proofs that the ancestors of the present Maoris killed and ate moas. The present generation knew the bones to be those of a bird which they called "moa;" and there are several names of places and of men in which the word "moa" occurs, and these certainly point to a knowledge of the bird. But in the large number of ancient Maori tales and poems which have been collected and published the allusions to the bird are very slight and obscure, and one very ancient poem mentions the moa as having been exterminated before the poem was composed. The so-called traditions of its habits and appearance may be, in large part, later deductions from these words and phrases; and we must conclude that in the North Island the moa was exterminated by the Maoris not very long after their arrival in New Zealand—that is, not less than four or five hundred years ago.

* "The Moa," Wellington, 1890, p. 5.

In the South Island, in addition to the proofs that the Maoris killed and ate moas, remains have been found which give the impression that the birds had lived not many years ago. These remains, indeed, are so fresh that if the birds died fifty years ago they must have been preserved under specially favourable conditions. But certainly the birds have been dead for more than fifty years; while we have reasons for thinking that the district in which these remains have been found is one specially favourable for preserving them. This being so, we cannot say for how many years these remains have been preserved—perhaps for centuries; and, as we have every reason to believe that the ancestors of the Ngaitahu, who have inhabited the South Island for the last two hundred or two hundred and fifty years, never had any personal knowledge of the birds, we must allow that the moas have been extinct for at least that time. On the other hand, it is quite certain that the moa was exterminated by Maoris, and the Maoris are not supposed to have inhabited the South Island for more than five hundred years; so that the time of extinction must fall between these dates. It seems to me improbable that the Ngatimamoe, the last remnant of whom inhabited the West Coast Sounds a few years ago, were moa-hunters. The moa-hunters of the South Island do not appear to have been cannibals, and, as Te Rapu-wai and the Waitaha, who preceded the Ngatimamoe, were, according to tradition, peaceful tribes not given to war, this lends support to the native tradition that it was they who exterminated the moa some three or four hundred years ago—that is, about a hundred years after they had been destroyed on the North Island.

Note to Table of Measurements.—In the pelvis the length is that of the pre-acetabular part of the ilium only; the breadth is taken at the antitrochanters. The breadth of the sternum is taken across the body just below the costal region. In the skull the length is from just above the foramen magnum to the nasals; B. sq. is the breadth of the squamosals; B. t.f. that at the temporal fossæ; while the height is the vertical from the middle of the basi-temporal.

TABLE OF THE AVERAGE MEASUREMENTS OF THE SPECIES.

—	Metatarsus.		Tibia.		Femur.		Pelvis.		Sternum.	Skull.			
	Length.	Girth.	Length.	Girth.	Length.	Girth.	Length.	Breadth.	Breadth.	Length.	B. sq.	B. t.f.	Height.
D. altus ..	21·5	6·3	..	..	..	..	..	..	..	..	..	..	..
D. maximus ..	20·0	6·5	39·0	8·5	18·5	9·4	..	..	..	..	..	..	..
D. excelsus ..	20·0	6·0	37·5	7·0	..	..	..	..	..	..	..	..	..
D. validus ..	18·5	6·4	35·0	7·0	16·5	8·0	..	..	..	3·8	4·7	2·8	2·2
D. giganteus ..	18·0	6·0	35·0	7·0	16·0	7·3	..	..	..	..	..	..	..
D. firmus ..	16·2	5·2	32·0	6·0	14·8	6·7	..	..	8·2	..	..	..	..
D. robustus ..	16·0	6·0	31·0	6·5	15·0	7·6	10·0	10·0	8·3	3·7	4·2	2·8	2·1
D. ingens ..	15·0	4·5	28·5	5·2	13·5	6·3	..	..	..	..	..	..	..
D. potens ..	14·5	5·3	28·0	6·0	13·5	7·4	8·5	9·5	7·5	3·5	4·1	2·7	2·1
D. gracilis ..	13·5	4·5	26·0	5·0	12·4	6·2	..	..	..	3·2	3·7	2·6	1·8
D. torosus ..	12·5	4·4	24·7	5·2	12·0	6·0	8·0	8·3	7·1	3·2	3·7	2·4	1·8
D. struthioides ..	11·5	4·0	22·7	4·6	11·0	5·2	7·7	6·7	..	2·9	3·1	2·2	1·7
P. plenus ..	10·4	3·8	21·0	4·2	9·5	3·6	7·5	6·0	5·2	..	..	..	..
P. dromioides ..	10·0	3·6	19·7	4·0	9·6	3·9	..	..	..	2·7	2·4	1·7	1·3
A. didiformis ..	6·5	3·0	14·0	3·5	8·0	3·6	5·7	5·4	3·7	2·8	2·6	1·7	1·7
A. antiquus ..	5·5	..	12·0	3·0	..	..	..	..	..	..	..	..	..
C. geranoides ..	5·7	3·0	12·4	2·9	7·3	3·5	5·2	5·2	..	..	2·4	1·7	1·8
C. curtus ..	4·8	2·6	10·5	2·6	6·0	3·0	4·0	3·5	2·7	..	2·4	1·7	1·4
M. didinus ..	6·8	3·6	14·9	3·8	9·1	4·4	6·4	7·6	4·2	2·7	2·4	1·8	1·6
S. rheides ..	9·3	5·2	21·2	5·3	12·0	6·3	9·0	11·0	..	..	..	..	..
S. crassus ..	8·5	5·0	19·0	4·8	11·0	5·8	8·1	10·1	6·5	3·8	3·4	2·2	2·0
S. casuarinus ..	7·6	4·3	17·1	4·0	9·8	5·0	7·0	9·0	5·2	3·7	3·2	2·0	2·0
E. elephantopus	9·5	6·5	22·4	6·2	12·3	7·3	7·0	11·7	8·4	2·9	2·8	2·1	1·9
E. ponderosus ..	8·5	6·0	19·5	5·5	10·5	6·0	6·0	10·0	7·2	2·7	2·7	2·0	1·8
E. gravis ..	7·4	5·0	16·7	4·2	9·2	5·0	4·5	7·0	6·5	2·4	2·6	1·8	1·7
E. pygmæus ..	6·0	4·0	13·5	5·0	7·5	4·5	..	..	..	..	..	..	..

EXPLANATION OF PLATES XV.-XVII.

Skulls of Moas one-half the natural size.

PLATE XV.

Fig. 1 and 1*a*. *Dinornis potens;* after Owen, Ext. Birds of N.Z., pl. lxiv.
Fig. 2 and 2*a*. *Dinornis (Tylopteryx) torosus;* after Owen, Ext. Birds of N.Z., pl. lxxxii.
Fig. 3 and 3*a*. *Palapteryx dromioides;* after Owen, Ext. Birds of N.Z., pl. xlv.
Fig. 4 and 4*a*. *Anomalopteryx didiformis;* after Owen, Trans. Zool. Soc., vol. xi., pl. lii.

PLATE XVI.

Fig. 5 and 5*a*. *Cela curtus;* after Haast, Trans. Zool. Soc., vol. xii., pl. xxxi.
Fig. 6 and 6*a*. *Syornis crassus;* after Owen, Ext. Birds of N.Z., pl. lxxvi.
Fig. 7 and 7*a*. *Mesopteryx didinus;* after Owen, Ext. Birds of N.Z., pl. lxxviii.
Fig. 8 and 8*a*. *Euryapteryx ponderosus;* after Owen, Ext. Birds of N.Z., pl. lxxvii.

PLATE XVII.

Bones of *Anomalopteryx antiquus*, from the North Mole Quarry, Timaru: *a*, right tibia, anterior aspect; *b*, left tibia, inner aspect; *c*, right metatarsus, proximal end; *d*, left metatarsus, distal end. The three other large fragments imbedded in the matrix are portions of the pelvis.

ART. VI.—*Notes on Moa Gizzard-stones.*

By A. HAMILTON.

[*Read before the Otago Institute, 10th November, 1891.*]

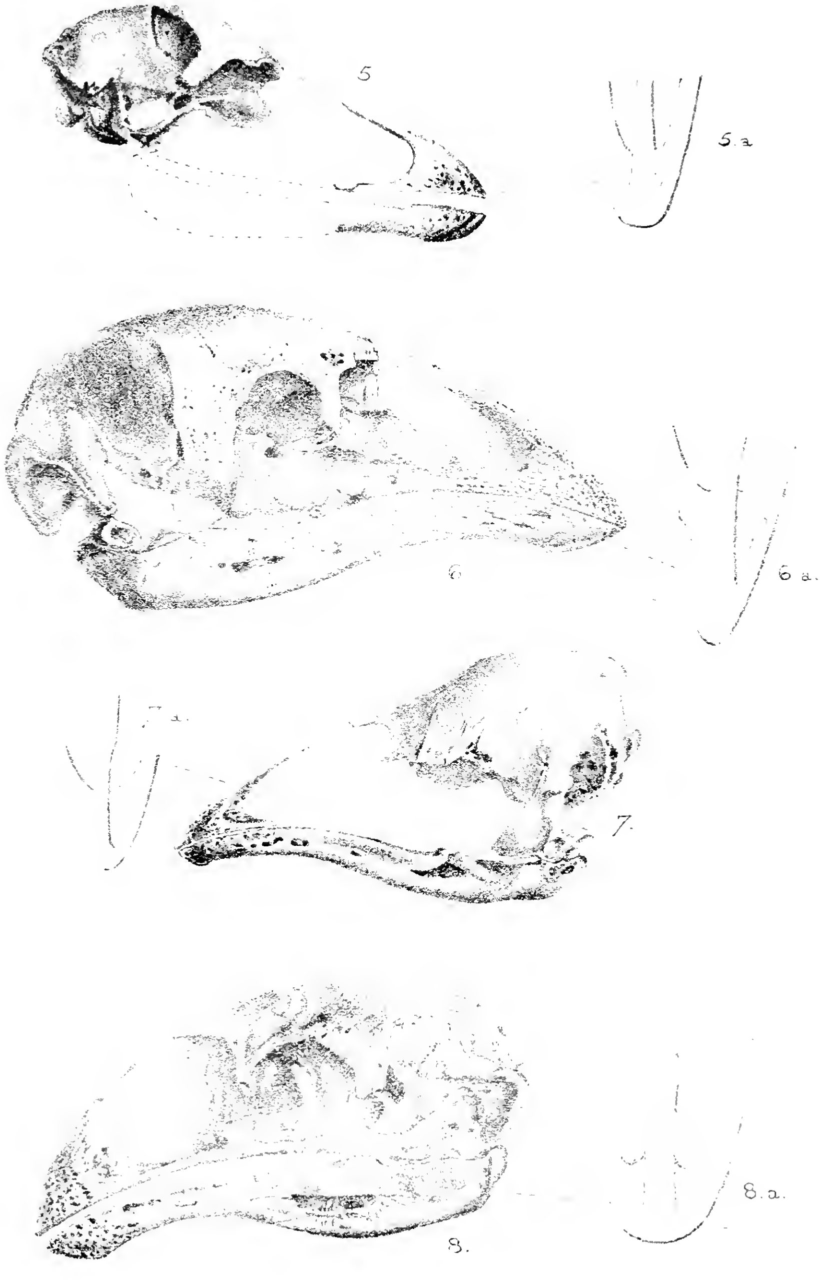
SOME little time ago I had the pleasure of seeing, through the kind offices of Mr. F. R. Chapman, some very remarkable traces of the moa, and I propose to offer to the society a short description of these interesting relics.

Mr. Chapman, in a paper communicated to this society in 1884,* described several collections of gizzard-stones examined by him in that year; and, as he had also noticed somewhat similar traces on the elevated plateau of Swampy Hill, in the neighbourhood of Dunedin, we took an early opportunity of examining the ground more closely. The surface of the range is here swampy moorland right up to the very verge of the precipitous declivities into the valley of the Water of Leith, and the mossy surface abounds in small lagoons, some of which have been considerably reduced in area by drains cut in various directions. The altitude is about 2,000ft., and the

* Trans. N.Z. Inst., vol. xvii., p. 172.

SKULLS OF MOAS.
½ nat. size.

J.E. del. C.H.P. lith.



J.E. del. SKULLS OF MOAS. ½ nat size C.L.P. lith.

From a Photograph. C.H.F. lith.

BONES OF ANOMALOPTERYX ANTIQUUS
From the North Mole Quarry, Timaru.

vegetation consists of small and inconspicuous plants, with occasional patches of manuka. In some places a space of ground of nearly an acre is completely bare, and by the sections exposed is seen to be solid vegetable peat, which in many places is certainly of a depth of 10ft., and probably even 20ft. The cause of these bare patches, devoid of any surface vegetation, may be either that the water of a pond or lagoon has been drained away, or that fire has burned a certain part away in the dry seasons; but, whatever the cause, on these barren areas are seen heaps of unmistakable gizzard-stones of pure-white quartz. In the majority of cases it is not possible to isolate absolutely the total contents of one gizzard, but we were fortunate enough to find at least two examples which would convince even the most sceptical as to the real character of the heaps more or less scattered on the ground.

The first of these was just being exposed by the action of the weather from underneath a clump of manuka, and only a few of the larger stones were visible. On digging into the peat we noticed that, although the interstices between the stones were filled up with closely-interlaced vegetable fibres, similar in substance to the rest of the peaty soil, yet it was of a decidedly yellow colour, in contrast to the brown of the peat. The stones were found to be closely compacted together in a ball-shaped mass, and were of all sizes, from those less than a pea to those larger than a pigeon's egg. We carefully cut out this mass, which was as large as a man's head, and could find no stones in the peat immediately surrounding the collection. The stones were carefully washed out and dried, and tied up in a separate bundle, and on weighing them afterwards they were found to turn the scale at 4½lb.

The second example was on lower ground close to a large lagoon, and only a few small stones were visible. Packed in between the stones was the same comminuted vegetable matter of a much lighter colour than the surrounding peat. This mass we removed as carefully as possible and tied it up separately. I have picked out most of the stones, and dried and examined the vegetable matter in which the stones are imbedded and interwoven, and I find it to consist of vast numbers of seeds of *Leucopogon* and *Coprosmas* (?), and short twigs and branches which cannot be well identified. Some of the material I have forwarded to Mr. T. Kirk for examination and identification.

The number of stones in these two gizzards must far exceed those described by Mr. Chapman in his paper. In the second example the weight of the stones was just six pounds.

Still continuing our walk over the bleak and barren moorland, we saw unnumbered scattered heaps of these white-quartz pebbles, and in one place more than a barrowload of them. This heap must have weighed over a hundredweight at least, and could only have resulted from the destruction of numbers of birds crossing some unusually soft or treacherous part of the swamp during a long series of years; or they may have been gathered together by flowing water, and deposited in a hole at the bottom of some channel or pool on the surface of the peat, and subsequently exposed by changes of level and subaërial action.

Near this great heap two curious observations were made: one was, on cutting into the peat for a few inches we came to a "pocket" of clean, sharp quartz-sand—about a pint, just like sea-shore sand—with a few small pebbles in it. This could not possibly have been deposited where we found it by any natural physical agency. Mr. Chapman, I believe, met with a similar small pocket of sand on the top of Maungatua, on the south side of the Taieri Plain, at the height of about 3,000ft.

The other find was the proximal end of a metatarsal bone of a moa of medium size (possibly *D. crassus*), almost entirely decalcified. This was the only fragment of bone which the most rigorous search could find, and Mr. Chapman informed me that on a previous occasion he had found a similar fragment in the same condition. Now, I had always supposed peat-swamps to be the happy hunting-grounds for the bone-hunter, and was much disappointed at not finding any trace of the birds which used all these gizzard-stones, and I constructed several ingenious theories to account for the matter, some of which fitted the facts delightfully; but on testing the samples of peat which I took home I found that ordinary litmus-paper was immediately reddened when placed in contact with the peat.

Here, then, was the explanation of the mystery—the strongly acid character of the decaying vegetable matter dissolved the bones entirely; and, instead of the peat-deposit of Swampy Hill turning out either a Glenmark, Hamilton, or Enfield, only the imperishable quartz pebbles contained in the gizzard have remained to testify to the former abundance of Dinornithidæ in that part.

On looking up the subject of peat, I find that Sir Charles Lyell* says, "The antlers of large and full-grown stags are among the most common and conspicuous remains of animals in peat. They are not horns which have been shed, for portions of the skull are found attached, proving that the whole animal perished. But as a general rule no remains are met with belonging to extinct quadrupeds, such as the elephant,

* "Principles of Geology," vol. ii., p. 505, tenth edition.

rhinoceros, hippopotamus, hyæna, and tiger, which are so common in the old European gravels." This extract seems to confirm the destructive properties of peat; and I believe that all the remains of the Irish elk from the bogs of Ireland are from the clay- or marl-beds immediately at the base of the peat.

Since writing the above I have seen large peat-deposits in Southland at a much lower level. In one place, at the Mararoa Station, near Mount Excelsior, the peat has been regularly worked for years for burning. Here also moa-stones occur in profusion. The process of cutting also exposed the fragments of perished bones. I carefully examined this deposit, and found it to consist almost entirely of *Calorophus*; and the *Sphagnum* which forms the majority of peat-mosses in England was entirely absent.

I should have mentioned above that the nearest place at which the quartz pebbles could be procured is at the outcrop of the Otago schist formation, distant from Swampy Hill about four miles. The weight of the largest stone in the two collections is a little over 1½oz.

ART. VII.—*On the Genus* Aptornis, *with more Especial Reference to* Aptornis defossor, *Owen*.

By A. HAMILTON.

[Read before the Otago Institute, 8th November, 1891.]

As long ago as the year 1842 Dr. Buckland received from New Zealand a collection of moa-bones from the east coast of the North Island, forwarded to him by the Rev. W. Williams. On examining this collection Professor Owen found ample confirmation of his previous determination of the cursorial character of the specimens on which he had founded his genus *Dinornis* in the year 1839.

Among the bones in this collection he found a tibia "which unequivocally establishes a fourth species of Cursorial bird, which, from the agreement of the bone in its general characters with the tibiæ of the larger species, most probably belonged to the same genus—*Dinornis*—but did not surpass in size the great bustard" (*Otis tarda*). This species the Professor named *Dinornis otidiformis* (1843).

Time passed on, and further collections of bones were made in New Zealand and sent Home (1846), and in the memoir on the genus *Palapteryx* a fragmentary femur is allotted to the previously-described tibia. The bone was, however, so imperfect that only the circumference could be given in the table of measurements of the bones of the leg in *Dinornis*.

On the arrival of the great collection of Dinornithie remains made by Mr. Walter Mantell in the South Island (1848), several "tarso-metatarsal bones, with the articular surface for a very strong hind-toe, and a conformation more resembling the dodo than those of *Dinornis* or *Palapteryx*," were recognised, and the special and extraordinary characters presented by the bone decided the professor to establish a new genus under the name of *Aptornis*, placing in this new genus the bones hitherto ascribed to *Dinornis otidiformis*. A cranium in the same collection was figured as probably that of *Dinornis casuarinus*; but when, in 1865, the Ralline characters of the skull were recognised and fully and clearly pointed out by Professor W. K. Parker,* this skull was also assigned to *Aptornis*.

A further addition to the knowledge of the skeleton was made by a description of the sternum, which was included in a collection of bones from Waingongoro, on the west coast of the North Island (1850). This was described and figured both in the Proceedings of the Zoological Society and in the "Extinct Birds of New Zealand," although in the text it is assigned to *Notornis* or *Brachypteryx*. All of the bones hitherto noticed may probably be classed as belonging to the smaller of the two species now known, *Aptornis otidiformis*, Owen.

No other bones of the genus were figured or described till a memoir appeared on the Anserine genus *Cnemiornis* (1865), and a humerus was then figured and described which has since been more correctly assigned to *Aptornis*. From a collection of bones forwarded by the Rev. Richard Taylor, of Wanganui, Professor Owen found himself called upon to name a second species of the genus, which he named *Aptornis defossor*, principally from a beautiful specimen of a skull and some other bones "discovered in a cave of soft sand about fourteen miles from Oamaru, which was filled with bird-bones." The monograph which resulted from the examination of these bones concluded with a comparative table of the measurements of the chief bones of the skeletons of the two species.

From another collection of bones from a fissure at Albury, near Timaru (1871), the sternum and pelvis of the larger species were described, and a restoration of the complete skeleton given.

In 1873 two important papers on *Cnemiornis* appeared—one read before the Wellington Philosophical Society by Sir

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* Phil. Trans. Royal Soc., vol. clvi., p. 113: "On the Structure and Development of the Skull in the Ostrich Tribe;" by W. K. Parker, F.Z.S.

James Hector, on a collection of bones found by Captain Fraser in a cave near Alexandra, in the Otago Lake District;* and the other by Professor Owen, being a restoration of the *Cnemiornis* skeleton from additional material received by him.

The coracoid which Professor Owen there figures on plate cii., Mr. H. O. Forbes identified in 1889 before the Philosophical Institute of Canterbury as belonging to *Aptornis;* and this identification I can now confirm, and show that the bone does not need the conjectural additions shown in pl. cii., as the union with the sternum is a ragged one, sometimes anchylosed, and not by a synovial joint. I must also claim from this *Cnemiornis* paper not only all the vertebræ figured on plate cii., but also those given on plate lxvi., "Extinct Birds of New Zealand," as vertebræ of *Aptornis defossor.*

Sir James Hector only figures a few dorsal vertebræ of *Cnemiornis* in his paper, but these are quite sufficient to show the great difference in almost every character from *Aptornis.*†

With the exception of the phototype of the nearly complete skeleton of an individual of the smaller species, now in the Canterbury Museum, published in Dr. von Haast's "Geology of Canterbury and Westland" (1879), and the figures of the type specimens accompanying the papers in the Proceedings of the Zoological Society (reproduced in the "Extinct Birds of New Zealand"), little else has been published on this genus.

It has fallen to the lot of Mr. W. S. Mitchell, of Lake Manapouri Station, Southland (1889), to find a number of bones of *Aptornis defossor* in some limestone caves on the Oreti River, in Southland, and through his kindness I have the opportunity of describing this important find, and I shall endeavour to supply a little information on points which could not well be made out from the original types.

All the bones came from a series of limestone caves, and are still partly covered with incrustation of fine limestone dust, but in the majority of cases the bones are in perfect condition. After careful and prolonged examination, I find that six or seven individuals are represented, and that in four cases the bones can be allotted to the skeleton without much doubt as to their having formed part of an individual bird. But the most important fact to be observed is that here there is no mixture of "doubtful" bones, all the other bones obtained from these caves and fissures at the same time and in the same neighbourhood being easily-distinguished species of *Dinornis*, kiwi, kakapo, (*Stringops*), &c., and in no instance have any *Cnemiornis* bones been found

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* Trans. N.Z. Inst., vol. vi.
† Trans. N.Z. Inst., vol. vi., pl. xiv.

here, so that such bones of this kind as are present can be identified with almost absolute certainty as being those of *Aptornis*, and, as I have before said, can by their peculiarities be allotted to definite individual skeletons. As will be seen from the table of measurements, the dimensions of the limbs agree very closely with the measurements given by Owen (p. 315, *op. cit.*), but the individual distinguished as B is slightly larger in all its measurements.* It is just possible that it may be found that this represents the species provisionally named by Professor Owen *A. bulleri*, in a letter to Sir Walter Buller, quoted at p. xxii. of the introduction to Buller's "Birds of New Zealand" (new edition). I am at present, however, inclined to regard the difference as due to sex.

The Skull.—Apparently the first *Aptornis* skull received by Professor Owen was a very fine specimen of the smaller species in Mr. Mantell's collection in 1848, and for a time it figured as the skull of *Dinornis casuarinus;* but in a paper in the Philosophical Transactions of the Royal Society of London, 1866, the late Professor W. K. Parker wrote very fully on the essentially Ralline characters presented by the skull, which he incidentally calls "nearly as precious and quite as unique as the skeleton of the *Archæopteryx*," and he goes on to say that in his opinion the skull has great affinities with *Psophia*, the trumpeter crane, specially drawing attention to the greatly-developed basi-temporal pterygoid processes, the decurved lower mandible, and the almost complete ossification of the interorbital septum. Professor Parker considered the bird a *Notornis*, and proposed the name of *Notornis casuarinus* for it.

For his work on the "Extinct Birds of New Zealand," Professor Owen was fortunate enough to receive a beautiful skull of *Aptornis defossor* from Oamaru, and it is excellently figured in plates lxxxiii. and lxxxiv. of that work.

The collection obtained by Mr. Mitchell contained one skull which is absolutely perfect, and three others more or less damaged. There are three lower maxillaries.

The Vertebræ.—At present I have only been able to select one complete set of the vertebræ. Fortunately, one atlas vertebra occurred, and, on comparing it with the three or four specimens of the axis vertebra, one was found to fit it exactly. Thus an important part, and one often missing from fossil skeletons, is now known. The cervical vertebræ immediately succeeding the axis rapidly increase in size, and

* I have given the measurements in decimal notation, as being more generally useful than inches and lines or tenths. Some of the slight differences may be accounted for by the system of measurement adopted. All my measurements are made on the lines of major axis of the bones, or at points at right angles to it.

are relatively enormous and very massive, and Professor Owen says (p. 373, *op. cit.*), "No Anserine comes near *Cnemiornis* in this respect. Its cervical vertebræ recall the proportions of those in *Megaceros*, and have a like relation to the muscular force brought to bear on the head. . . . This is probably related to the grip and tug exercised by the . . . strong beak upon the vegetable growths torn up for food." The professor, in the note at the foot of p. 372, states that twelve cervical vertebræ of *Cnemiornis* were collected by the Hon. Captain Fraser in the Earnscleugh Cave, and that Dr. Hector attributed them to the same individual bird. If figures of these had been available, the professor would have doubtless corrected his identification, as they would have differed greatly from those put forward in plates lxvi., cii., and lxvii. of his memoir on the "Extinct Birds of New Zealand."

The whole of the vertebræ figured by Professor Owen as belonging to *Cnemiornis* may be taken as representing vertebræ of *Aptornis*. I do not now intend to go into the details of the structure of the bones of the axial skeleton of this bird, but I may say that every vertebra will well repay careful examination, the whole forming a series quite unique in its proportions, and I have no doubt that some day a most interesting paper will be written concerning it. I have not yet succeeded in finding any caudal vertebræ.

The Pelvis.—The series of bones of *Aptornis* included four specimens of that compound bone called the pelvis; and one of the specimens is absolutely perfect, just as if it had been prepared by maceration in the workshop. The others are more or less imperfect, the only point of interest about them being that in the one marked C an additional vertebra has coalesced with the sacral portion of the pelvis, making three rib-bearing vertebræ in the pelvic mass. The pubic bones in the best specimen are quite entire, and enable the figure given in plate lxxxix. of the "Extinct Birds of New Zealand," and plate xiv. in the 8th volume of the Transactions of the Zoological Society, to be completed. As already noticed by Professor Owen, the structure of the pelvis of this bird is pre-eminent as an example of strength combined with lightness.

The Sternum.—The much-reduced sternum of this bird is represented by four specimens, three of which are perfect, the other being very slightly injured. They agree almost exactly with the one already figured. The coracoid has been figured by Owen as the coracoid of the extinct goose (*Cnemiornis*), and a portion added in outline to show how it fitted the coracoid notch in the sternum. Now, in this collection there are three specimens of this important bo e, and, as if to prevent any possibility of error, one is completely anchylosed to the sternum of the skeleton marked A. The corresponding bone (the left) is present, but is free, and shows that the whole of the bone was present in the specimen figured on plate lxxxix. of the "Extinct Birds of New Zealand."

The Scapula.—The remaining element of the scapulo-coracoid arch is represented by three specimens; and, as the exact fit of the bone with the coracoid, and the resulting angle, is a matter of some considerable interest, I hope Professor Parker will investigate it, and collate the results with those he has so elaborately worked out in his paper on the skeleton of *Notornis*.

The Humerus.—This bone is represented by five specimens, and has been figured and described already. The engraving gives a good idea of the bone; but the small tubercle or prominence on the lower third of the shaft is not present in any of the specimens examined by me. It should be noted that on page 378 of the book Professor Owen corrects his previous identification, and ascribes it to *Aptornis*.

The Femur.—Represented by six specimens. The published figures of this important bone are not satisfactory.

The Tibia and Fibula.—The figures on plates lxxxiv. and lxxxvi. not being taken from very perfect bones, I hope to give a figure taken from complete specimens. The metatarsus is an exceptionally interesting bone, and quite easily recognised. There were six metatarsi, and a sufficient number of the phalanges to partially restore the feet.

The *ribs* have not hitherto been described or identified; they are of a unique character, and some have very curious epipleural appendages; others are very long and thin—very different from the Dinornithic ribs of the restoration on plate xciv. of the "Extinct Birds of New Zealand."

The few tracheal rings found with the skeletons are quite different from those assigned to *Aptornis* on plate xcii. (*op. cit.*). There is no notch on the rings, and a section of the circumference is merely circular, and not flat as in most of the Dinornithidæ. The diameter of the rings, which are oval, is as 2 to 1. I am somewhat inclined, after all, to consider these as belonging to *Anomalopteryx didiformis*, found in the same locality.

TABLE OF ADMEASUREMENTS OF APTORNIS DEFOSSOR, OWEN (IN MM.)

—	Owen.	A.	B.	C.	D.	E.
Skull—						
Length	182	183	..	..	..	..
Breadth across paroccipitals ..	82	80	86	..	..	..
„ across post-frontals	80	86	88	..	..	..
„ across temporal fossa ..	57	49	..	..	..	..
„ of middle of upper mandible ..	35	32	..	..	..	..
„ of fore-end of upper mandible	16	16	..	..	..	..
Width of basi-sphenoid	27	27	35	29	29	..
Pelvis—						
Width at post-acetabular prominence ..	..	108	109	105	102	..
Extreme length	..	280	..	265	..	..
Sternum—						
Length in central line	141	134	147	134	137	..
Extreme width	..	90	104	84	96	..
Coracoid—						
Greatest length	..	90	92	..	..	..
Scapula—						
Greatest length	..	112	110	103	..	..
Humerus—						
Greatest length	..	132	136	135	..	133
Femur—						
Length	190	184	191	187	190	190
Breadth of proximal end in the axis of the neck	55	55	53	54	57	..
Breadth of distal end	55	54	53	54	57	..
Circumference of middle of shaft ..	69	71	67	68	72	71
Tibia—						
Length	259	259	278	260	262	264
Breadth of proximal end	57	71	74	71	71	66
„ of distal end	47	37	41	37	39	37
Circumference of middle of shaft ..	63	63	63	60	64	63
Metatarsus—						
Length	107	107	118	109	110	110
Breadth of proximal end (transverse) ..	41	41	47	43	42	42
„ of distal end (transverse) ..	42	42	45	50	44	44
„ of calcaneal process.. ..	35	35	40	37	37	37

TABLE OF REFERENCES TO FIGURES OF THE BONES OF THE SKELETON OF APTORNIS DEFOSSOR, OWEN.

—	Figure.	Description.	Remarks.
Skull ..	Trans. Zool. Soc., vol. vii., pl. xl. and xli., figs. 1–3	Vol. vii., p. 354 ..	The mandible of *Aphanapteryx* is figured on these plates, ex *Ibis*, 1869.
	Ext. Birds of N.Z., vol. ii., pl. lxxxiii. and lxxxiv.	Vol. i., p. 291.	
Vertebræ..	Trans. Zool. Soc., vol. v., pl. lxiii., figs. 3, 4 ..	Vol. v., p. 396 ..	All cervicals, described and figured as belonging to *Cnemiornis*.
	" vol. ix., pl. xxxvi., fig. 1 ..	Vol. ix., p. 260 ..	
	Ext. Birds of N.Z., vol. ii., pl. lxvi., figs. 3, 4 ..	Vol. i., pp. 239–372	
	" " pl. lxvii., fig. 1 ..	Vol. i., p. 240 ..	
	Trans. Zool. Soc., vol. v., pl. lxiv., fig. 1	Vol. v., p. 396 ..	
	" vol. ix., pl. xxxvi., fig. 6 ..	Vol. ix., p. 261 ..	
	Ext. Birds of N.Z., vol. ii., pl. lxvii., fig. 1 ..	Vol. i., pp. 372–4 ..	
	" " pl. cii., fig. 6 ..	Vol. i., p. 240 ..	
	Trans. Zool. Soc., vol. ix., pl. xxxvi., figs. 11, 12	Vol. ix., p. 262 ..	
	Ext. Birds of N.Z., vol. ii., pl. cii., figs. 11, 12 ..	Vol. i., p. 240 ..	
	Trans. Zool. Soc., vol. ix., pl. xxxvi., figs. 15, 16	Vol. ix., p. 262 ..	Dorsals, described and figured as belonging to *Cnemiornis*.
	Ext. Birds of N.Z., vol. ii., pl. cii., figs. 15, 16 ..	Vol. i., p. 240 ..	
	Trans. Zool. Zoc., vol. ix., pl. xxxvi., fig. 17 ..	Vol. ix., p. 262 ..	
	Ext. Birds of N.Z., vol. ii., pl. cii., fig. 17 ..	Vol. i., p. 240 ..	
Pelvis ..	Trans. Zool. Soc., vol. viii., pl. xv., figs. 1, 2 ..	Vol. viii., pp. 122, 126	In the figure in the Transactions the restored outline is indicated.
	Ext. Birds of N.Z., vol. ii., pl. lxxxviii., figs. 1, 2	Vol. i., p. 342.	
	Trans. Zool. Soc., vol. viii., pl. xiv., fig. 1 ..	Vol. viii., pp. 122, 126.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxix., fig. 1 ..	Vol. i., p. 342.	
Sternum ..	Trans. Zool. Soc., vol. viii., pl. xiv., figs. 2, 3, 4	Vol. viii., pp. 119, 121.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxix., figs. 2, 3, 4	Vol. i., p. 340.	
Coracoid ..	Trans. Zool. Soc., vol. ix., pl. xxxvii., figs. 4, 7 ..	Vol. ix., p. 264.	
	Ext. Birds of N.Z., vol. ii., pl. ciii., figs. 4, 7 ..	Vol. i., pp. 376, 377.	

Humerus	Trans. Zool. Soc., vol. v., pl. lxvi., figs. 7, 10 ..	Vol. v., p. 399, and vol. ix., p. 266.	
	Ext. Birds of N.Z., vol. ii., pl. lxix., figs. 7, 10 ..	Vol. i., pp. 242, 243; p. 366, and p. 378	In the index of plates in the "Extinct Birds of New Zealand" the humerus is said to be on pl. lxvii. It, however, appears on pl. lxix., but is not noticed in the index when describing that plate.
Femur ..	Trans. Zool. Soc., vol. vii., pl. xliii., figs. 5–7 ..	Vol. vii., p. 371.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxvi., figs. 5–7 ..	Vol. i., p. 306.	
Tibia ..	Trans. Zool. Soc., vol. vii., pl. xli., fig. 9.. ..	Vol. vii., p. 372.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxiv., fig. 9 ..	Vol. i., p. 309.	
	" vol. ii., pl. lxxxvi., fig. 8 ..	..	Head of tibia, from above. Not mentioned in description of plate in index.
Fibula ..	Trans. Zool. Soc., vol. vii., pl. xli., figs. 10, 10A..	Vol. vii., p. 373.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxiv., figs. 10, 10A	Vol. i., p. 310.	
Metatarsus	Trans. Zool. Soc., vol. vii., pl. liv., figs. 1–5 ..	Vol. vii., p. 374.	
	Ext. Birds of N.Z., vol. ii., pl. lxxxvii., figs. 1–5 ..	Vol. i., p. 311.	
Ribs ..	.. ..	Vol. i., p. 210 ..	Casual mention, as occurring in the Timaru fissure.
Tracheal rings	Trans. Zool. Soc., vol. vii., pl. xlvii., fig. 7 ..	Vol. vii., p. 392.	
	Ext. Birds of N.Z., vol. ii., pl. xciii., fig. 7 ..	Vol. i., p. 333.	
Restoration of skeleton	Trans. Zool. Soc., vol. viii., pl. xvi.	Vol. viii., p. 126.	
	Ext. Birds of N.Z., vol. ii., pl. xciv.	Vol. i., p. 339.	
Table of admeasurements	Ext. Birds of N.Z.	Vol. i., p. 315.	

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" " vol. v., p. 232.
" " vol. vii., p. 83.
" " vol. viii., pp. 68, 71.
" " vol. xiv., p. 245.
" " vol. xv., p. 526.
" " vol. xxii., p. 545.

[NOTE.—Since the above paper was read before the Otago Institute, the Catalogue of the Fossil Birds in the British Museum, by R. Lydekker (London, 1891), has been received from England for the library of the Otago Museum, and on consulting this I find that I have been anticipated by Mr. Lydekker in identifying the vertebræ of *Aptornis*. Had I been able to obtain the catalogue at an earlier date, I should have been saved the trouble of tabulating and arranging the references to the various particulars and publications.

There is probably a misprint in p. 152, line 13, the length of the tibia being given as 285. Judging from my own series of measurements, I should say "258" was intended. It is a curious coincidence that the right coracoid (46623) should be anchylosed to the sternum, as in my specimen A. Mr. Lydekker has been anticipated by Mr. Forbes in his identification of the coracoid.

The information about the skulls which compose the figures given by Owen is of interest, and the evidence afforded in corroboration of the details by the perfect specimens from Southland the more valuable. The second reference for specimens Nos. 46578 and 46579 has been omitted, and a few typograpical errors occur.

I find that the skeleton figured by von Haast in the Geology of Canterbury and Westland is not *otidiformis*, as stated on the plate, but represents the skeleton of *A. defossor* in the Canterbury Museum.

I have also seen three skulls of *Aptornis* in the same Museum, and three in the Colonial Museum, where there are also seven dorsal vertebræ from the Nelson District, and a few other bones of *Aptornis*.]

Art. VIII.—*Preliminary Notice of Additions to the Extinct Avifauna of New Zealand. (Abstract.)**

By H. O. Forbes.

Communicated by J. T. Meeson, B.A.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1891.*]

In the majority of the larger deposits of moa-bones discovered in both Islands the remains of numerous smaller birds have also been obtained. With a few exceptions these had been laid aside to wait identification and description at some future time. The chief reason for this neglect was doubtless the keener interest aroused in the scientific world in the moa, and the expectancy and the hopes, so often realised, of the explorers being able to add to the list of these giant struthioids which every new cave or swamp for many years raised; a second and very valid reason being the almost total lack in most of the museums of the colony of the necessary skeletons of recent birds of every family with which to compare these unknown subfossil remains. This latter drawback still exists to a great extent, and till a more complete series has by degrees accumulated many of the bones so discovered must remain unidentified. The acquisition of birds and the preparation of their skeletons for the purposes of this paper have been in progress for upwards of two years, and by their means and along with the avian osteological collection accumulated by him during his lengthened travels the author is able to present to the Institute to-night the first instalment of his identifications. The material on which the author bases this paper was collected from the Glenmark Swamp by Sir Julius von Haast; from the Hamilton Swamp by the Otago Museum Committee; from the Earnscleugh Cave by his late friend the Hon. Captain Fraser, by D. Thompson, and Captain Hutton; from the Moa-bone Point Cave, Sumner, by his predecessor; from the Arkle Creek deposit by himself; from the Te Aute Swamp by Mr. A. Hamilton; from Monck's Cave, Sumner, and from the Enfield Swamp, Oamaru, under the author's supervision; from Shag Valley, and in the notorious Rauparaha's Pa kitchen-middens, by Mr. A. Hamilton. For the generous use of this material the author offers his warmest thanks to the Hawke's Bay Philosophical Institute, to Professor Parker, F.R.S., Otago Museum, and especially to Mr. A. Hamilton, by whose inde-

* This paper is published in abstract, as it has been found impossible to prepare all the necessary drawings for its proper illustration in time for the present volume.

fatigable energy a great part of the collection was personally brought together. This collection of bones indicates that, besides the moas, a host of smaller birds have dropped out of the race, and remained with the years that are behind. The cause of the disappearance of so many species, to all appearance equally fitted to succeed in the struggle against extermination with many of those that have survived and are now with us, is still to seek.

The author in this paper describes twelve species new to the ancient bird-life of New Zealand. The list is headed by two harriers, *i.e.*, *Circus hamiltoni* and *Circus teauteensis*, two raptorial birds much larger than the present New Zealand harrier (*Circus gouldi*) without approaching in size or power the gigantic *Harpagornis*. From the swamps and caves of both Islands, bones referable to the genus *Notornis*, to which the apparently extinct takahe belongs, are not infrequent. The *Notornis mantelli* was founded in 1848 by Professor Owen on the skull of the bird; and in a later paper in the Transactions of the Zoological Society of London, vol. iv., part i., he describes and illustrates on pl. ii., fig. 4, a tibia of this bird, of which the length is given as 7in. 10 lines. On examining this figure carefully, the author has come to the conclusion that some mistake must have occurred, as the bone figured does certainly not present the characteristics of a Ralline tibia, especially in the outline and position of its cnemial crests and in the form of its fibular ridge. It more closely represents a swan's leg-bone. The question of the determination of the species of *Notornis* to which the bones now being discussed by the author belong depends on the correctness of Sir Richard Owen's determination of the tibia he has figured. On comparing the description with the figure of the bone there seems no discrepancy, so far as the figure allows one to judge; consequently, if he was describing a non-Ralline bone the descriptions and the dimensions given will not fit a *Notornis* tibia. Perhaps, however, the error may have been committed by the artist through inaccurate delineation, or by his drawing the tibia of some other bird instead of the rail's, when the dimensions of the *Notornis* tibia in the text must be accepted as correct. The only other record of the dimensions of a *Notornis* tibia that the author has access to is that quoted by Sir Walter Buller in his "History of New Zealand Birds," who gives (vol. ii., p. 93) the length of this bone, in a second skeleton acquired by the Otago Museum, as 6½in. The bones under description in the present paper consist of four tibiæ and three femora. Of the former, the larger measures 7·18in. as compared with Owen's 7·83in., while, of the remaining three, two measure 6·35in. as compared with the Otago Museum specimen, which is 6·25in. in length, and one 6·90in. Of the three thigh-bones in the collection, all are shorter and considerably more slender than the corresponding bone of the Dunedin skeleton, and markedly shorter than the type figured by Sir Richard Owen, while one is larger, one smaller, and one equal to *N. hochstetteri*, Meyer. Of these thigh-bones, one was discovered along with one of the shorter leg-bones, and, though of the opposite side of the body, probably belonged to the same skeleton. Buller considers that the skin described by him in the Transactions of the New Zealand Institute, vol. xiv., belonged to a specimen "slightly larger than the type specimen;" and Meyer, of the Dresden Museum (for which the skin was purchased), considering it a new species, has named it *Notornis hochstetteri*, the original description of which is not available to the author. In Professor Parker's paper, quoted above, the length of the thigh-bone in the skeleton of this identical specimen is given as 10·3 centimetres (4·06in.). The same bone in the skeleton subsequently found is 11·2c. (4·43in.) in length, with a tibia measuring 16·3c. (6·43in.); whereas the femur of Owen's specimen is 12·4c. (4·89in.), with a tibia (as the author thinks, erroneously) 19·83c. (7·83in.) long. It follows, therefore, that Sir Walter has probably written "larger" by a *lapsus calami* instead of smaller, and that, of the bones in the present collection, three tibiæ and two femora (one of them from the Tertiary beds in Hawke's Bay, collected by Mr. Hamilton) belong to the smaller sex of *Notornis hochstetteri*, Meyer; while, if Professor Owen be incorrect in his measurements, or in the bone, the longer tibia from Te Aute will probably prove a true leg-bone of the male of *Notornis mantelli*. The former differs by 0·83c. from the length calculated for a femur of 12·40c. on the basis of the Otago Museum specimen. The femur proportionate to a tibia of 18·20c. would be 12·99c. long, on the same basis. If the professor be correct, then none of the bones in this collection belong to the type species, in which case the Otago Museum skeleton belongs to a distinct species, for which the author suggests the appellation of *Notornis parkeri*, in honour of Professor T. Jeffery Parker, F.R.S., to whom science is indebted for a valuable paper on the comparative osteology of this genus, founded on a skeleton which it was his great fortune to prepare from the fresh body of the bird, with the reverential feelings arising from the knowledge of its probably being (as time, unfortunately, seems to prove more certainly) the very last survivor of its race.

The author next describes two species of *Cnemiornis*: *C. gracilis*, a most elegantly moulded goose from the North Island; and *Cnemiornis minor*, founded on tibiæ now in the Canterbury Museum, which for many years have passed as belonging to the long-known *calcitrans*, but which require only to be compared with the type species to disclose their distinctness.

In the collection are bones belonging probably to still another species of this remarkable genus. Sir Richard Owen early detected, in the disjointed fragments of the *Cnemiornis* skeleton, its near relationship to the unique Cape Barren goose of Australia, or *Cereopsis*. It is with much satisfaction that the author has to announce the addition to the New Zealand fauna of a species of *Cereopsis* itself. The species is founded on a portion of the cranium, which, except that it is slightly larger, is almost indistinguishable from *Cereopsis novæ-hollandiæ*. This species has been designated *Cereopsis novæ-zealandiæ*, and is important from the point of view of geographical distribution.

Equally interesting and important is the next species, as it belongs to a genus of ducks confined to Australia, and represented there by a single species, the Musk Duck, *Biziura lobata*. The present species is named *Biziura lautouri* in compliment to Dr. H. de Lautour, of Oamaru, to whom the author, as well as the Canterbury Museum, is deeply indebted for his kind aid in its acquisition of the recent important deposit of *Dinornis* remains discovered near that town.

In the present collection there is a considerable number of bones referable to Ralline birds, but for the present the author is unable to determine to what species they should be assigned, for want of the necessary skeletons to compare them with. One tibia is sufficiently distinct, however, to indicate a species of *Ocydromus* far exceeding in size any existing New Zealand form, and for it he proposes the name of *Ocydromus insignis*.

It will be within the recollection of the members that the author founded a species of swan (which he named *Chenopis sumnerensis*) on a coracoid and portion of a humerus found in Monck's Cave at Sumner. The correctness of this determination has been amply verified by the receipt of swan remains from widely-separated parts of New Zealand. Among the material referable to this group, there appears evidence of there having been probably more than one species of *Cygnus* or *Chenopis* in these Islands in ancient times—a fact of great interest also from the point of view of the geographical distribution of this disrupted family, now found living only in Europe, in South America, and in Australia. The author, not having, however, any skeletons of South American forms for purposes of comparison, is unable to decide with certainty whether the affinity of the New Zealand species is closer to the Australian species than to their Neotropical relatives.

The species next described is a shag of greater dimensions than the largest New Zealand species, *Phalacrocorax novæ-*

zealandiæ; but until more material is available the author prefers to describe it under a variety of that species, *i.e.*, *Phalacrocorax novæ-zealandiæ*, var. *major*.

The most interesting addition to the extinct avifauna of New Zealand, however, in the estimation of the author, is a group of birds belonging to the Dinornithidæ, or family of the moas, so distinct from the genus *Dinornis*, and presenting so many Casuarine characters that he has proposed a new genus, *Palæo-casuarius*, for the reception of the three species he at present considers referable to it. The genus is founded on tibiæ in his collection, very remarkable for their resemblance to those of the cassowary (*Casuarius galeatus*). These bones are at once distinguishable by their straightness, their graceful and slender contours, indicating, in contradistinction to the heavy-limbed moas, birds as fleet of foot as the emus and cassowaries. The species he has proposed to designate as—(1) *Palæo-casuarius haasti*, in memory of his predecessor, and in recognition of his great and important services to science in this colony, especially by his valuable contributions to our knowledge of the moas. This bird exceeded considerably the cassowary in size. (2) *Palæo-casuarius elegans;* and (3) *Palæo-casuarius velox*—the former of these equalling, and the latter being less than, the helmeted cassowary.

The interest of this collection consists chiefly in the evidence of a former closer connection between the avifaunas of Australia and New Zealand, exhibited by the discovery in this colony of species of swan, of musk duck, and of a true *Cereopsis*, or Cape Barren goose, and by the much closer affinity of some of the Dinornithidæ to the Struthious birds of northern Australia and of the Melanesian Islands than has hitherto been apparent.

P.S.—25th February, 1892.—A visit paid to the Chatham Islands by the author since the reading of this paper has brought to light there several highly interesting fossil and subfossil avian remains. Of these, the recovery of the Mauritian genus *Aphanapteryx* is the most important. For this species the author proposes the name of *A. hawkinsi*, in honour of the gentleman who first brought him a portion of the cranium of this bird from the islands. *Rallus dieffenbachii*, *Nestor notabilis*, and species of *Chenopis* (in very old Moriori middens), *Himantopus*, *Carpophaga*, and *Columba* are also represented among the remains from this outlying group of islands.

Art. IX.—*Note on a Species of* Platycercus (P. erythrotis, *Wagl.*) *from Antipodes Island.*

By H. O. Forbes.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1891.*]

I have lately had an opportunity of examining a species of *Platycercus* from Antipodes Island, on which I offer the following observations :—

In general appearance the bird resembles its near relative, *Platycercus novæ-zealandiæ*, but it is unmistakably larger and more robust. In general plumage the Antipodes bird is dark yellowish-green, and of a lighter shade still on the wing-coverts, owing to a bright edging of orange to the feathers, while on the under-side the green is conspicuously yellower than in *Platycercus novæ-zealandiæ*. Compared with it, the Antipodes specimen has the crimson patch on the forehead as large, or, indeed, a little larger, and somewhat lighter in colour, and has the streak in front of the eye orange-red, while the ear-spots are narrower and extend less far back. Both birds present a distinct spot of scarlet on each side of the rump. On the nape there is in both sexes the same concealed nuchal patch of yellowish-white, but it is smaller in the Antipodes specimen. The wing-feathers of the latter are dull greenish-black, having the under-surface lighter and crossed by two obscure, broken yellowish bands, composed of yellowish blotches on the secondaries and secondary coverts. The outer primaries and their coverts are deep-blue on their external webs, but only along a band next the shaft, and ceasing at the notch, being followed, except on the coverts, by a second narrow band of yellowish-green, succeeded by a bright edging of greenish-yellow, more marked distally, and disappearing in the dusky terminal spot. The bastard quills are pale greenish-blue, with a yellowish-blue termination. Irides yellow. Upper mandible, for three-quarters of its extent from the tip backwards, deep-black, the rest whitish-blue. In *P. novæ-zealandiæ* the black colour of the upper mandible is confined to the tip, and is a character of great constancy in the New Zealand birds. Lower mandible black; legs and feet bluish-black.

The dimensions of the leg-bones fully demonstrate the greater strength of the bird in this region as compared with its New Zealand congener.

	P. novæ-zealandiæ.	P. ex Ins. Antip.
Tarsus	0·875	1·075
Tibia	1·6	2·075
Femur	1·1	1·275
Humerus	1·0	1·25
Ulna	0·875	1·375

The width between the extreme edges of the ulna and radius is more than twice as great in the Antipodes as in the New Zealand bird.

The Antipodes Island specimen is therefore, though nearly related to *P. novæ-zealandiæ*, a larger-boned bird. Sir Walter Buller, in his "History of the Birds of New Zealand," says that "Dr. Finsch is of opinion that *P.* (*Cyanorhamphus*) *saissetti*, Verr., is inseparable from his species [*P. novæ-zealandiæ*]. On comparing a specimen sent by Mr. Edgar Layard from New Caledonia to the Otago Museum, I find that the bird differs from *P. novæ-zealandiæ* only in having the sides of the face, throat, breast, and under-parts generally greenish-yellow, deepening into grass-green on the sides of the body and on the flanks. If, however, this is a constant character, I accept it as specific" (vol. i., p. 139). In the *Ibis* for 1879, p. 110, Mr. Layard, in writing of *C. saissetti*, says, "It closely resembles *Platycercus novæ-zealandiæ*, Sparrm.; . . . but on comparing it with specimens of that bird it is at once seen to be larger, has a yellower green on the under-side of the body, a bluer tinge on the upper side of the tail-feathers, and these last are rounded at the ends, not pointed as in the former." The present specimen unfortunately lacked its tail. The predominance of the yellower shade in the green would appear, from what I have said above, to be a constant character; so also would the larger size. I believe, therefore, the Antipodes Island parrakeet to be the same as that found in New Caledonia—*i.e*, *Cyanorhamphus saissetti*, Verr. On examining the synonymy of this bird, I find it to be as follows:—

Platycercus erythrotis, Wagl., 1825.
P. (*Cyanorhamphus*) *saissetti*, Verr., 1860.
P. novæ-zealandiæ, Buller, *nec* Sparrm.
P. novæ-zealandiæ, Finsch.

The parrakeet inhabiting Antipodes Island is therefore *Platycercus erythrotis*, Wagl.; and it is found also in New Caledonia, the Macquaries, and Norfolk Island. It will be interesting to ascertain whether the species found abundantly on the Campbell Islands, as reported by Mr. Chapman, is the larger and yellower-green species or the true *P. novæ-zealandiæ*.

Art. X.—*On a Species of* Regalecus *or Great Oar-fish, caught in Okain's Bay.*

By H. O. Forbes.

Communicated by J. T. Meeson, B.A.

[*Read before the Philosophical Institute of Canterbury, 4th June, 1891.*]

On the morning of the 28th May I received a note from Mr. Warnes, the fishmonger, requesting me to inspect a curious fish caught in Okain's Bay, Banks Peninsula, on the 26th, and which he was bringing up to town that day. On its arrival in Christchurch in the afternoon I found the fish to be a species of *Regalecus*, or oar-fish, of unusually large proportions.

Regalecus is a genus of fishes belonging to the family *Trachypteridæ* or ribbon-fishes. According to Dr. Günther, of the British Museum, they "are true deep-sea fishes, met with in all parts of the ocean, generally found when floating dead on the surface or thrown ashore by the waves."

The oar-fishes are among the largest of the deep-sea fishes known. They derive their name from the singular form of their ventral fins, which—reduced to one long, slender, and fragile filament, terminating in an oar-blade-like expansion, which projects from its sides for a distance, in our specimen, of nearly 3½ft.—are functionally useless.

The *Regaleci*, or oared ribbon-fishes, have been taken in the Mediterranean, in the North and South Atlantic, and in the Indian Ocean. In Australasian waters one has been taken off the coast of Victoria, and several on the shores of this colony. But they are very scarce, not more than twenty captures having been recorded from England in the space of a century and a half, and not more than thirteen from the coasts of Norway. The present specimen is the tenth caught in New Zealand. I take from a paper read before the Otago Institute by Professor Parker, F.R.S., who has compiled a list of these captures up to the date of his communication, which described the last species known to have been stranded on our coast, the following notes: Of these one was captured at Nelson in 1860; a second at Jackson's Bay in 1874; another (*Regalecus pacificus*, Haast), which is now in the Canterbury Museum, as well as a drawing of it by Dr. Powell, was caught at New Brighton in 1876; a fourth was cast ashore on Little Waimangaroa Beach, on the west coast of the South Island, in 1877; a fifth (*R. banksii*) at Cape Farewell in 1877; the sixth was thrown on the shore near Moeraki about the year 1881, and near the same place; the seventh also (*Regalecus argenteus*, Parker) on the 14th June, 1883, whose skeleton is now in the British Museum, South Kensington; the eighth—a specimen of the same species—came ashore in Otago Harbour about ten miles north of Dunedin on the 3rd June, 1887; while the ninth was taken in Nelson Harbour on the 23rd September, 1890, and is now in the Otago Museum. Of the fewer than twenty specimens captured in England, eleven are referable, the same author observes, to a single species, *Regalecus banksii*, while one is assigned to *Regalecus grillii*. The specimen captured in May, 1878, between Victoria and Tasmania has been identified by Sir Fred. McCoy as *Regalecus banksii*. Taking as our guide, however, the key to the species of *Regalecus* given by Professor Parker in vol. xvi. of the Transactions of the New Zealand Institute, it ought, it would appear, to bear the name of *R. grillii*, on account of the number of its dorsal-fin rays. This specimen has been described and figured by Sir Frederick in the 15th decade of the Prodromus of the Zoology of Victoria. After a careful comparison of the descriptions and figures of the species of *Regalecus* known to me, I have come to the conclusion that the species that has been exhibited during the past week in Christchurch is identical with that taken off the Australian coast—namely, the species described by Lindroth under the name of *Regalecus grillii*. In an addendum to his paper in volume xx. of the Transactions of the New Zealand Institute, Professor Parker, who, while writing his excellent monograph on *R. argenteus*, gave the literature of the subject his careful attention, writes, "Everything seems to lead to the conclusion that most of the supposed species of *Regalecus* are identical, and that the more recent specific names (including *argenteus*) will have to give way, probably in favour of Ascanius's original name '*glesne*.'" The synonymy of the species is rather involved, and the works necessary to its elucidation are not within my attainment here. Professor Parker's opinion, however, is entitled to very great weight, and the observations on the present specimen tend to support it. This new specimen, therefore, ought strictly to be denominated *R. glesne;* but for the present I shall speak of it under the name *R. grillii*, to indicate that in my opinion it belongs to the same species as Lindroth described.

This fish had been exhibited in Lyttelton, I believe, before being brought to Christchurch, and had, unfortunately, in its various transports, and perhaps also in its capture—for it was still alive when caught—suffered to some extent. It had lost much of its brilliant colouring, and most of the singular rays of its crest, as well as received damage to the long rays of the ventral fins. With these exceptions, however, the specimen was a particularly fine and complete one. The *Regaleci*, being deep-sea denizens, are generally found to have suffered on approaching the surface from the expansion of their internal gases consequent on the diminution of pressure; but the specimen under description showed no signs of any "loosening or tearing of its ligaments and tissues" by its ascent to the surface of the sea.

The following notes were drawn up under considerable disadvantage owing to the fish being under exhibition at the time, and that in a very badly lighted room. I had to write amidst a talkative crowd, while my observations were confined to the one side—naturally the best—exposed to the public. Imperfect as they may be, I lay them before the Institute as a contribution towards our better knowledge—still very imperfect—of this rare genus of fishes.

It is remarkable that all the New Zealand specimens have been found on the South Island; and, like all the other specimens, European or New Zealand—except the Nelson Harbour one, which was a male—whose sex has been determined, the present is a female, and it has occurred on our shores at the same period of the year (the spring and early winter) as they have invariably done on previous occasions.

In order to facilitate comparison with the observations recorded by Professor Parker in the Transactions of this Institute for 1887, I shall arrange my notes under the same heads, and in the order adopted by him.

Size, Proportions, and Number of Fin-rays.—It will be seen from the accompanying measurements (Appendix A) that the present is the largest species of *Regalecus* yet taken on the coast, its length being 18ft. 10in., with its protrusile mouth not extended. It is probable, however, that it does not exceed by much the length attained by Professor Parker's Otago Harbour specimen when complete. This specimen was broken across, and he conjectures that it was most likely about 17ft. in length. Its ribbon-like form is indicated by the proportion of its height to its length, which was one-fifteenth; the New Brighton specimen was one-eleventh; the Moeraki specimen, sent to London, one-tenth; while the Victorian specimen was still more band-like, its height being only one twenty-third of its total length. The Otago Harbour specimen is given as one-eleventh; but if this were corrected for the length that the fish is conjectured, as stated above, to have reached, the proportion of height to length would closely approximate that of the Okain's Bay example. In this specimen the nuchal crest is damaged, and a gap occurs in the dorsal fin, so that it is difficult with absolute accuracy to determine the number of the fin-rays. Taking 14, the number given by Professor Parker in the crest of the Otago Harbour specimen, as the probable number here, these were succeeded by 221 rays anterior to the gap—in which 17 were made out, but there may have been one more—and succeeded by 170 more to the termination of the tail, giving in all 422, which comes very close both to the number recorded by Lindroth in *R. grillii*, and by Professor McCoy in the Victorian specimen, which is 423. The accompanying table (Appendix A), taken from Professor Parker's paper, with the addition of the Okain's Bay and Victorian specimens, will enable the eye to compare these measurements at a glance. The number of the pectoral, ventral, and branchiostegal rays corresponds with those in *R. argenteus*.

Tail.—In the present specimen the tail is almost perfect, a mere fraction only being possibly absent. It terminates in a point, and is curved upwards for its terminal few inches. The dorsal fin extended, I am convinced, to, but it did not pass, the extreme point. Its fin-rays have been broken off for the last few inches, but with a magnifying-glass it was possible to detect their broken extremities. There is therefore no caudal fin. There is no sign of any old fracture having at any time taken place, as the body graduates gently from head to tail. It would seem, therefore, that the supposition that the end of the tail "has been lost as a useless appendage at a much earlier period of the life of the fish," which has arisen from the circumstance that these fishes are so often found in a truncated condition, is probably groundless, and their mutilation is merely the result of accident. Moreover, as the stomach has an extraordinary cæcal prolongation, which extends for many feet behind the anus, it is evident that a loss of any considerable length of its tail would probably be fatal to the fish.

Colour and Markings.—In general appearance the fish presented on its arrival in Christchurch numerous bright silvery patches, and indications that this colour had covered the whole general surface of the fish. These patches were eventually lost, and the fish assumed a light-greyish colour. Its crest, its dorsal, pectoral, and ventral fins, had faded to a dark salmon-red colour. In some lights it could be detected that dark spots and stripes had been dispersed over the anterior part of the body, but they had almost faded out at the date of examination. As to their number, form, and situation, I can therefore speak with no certainty. On the sides of the body there are five well-defined black bars (or ridges) running longitudinally. These bands, on examination, prove to be composed of raised tubercles, and they are distinctly separated by interspaces, which in the fresh fish would be bright silvery stripes, quite free of tubercles, as a sensitive finger passed along them discovers only the very finest skin-granulations. Above the uppermost of these bars, and separated by a smooth interspace, a broader tuberculated band extends up to the base of the dorsal fin. The tubercles in this band are not so rough as on the lateral bars. Towards the tail, and at a few feet anterior to it, these bars become lost, and exchange their dark colour for a silvery-white. The second, which is the most prominent of all, runs furthest along the body, and is finally lost at 2ft. from the tail, when the tuberculations entirely cease, and the rest of the body is soft and glistening. The first true bar and the sub-dorsal-fin band pass forward, which is not the case with the others, and terminate on the front of the head above the anterior margin of the eye. The lateral line cuts the second, third, and fourth true bar (or ridge) a little posterior to the hind margin of the operculum, while the fifth follows the lateral line for a great part of its length. The ventral surface is very roughly tuberculated—rougher than any other part of the body, the tubercles presenting a suspicion of points. Behind the anus this surface is very dark-coloured, and was probably black in the living fish.

Mr. Warnes was good enough to give me the entrails, which, for the better preservation of the fish, he had removed from the body. These organs were not entirely complete, but they agree so closely with those figured by Hancock and Embleton in the "Annals and Magazine of Natural History" as to require no further description except in regard to the liver, which must arrest the attention of any one opening the body of *Regalecus* by its rich-pink colour. This organ was very tender and friable when it reached my hands. In form it differed considerably from the figure I have referred to. On its upper surface, partially dividing it into two unequal portions, lies a deep fissure, in which are the hepatic and other vessels. The right portion has its lower fourth separated into a distinct lobe; and on the left portion occurs, on its external margin, a small lobule. The anterior ends of the two main portions are pointed, but towards the posterior end the liver is thicker and bluntly rounded. From this organ, when placed in spirit, escaped a very large quantity of a deep-salmon-coloured oil. In the ovaria there were very minute ova; but, as in all the other specimens hitherto examined, these were unimpregnated, as the winter is evidently not their breeding-season.

The food in the stomach consisted of finely-comminuted matter, entirely structureless under the microscope. In the œsophagus a gelatinous glairy fluid was found, mingled with a quantity of very fine grey sand. It is probable, therefore, that *Regalecus* finds its food in the minute animal forms, or *débris*, among the fine sand at the bottom of still deep waters. It has no teeth.

As was found in the gigantic skate recently thrown on the Sumner coast, this *Regalecus* was infested to an extraordinary degree with intestinal worms, thousands extruding themselves from the liver as it lay on the table. They were found in the œsophagus also. Perhaps these fishes become infested during the winter season with these parasites, and in their desire to rid themselves it may be that they seek shallower water, and are thus thrown on our coasts by currents in a dying state.

Again following Professor Parker, I have given a table of measurements for easy comparison of *R. argenteus* with *R. grillii*, Lindroth (cf. Appendix B).

I have to record my thanks to Mr. Warnes and the syndicate exhibiting this fish for their extreme courtesy and good-nature in allowing myself and my assistant to intrude on their show whenever we desired in order to make the notes recorded above, and especially for their kindness in permitting us to remove the fish from its stand for the purpose of obtaining a photograph of it. I am indebted also to Mr. Sparks, the taxidermist of the Museum, for his help and care in taking the measurements.

Appendix A.

—	New Brighton.	Moeraki.	Otago Harbour.	Okain's Bay.	Victorian.
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.
Total length	12 5	12 6	{ [17 0] / 11 0 }	18 10	13 7
Greatest height of body ..	0 13·5	0 15·25	0 12·1	0 14·5	0 7·25
Length of head (jaws retracted)	0 7·75	0 9·0	0 9·5	0 8·125	0 7·5
Distance between snout and anus	4 11	5 6	4 9·5	5 4·125	..
Proportion of height to length	1 : 11	1 : 10	1 : 11	1 : 15·6	1 : 23
Proportion of length of head to total length	1 : 19	1 : 17	1 : 14	1 : 27·35	1 : 22
Proportion of pre-anal region (= head + trunk) to total length	1 : 2·5	1 : 2·27	1 : 2·29	1 : 3·36	..
Total number dorsal-fin rays ..	232 [9+223]	205 [14+191]	189 (?) [14+175]	422 [14 + { 221 / 17(?)* / 170 }]	423 [17+406]

* Gap.

Appendix B.

—	Moeraki.	Otago.	New Brighton.	Okain's Bay.	Victorian.
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.
Total length (jaws retracted)	12 6	11 0	12 5	18 10	13 7
Length of head (jaws retracted)	0 9	0 9·5	0 7·75	0 8·125	0 7·50
Length of head (jaws protruded)	0 11	..	..	0 11·75	..
Height of head through centre of eye	0 9	..	..	0 8·25	..
Height of body at post. ext. oper.	0 11	..	..	0 10·5	..
Height of body 2ft. from head	1 2·5	..	..	1 1·5	..
Height of body 4ft. from head (greatest)	1 3·25	1 0	1 1·75	1 2·5	0 7·25
Height of body 5ft. 6in. from head (level of anus)	1 2·5	1 1·25	..	1 1·625	..
Distance of anus from post. ext. oper.	..	..	..	4 8	..
Distance of anus from snout ..	5 6·0	4 9·5	4 11	5 4·125	..
Height of body 4ft. from tail	0 11·25	..	..	0 5·75	..
Height of body 2ft. from tail	0 9	..	..	0 3·875	..
Thickness of body 3ft. 2in. from head	0 3·5	..	..	?0 3·0*	..
Thickness of body 5ft. 11in. from head	0 3·0	..	..	?0 2·0	..
Thickness of body 9ft. from head	0 2·0	..	..	?0 1·5	..
Diameter of iris	0 1·35	..	..	0 1·375	..
Diameter of pupil	0 0·5	..	..	0 0·562	..
Length 1st dorsal	1 5·5	..	..	0 1·375	..
Length 7th dorsal	1 5·5	..	..	0 1·125	..
Length 9th dorsal	1 3·5	..	..	0 1·75	..
Height of 2nd dorsal fin ..	0 2·25–3	..	..	0 2·0	..
Length of pectoral fin ..	0 3·0	..	..	0 1·75†	..
Base of pectoral fin ..	0 1·25	..	..	0 1·375	..
Length of ventral fin ..	3 1·0	..	..	3 5·25	..

* Approximate. † Broken.

Art. XI.—*On some Points in the Anatomy of a Species of Sea-bear caught off Sumner, Canterbury, New Zealand; with Notes on the New Zealand Eared Seals. (Abstract.)*

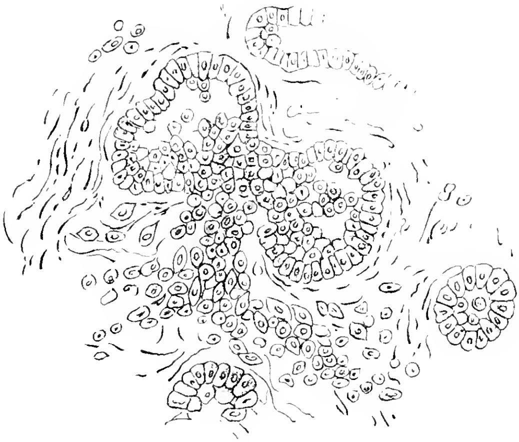
By H. O. Forbes.

Communicated by J. T. Meeson, B.A.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1891.*]

In this paper (which will be published *in extenso* in a future volume, when the necessary drawings—which, for want of a competent artist, are not yet completed—are prepared) the author gives an account of his dissection of a specimen of *Arctocephalus forsteri*, presented to the Museum by the proprietor of the Heathcote Hotel. It had been caught in 1890 off Sumner, and since then, till its death in July, it had lived in captivity. The anatomy of so few species of the eared seals is known that every addition to our knowledge cannot but assist in reducing to something like fixity the extraordinary diversity of opinion and of classification that exists at present with regard to the Australasian Otaries. The present communication deals chiefly with the anatomy of the viscera and brain. The preparation of a catalogue of the New Zealand collections in the Museum, and the determination of the subject of these notes, has necessitated an examination and comparison of the specimens in the collection there. Here the greatest confusion in the species was found, unmistakable hair-seals being identified as fur-seals. The author is inclined to agree with the classification of the seals by Sir W. Turner, in his monograph in vol. xxvi. of "The Scientific Results of the Voyage of H.M.S. 'Challenger,'" in preference to that advocated by Mr. Beddard, the present prosector of the Zoological Society of London. This anatomist, in his valuable paper in the Transactions of the Zoological Society, vol. xii., p. 379, suggests the inclusion of all the eared seals in two genera only—*Otaria* and *Arctocephalus*—including in *Otaria* only the single species *Otaria jubata*, a hair-seal, while all the remaining species would fall under the genus *Arctocephalus*. This arrangement would group together both hair-seals or sea-lions, and fur-seals or sea-bears. The different species of eared seals, with the exception of *Otaria jubata*, seem to agree so closely in their anatomical details that it is very difficult to state any differentiating characters. The character of their fur, however, appears to the author a mark so distinctive and discriminating that he prefers to follow the proposal of Sir W. Turner in dividing the remaining seals, after the separation of *Otaria jubata*, into sea-lions and sea-bears, assigning to the former the name of *Eumetopias*, and retaining for the latter the designation of *Arctocephalus*. Of the New Zealand seals the Auckland Island hair-seal would fall into the first, as *Eumetopias hookeri* (the males of which are at present incorrectly labelled in the Museum as *Otaria forsteri*), and the specimen common to our coasts as *Arctocephalus forsteri*; the species denominated under the name *cinereus*, or grey seal, being the female of *Arctocephalus forsteri*. Sir William Turner, in the monograph just referred to, includes under *Eumetopias* the species *cinerea*, of Peron, the grey sea-lion of New Zealand and Australia. "This hair-seal," he says, "was first noticed by Peron. . . . In a recent memoir, however, Mr. J. W. Clark (Proc. Z.S. Lond., 1884, p. 188) gives a careful description of the skins and more salient features of the skull of several specimens of the grey sea-lion from the Seal Rocks, near Port Stephens, New South Wales, which animal he identifies with the *Otaria cinerea* of Peron." On consulting Mr. Clark's paper, one is surprised to discover that he is dealing with four stuffed specimens, *all with underfur* (Peron's seal being undoubtedly a hair-seal), with a not quite full-grown skeleton, and a skin and a skull of an animal of about the same age which had been taken at the same time and place as those of the four stuffed specimens. From the descriptions given by Mr. Clark, the author of the present paper is convinced that they all belong to the same species as the New Zealand fur-seal (*Arctocephalus forsteri*, Lesson), for they cannot be Peron's *cinerea*, inasmuch as it was a hair-seal. There is at present no evidence that there is a grey hair-seal of New Zealand; and the author agrees with Mr. Allen, in his "History of the North American Pinnipeds," that it would be well, on account of the uncertainty of identifying the species Peron meant to apply that name to, to discard it altogether. The author is personally inclined to believe that Peron applied the term to a female of *Eumetopias hookeri*, which is grey or almost white in colour. In the New Zealand region, therefore, there are only two eared seals—one of them a hair-seal (*Eumetopias hookeri*), inhabiting the Auckland Islands, and, so far as the author can discover, never yet taken in New Zealand; and a fur-seal (*Arctocephalus forsteri*), which is common on both coasts of the South Island, frequents the Chatham Islands, and inhabits also the Seal Rocks, near Port Stephens, New South Wales, but unrecorded (so far as the author knows) from the Auckland Islands with any certainty. The great confusion among the species has arisen from the marked difference existing between the young at different ages and different seasons, and between the sexes, in their external appearance, and the great changes that take place in their bony framework from youth to adult life and in old age. The same species has been described by a different name under each of these conditions, and it is matter for little surprise that the synonymy of the various species is as confused as it well can be, and is a study in itself to unravel.

The sea-leopard (*Ogmarinus leptonyx*), so common on our shores, is not an eared seal—that is, it has no *external* ears—and is placed in a distinct family—the Phocidæ—of the fin-footed carnivorous animals, and is the third and remaining species of seal belonging to the New Zealand fauna.



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1.

J.H.S. del. CANCER IN FISH. C.H.P. lith.

ART. XII.—*Note on the Occurrence of Cancer in Fish.*

By Professor SCOTT.

[*Read before the Otago Institute, 9th June, 1891.*]

Plate XVIII.

THE fish afflicted with this disease were all specimens of the American brook-trout (*Salmo fontinalis*) kept in confinement in one of the ponds at Opoho belonging to the Dunedin Acclimatisation Society. Males and females were alike affected, and the diseased fish never recovered. Through the kindness of Mr. Deans, the manager, I was able to examine several specimens showing the disease in various stages of advancement, and the following is a short account of the naked-eye and microscopic appearances of the growth.

In the earliest stages the ventral wall of the pharynx in the middle line, a short distance behind the tongue, is seen to be somewhat roughened, and raised in low irregular swellings. At this stage nothing is to be seen unless the mouth is opened widely. As the tumour grows, however, not only does it involve more and more of the pharyngeal floor, spreading also to a slight extent laterally, and involving the ventral ends of the gill-arches, but it ultimately shows itself externally as a rounded pink lump on the isthmus in the angle between the diverging branchiostegal rays.

A microscopic section of the tumour shows all the stages in the development of a carcinomatous growth. In parts a purely glandular structure is seen—the glands apparently of the acino-tubular type. Elsewhere, owing to proliferation of the cells, the gland acini have become distended and irregular in form (adenoma stage), while in large areas these over-distended acini have, as it were, burst, and the liberated cells, making their way into the stroma, infiltrate it, and all gland-structure is lost (carcinoma stage).

Of the two figures which accompany this note, the first (Pl. XVIII., fig. 1) shows the floor of the mouth and pharynx, as seen from above, of a fish suffering from the disease. The nodular character of the tumour is clearly seen. The second shows a small portion of a section as seen under the microscope. A distended acinus is seen liberating a stream of cells into the gland stroma (fig. 2).

The occurrence of cancer in the lower animals has been frequently noted of late years, and it is by no means so rare among them as it was at one time thought to be. I have, however, been unable to find any mention of its having been noted in fish.

Art. XIII.—*Notes on Sea-fishes.*

By Geo. M. Thomson, F.L.S.

[*Read before the Otago Institute, 10th November, 1891.*]

The late Mr. W. Arthur, a former member and president of this Institute, when secretary of the Otago Acclimatisation Society, prepared a somewhat elaborate form, which he supplied to a few enthusiastic friends and correspondents, such as the late Captain Hayward of Catlin's River, Mr. Sutherland of Milford Sound, and others, in which he got them to record all the fish caught by them, with sundry particulars as to contents of stomach, condition of ova, &c. On his death, all his papers dealing with this subject were handed over to me, as I had shown some little interest in the work, and had made a few suggestions which Mr. Arthur thought worthy of adoption. It seemed to me advisable to widen, if possible, the scope of these observations, and with this object in view I wrote to Mr. Lewis H. Wilson, of the Marine Department, a gentleman who takes much interest in the sea-fish of this colony, and asked his co-operation. Mr. Wilson obtained printed forms drawn up somewhat on the lines of those prepared by Mr. Arthur, and issued them, through the department, to all the principal lighthouse-keepers on the coast. These forms have been filled in more or less regularly for some years past—many necessarily in a very perfunctory way—and duplicates have been forwarded to me. From these the following notes have been compiled and condensed. A considerable proportion of the returns sent in contain no new information whatever. On the other hand, some of the recorders have undoubtedly been stimulated to exercise their observational powers to a gratifying extent, and there can be little doubt that in time, and with better direction,—which I hope will be forthcoming,—we shall obtain from the lighthouse-keepers of this coast—one of the most intelligent bodies of men in the public service—a mass of observations which will prove to be of very considerable scientific value. Already I have obtained from some of these correspondents many species of Crustacea (fish-parasites and others) which I could hardly have got in any other way.

The returns tabulated by me in this paper, including those obtained by Mr. Arthur, cover a period extending from 1884 to the present time. Their examination and summarisation have produced only a very small addition to our existing knowledge—an amount, indeed, which may seem out of all proportion to the work involved; but if this paper is thought worthy of publication, and if copies of it are distributed to those who have aided in accumulating the material dealt with, I have little doubt it will stimulate many to fresh exertion.

The public at large do not know much about the fishes of our coast, except as far as the commonest kinds only are concerned. They cannot even name the majority of them. This is seen in the returns examined by me, where in several cases wrong names or unknown names are given, so that I cannot identify them, and have had to reject the observations. It is quite evident that the people require to be educated in regard to the asset this country possesses in her fishes. And it is by headmark, and not by any amount of scientific description, that this will be best done. The most satisfactory mode would be to issue large-sized drawings, accurately printed in colours, in the best style of art, with brief accompanying letterpress, and distribute these among schools in the coast districts, to lighthouses, pilot-stations, &c., as well as selling them to the public at as low a figure as possible. The expenditure incurred by such a publication would be recouped to the country in many ways.

The following is a list of the localities from which fish have been recorded. Those which are not lighthouses are marked with an asterisk. It must be borne in mind, in going over such a list, that, situated as most of the lighthouses are on rocky promontories or islands, the conditions are not often favourable for fishing, even from the shore, and still less often for boat fishing. Hence in some cases the number of fish recorded as taken is very small:—

1. *Cape Maria van Diemen.*—Kahawai, snapper, moki, trevally, king-fish (haku or yellowtail), rock-cod.

2. *Mokohinou Islands.*—Hapuku (or groper), kahawai, snapper, hiwihiwi, *Scorpæna bynoensis*, barracouta, trevally, maomao, rock-cod, spotty, parrot-fish, *Cymolutus sandageri*, leather-jacket (*Monacanthus*), korokoro-pounamou.

3. *Tiritiri (Auckland).*—Snapper.

4. *Bean Rock (Auckland).*—Kahawai, snapper, king-fish, conger-eel.

5. *Ponui Passage.*—Kahawai, snapper, king-fish, mullet (kanae), dog-fish, stingaree.

6. *Cuvier Island.*—Hapuku, snapper.

7. *Portland Island.*—Hapuku, kahawai, snapper, tarakihi, moki, frost-fish, barracouta, trevally, king-fish, john-dory, warehou, maomao, parrot-fish, flying-fish, smooth-hound, soldier-fish (?).

8. *Pencarrow Head.*—Butter-fish (kelp-fish).

9. *Somes Island (Wellington).*—Rock-cod.

10. *Kaipara Heads.*—Snapper, frost-fish.

11. *Manukau Heads.*—Kahawai, snapper, king-fish, mullet (kanae).

12. *The Brothers (Cook Strait).*—Hapuku, moki, rock-cod, spotty, butter-fish, red-cod, conger-eel.

13. *French Pass.*—Snapper, moki, barracouta, king-fish, rock-cod.

14. *Cape Campbell.*—Hapuku, kahawai, rock-cod.

15. *Akaroa Heads.*—Rock-cod.

16. *Moeraki.*—Hapuku, frost-fish, barracouta, rock-cod, gurnard, parrot-fish, butter-fish, red-cod, sprats, conger-eel.

17. *Taiaroa Head.*—Trumpeter, moki, pig-fish, frost-fish, rock-cod, Maori chief, butter-fish, red-cod, ling, flounder.

18. *Cape Saunders.*—Hapuku, trumpeter, barracouta, rock-cod, Maori chief, parrot-fish, butter-fish, red-cod, skate.

19. *Nuggets Point.*—Hapuku, rock-cod, red-cod, skate.

20. **Catlin's River.*—Kahawai, moki, mullet (sea), butter-fish, flounders, sole, sardines, eels.

21. *Waipapapa Point.*—Hapuku, kahawai, trumpeter, moki, rock-cod, red-cod, flounders, Forster's brill (?), soles, herrings, conger-eels, skate.

22. *Dog Island.*—Hapuku, tarakihi, trumpeter, moki, barracouta, rock-cod, butter-fish, red-cod, conger-eel, skate.

23. *Centre Island.*—Hapuku, trumpeter, moki, rock-cod, butter-fish, red-cod, conger-eel.

24. *Puysegur Point.*—Hapuku, kahawai, trumpeter, moki, pig-fish, trevally, rock-cod, perch, butter-fish, red-cod, dog-fish.

25. **Caswell Sound.*—John-dory, rock-cod.

26. **George Sound.* — Tarakihi, john-dory, rock-cod, flounder.

27. **Bligh Sound.*—Tarakihi, trumpeter, barracouta, john-dory, rock-cod, wrasse, butter-fish, flounder.

28. **Poison Bay.*—Hapuku, tarakihi, moki, blue-cod, gurnard.

29. **Milford Sound.*—Hapuku, tarakihi, trumpeter, moki, barracouta, horse-mackerel, john-dory, rock-cod, gurnard, mullet, wrasse, butter-fish, red-cod, *Macrurus australis*, flounder, pilchard.

30. **Martin's Bay.*—Hapuku, tarakihi, moki.

The following list of the fishes recorded in these returns summarises as far as possible their distribution, food, state of reproductive organs, &c. :—

1. Hapuku, or Groper (*Oligorus gigas*).

Number of Fish recorded and reported on.—141.

Localities where taken.—Mokohinou, Cuvier Island, Portland Island, the Brothers, Cape Campbell, Moeraki, Cape Saunders, Nuggets Point, Waipapapa, Dog Island, Centre Island, Puysegur Point, Poison Bay, Milford Sound.

Dates of Capture.—Every month of the year.

Weight of Fish taken.—Average, 40lb. to 45lb.; largest recorded, 122lb., taken at the Brothers, Cook Strait.

Food.—In almost every case the stomachs were found to contain various kinds of fish, as "red-cod," "herrings," "sprats," "sardines," "garfish," and "rock-cod." In a few instances "crayfish" and "shellfish" are reported.

Reproduction.—The observations on this head are quite contradictory. Some are recorded as containing "ripe" ova in January, April, May, June, July, and December; as "near ripe" in June; as "well advanced" in May; as "full of ova" in March. Others, however, are recorded as "unripe" in the very same months.

2. KAHAWAI (*Arripis salar*).

Number of Fish recorded.—101.

Localities.—Cape Maria van Diemen, Mokohinou, Bean Rock, Ponui Passage, Portland Island, Manukau Heads, Cape Campbell, Catlin's River, Waipapapa Point, Puysegur Point.

Dates.—Taken every month of the year.

Weights.—Average, 3lb.; largest recorded, 16lb., from Cape Maria van Diemen.

Food.—"Small fish" is the most frequently recorded; but "mussels," "pipi," "shellfish," "crayfish," "shrimps," and "kelp" are also stated as being found in the stomachs.

Reproduction.—Specimens taken at Cape Campbell and the Bean Rock are reported as "ripe" in January and February, while the large fish taken at Cape Maria in March are stated to have been "full of roe."

3. SNAPPER (*Pagrus unicolor*).

Number of Fish recorded.—510.

Localities.—Cape Maria, Mokohinou, Tiritiri, Bean Rock, Ponui Passage, Cuvier Island, Portland Island, Kaipara Heads, Manukau Heads, French Pass.

Date of Capture.—Every month of the year.

Weights.—Average, 3½lb.; largest recorded, 20lb., from Portland Island.

Food.—"Shellfish" is the most common record (sometimes "mussels" or "barnacles"); but Crustacea ("crayfish," "crabs," and "shrimps") are almost as numerous. Less frequently we have "small fish;" while other records give "Hippocampus," "Medusæ," "jelly-fish," "young octopus," and "sea-eggs" (?). In several instances a quantity of sand was present in the stomach.

Reproduction.—In the majority of the records the ova are stated to be "ripe" from November to February.

4. Hiwihiwi (*Chironemus fergussoni*).

This fish is only once recorded, a single specimen having been taken at Mokohinou in September, 1887. The stomach contained "Algæ and crabs."

It is more than likely that the fish was taken elsewhere in the North Island; but, not being known, it has not been recorded.

5. Tarakihi (*Chilodactylus macropterus*).

Number of Fish recorded.—108.

Localities.—Portland Island, Dog Island, George Sound, Bligh Sound, Poison Bay, Milford Sound, Martin's Bay.

Date of Capture.—Every month of the year.

Weights.—Average, 2½lb.; largest recorded, 9lb., from coast north of Milford Sound. Mr. Sutherland, however, states, "I have got them up to 18lb. in weight."

Food.—"Shellfish" is the record in the great majority of cases. Occasionally the food-material is stated to consist of "fish," "seaweed," "Crustacea," "squids," and "sand-worms."

Reproduction.—Only one entry of "ripe" occurs in January. Other entries give "unripe" during the months of March, May, June, and November. Apparently the observers were not well able to make out the reproductive organs in this species.

6. Trumpeter (*Latris hecateia*).

Number of Fish recorded.—573 (often, however, reported as occurring in enormous quantities).

Localities.—Taiaroa Head, Cape Saunders, Waipapapa Point, Dog Island, Centre Island, Puysegur Point, Bligh Sound, Milford Sound.

Dates of Capture.—Every month of the year.

Weights.—Average, 6lb.; largest recorded, 11lb., from Milford Sound.

Food.—In a large number of cases the entries under this head are "gravel," "sand," or "empty." In two or three instances we have "fish," "weed," and "crayfish."

Reproduction.—Hardly any observations on the condition of the ova are made. The probability is that all the fish taken were young and sexually immature. I believe that fish under 15lb. weight are seldom found with fully-formed ova, and such large fish are only found in deep water.

7. Moki (*Latris ciliaris*).

Number of Fish recorded.—711.

Localities.—Cape Maria van Diemen (only a single specimen), Portland Island, the Brothers, French Pass, Taiaroa

Head, Catlin's River, Waipapapa Point, Dog Island, Centre Island, Puysegur Point (very abundant), Poison Bay, Martin's Bay.

Dates when caught.—Every month of the year.

Weight.—Average, 4lb.; largest recorded, 15lb., at the Brothers.

Food.—Crustacea (crabs, whale-feed. sea-lice, &c.) form the most common food of this fish. But nearly as many entries of "seaweed" occur, as if it was the habit of the fish to grub closely along the kelp-covered rocks. "Shells," "sand-worms," "fish," and "mussels" are the only other food-materials recorded. In about one-third of the fish examined the stomachs were empty, or contained a little gravel or fine sand.

Reproduction.—Very few notes occur on this point, and they are contradictory. Some record them as containing ripe ova in December and January; but others give them as unripe during the same months. One entry gives them as "ripe" in August; another gives "a few ripe" in May.

8. *Scorpæna bynoensis.*

This fish is given as occurring at Mokohinou, where three examples were taken by Mr. Sandager in the month of September, 1887 and 1888. The weight of one is given as $2\frac{1}{2}$lb. The entries under the head "Contents of stomach" are "fish," "crab," and "empty."

9. PIG-FISH (*Agriopus leucopœcilus*).

This is called "leather-jacket" in Dunedin, where the fish occurs in immense numbers. It is only recorded from Taiaroa Head, in the month of October (twelve examples, averaging $\frac{1}{4}$lb. each), and from Puysegur Point, where three specimens, ranging from $\frac{3}{4}$lb. to $1\frac{1}{2}$lb. in weight, were taken in November and January. The stomachs were either empty or contained a little gravel.

10. FROST-FISH (*Lepidopus caudatus*).

Number of Fish recorded.—31.

Localities.—Portland Island, Kaipara Heads, Moeraki, Taiaroa Head.

Dates.—May to August (all taken on the beaches).

Weight.—Average, 4lb.; largest, 6lb.

Food.—Mr. Johnson records one fish taken at Moeraki as having the stomach full of sprats, and as some of these were perfect he infers that they had evidently been caught by the frost-fish just before it was stranded. No other reports are made as to food.

Reproduction.—No observations.

11. Barracouta (*Thyrsites atun*).

Number of Fish recorded.—39.

Localities.—Mokohinou, Portland Island, French Pass, Moeraki, Cape Saunders, Dog Island, Bligh Sound, Milford Sound.

Dates.—January to October.

Weight.—Average, 5lb.; largest recorded, 8lb.

Food.—In every case but one the stomachs contained small fish (herrings, sprats, mullet, trevally, &c.). One opened at Dog Island contained shellfish and crabs.

Reproduction.—The record is unsatisfactory. One fish taken at Mokohinou in September was said to contain "ripe" ova, and others taken in January in Milford Sound were also ripe. The late Captain Hayward, of Catlin's River, was of opinion that this species spawned twice a year, but I do not know on what data his conclusions were based.

12. Horse-mackerel (*Trachurus trachurus*).

Number of Fish recorded.—49 (examined), but immense numbers stranded on the beaches.

Locality.—Milford Sound.

Date.—November to January, but seen in the sound for the greater part of the year.

Weight.—Average, 2lb.; largest, 4lb.

Food.—In nearly every instance the stomachs contained pilchards, and it was in pursuit of these fish that the horse-mackerel got ashore in such numbers. Some caught in November contained shellfish.

Reproduction.—Some of the large fish taken in January contained "ripe" ova.

13. Trevally (*Caranx georgianus*).

Number of Fish recorded.—60.

Localities.—Cape Maria van Diemen, Mokohinou, Portland Island, Puysegur Point.

Dates.—All the months except March, May, June, and July.

Weight.—Average, 3lb.; largest recorded, 6lb., at Cape Maria.

Food.—Crustacea (crayfish, crabs, whale-feed, and shrimps), small fish, shellfish (chiefly mussels), and in one instance squids.

Reproduction.—One entry under this head gives "Full of roe" in November. Two others give "No ova" and "Unripe" in October and December respectively.

14. KING-FISH, or HAKU (*Seriola lalandii*), sometimes also called YELLOW-TAIL.

Number of Fish recorded.—7.
Localities.—Cape Maria van Diemen, Bean Rock, Ponui Passage, Portland Island, Manukau Heads (where it is reported as occurring very plentifully in the month of January).
Dates.—November, December, January, March, and April.
Weight.—Average, 10½lb.; largest recorded, 30lb., at French Pass.
Food.—Fish and shellfish.
Reproduction.—The only record is in the month of April, "No ova."

15. JOHN-DORY (*Zeus faber*).

Number of Fish recorded.—270.
Localities.—Caswell, George, Bligh, and Milford Sounds.
Dates.—Every month except February and April.
Weight.—Average, 1lb.; largest recorded, 6lb., at Milford Sound.
Food.—Fish, shellfish, and seaweed.
Reproduction.—Several recorded as "ripe" in November and December; others as "unripe" in March, May, June, and July.

16. WAREHOU (*Neptonemus brama*).

Number of Fish recorded.—59.
Locality.—Portland Island.
Dates.—August and September.
Weight.—Average, 6lb.; largest recorded, 8lb.
Food.—Crayfish and small fish.
Reproduction.—28 recorded as "near ripe" in August; 1 as "ripe" in September.

17. MAOMAO (*Ditrema violacea*).

Number of Fish recorded.—85.
Localities.—Mokohinou and Portland Island.
Dates.—August, September, October, November, December, and February.
Weight.—Average, 1½lb.; largest, 2lb.
Food.—Crustacea (chiefly crayfish), small fish, shellfish, seaweed, Medusæ, and squids.
Reproduction.—Several stated to be "unripe" in October, November, and December.

18. ROCK-COD, or BLUE-COD (*Percis colias*).

Number of Fish recorded.—6,286.
Localities.—Reported from all the stations except the following (which are the localities from which the most im-

perfect returns have come in): Tiritiri, Bean Rock, Ponui Passage, Cuvier Island, Pencarrow Head, Manukau Heads, Kaipara.

Dates.—Every month of the year.

Weight.—Average, 1¾lb.; largest recorded, 7¼lb., from Puysegur Point.

Food.—Small fish, shellfish, Crustacea, seaweed, worms, octopus, and starfish. Several entries give gravel or mud as the contents of the stomach. The fish seem to graze along the rocks for part of their food, eating seaweed, corallines, &c., along with the molluscs, worms, and Crustacea which take refuge among them.

Reproduction.—The returns in regard to these fish are much more satisfactory than in any other case, for, while the entry "Unripe" occurs under every month of the year, it refers almost always to small fish only in the summer months. The larger fish appear to mature their ova from September to January, but by far the largest number in November, December, and January. In several cases the entry "Spawning" occurs in the two last months of the year, while by February nearly all the female fish are recorded as having no ova.

[NOTE.—From Cape Maria van Diemen a number of fish termed "blue-fish" are recorded. The same returns also record rock-cod. I am quite unable to suggest what fish is meant by "blue-fish," unless, indeed, the observer has used the names indiscriminately. These fish were very numerous, were taken during every month of the year, and fed chiefly on mussel, but occasionally on small fish. They weighed from 1lb. to 2lb. each.]

19. MAORI CHIEF (*Notothenia coriiceps*).

Number of Fish recorded.—8.

Localities.—Taiaroa Head, Cape Saunders.

Dates.—August, September, and October.

Weight.—Average, 3lb.; largest recorded, 4lb.

Food.—Seaweed; in one instance the stomach contained also small fish.

Reproduction.—In six fish the ova were "ripe," or nearly so, in August.

20. GURNARD (*Trigla kumu*).

Number of Fish recorded.—14.

Localities.—Moeraki, Poison Bay, Milford Sound.

Dates.—March, August, and October.

Weight.—Average, 1lb.; largest recorded, 3lb., at Milford Sound.

Food.—Shellfish in every case.

Reproduction.—Not recorded.

21. MULLET, or KANAE (*Mugil perusii*).

Number of Fish recorded.—93.

Localities.—Ponui Passage, Manukau Heads.

Dates.—June, August, November.

Weight.—Average, 2lb.; largest recorded, 4lb.

Food.—In every case the stomachs contained either "blackish matter" or "slimy sand."

Reproduction.—Not recorded.

22. SEA-MULLET (*Agonostoma forsteri*).

Such numbers of these fish were taken from time to time by netting that no attempt was in many cases made to state them in figures: they amount to several thousands.

Localities.—Catlin's River, Milford Sound.

Dates.—January, February, March, July, December.

Weight.—Average size, about 9in. long; the largest recorded weighed 1½lb.

Food.—*Reproduction.*—No entries occur under these heads.

23. PERCH (*Labrichthys celidota*).

Only one example of this fish was recorded, from Puysegur Point. It was taken in June, and weighed 3lb. Its stomach contained small fish.

24. WRASSE, or SPOTTY (*Labrichthys bothryocosmus*).

Number of Fish recorded.—36.

Localities.—Mokohinou, the Brothers, Bligh Sound, Milford Sound.

Dates.—Every month except January, February, April, and December.

Weight.—Average, under 1lb.; largest recorded, 3lb., at Milford Sound.

Food.—Seaweed, fish, shellfish, and Crustacea.

Reproduction.—One record gives "spawning" in September; the others are negative.

25. PARROT-FISH (*Labrichthys psittacula*).

Number of Fish recorded.—12.

Localities.—Mokohinou, Portland Island, Moeraki, Cape Saunders.

Dates.—March, August, September, November, and December.

Weight.—Average, 1lb.

Food.—Crustacea, shellfish (mussels, &c.), and seaweed.

Reproduction.—"Nearly ripe," September and November.

26. Butter-fish, or Kelp-fish (*Coridodax pullus*).

Number of Fish recorded.—365.

Localities.—Pencarrow Head, the Brothers, Moeraki, Taiaroa Head, Cape Saunders, Catlin's River, Dog Island, Centre Island, Puysegur Point (where it is almost the only fish recorded), Bligh Sound, Milford Sound.

Dates.—Every month in the year.

Weight.—Average, 2lb.; largest recorded, 7¼lb., at Dog Island.

Food.—By far the commonest material found in the stomachs of these fishes was "seaweeds." Occasionally "small shellfish," "small mussels," "small barnacles," fish, small crabs, and "gravel" are recorded.

Reproduction.—The most of the observations give the ova as ripe from August to January. A single record from Dog Island gives May and June for the maturation of the ova, and one from Puysegur Point throws it on to February.

27. *Cymolotus sandageri.*

Only two specimens of this fish are recorded, both taken at Mokohinou, in August, 1887. The stomach of one contained Crustacea; the other was empty.

28. Hake (*Lotella rhacinus*).

Only one specimen recorded, from Mokohinou, in August, 1887. Its weight was 2lb., and its stomach contained small fish.

29. Red-cod (*Lotella bacchus*).

Number of Fish recorded.—372.

Localities.—The Brothers, Moeraki, Taiaroa Head, Cape Saunders, Nuggets Point, Waipapapa Point, Dog Island, Centre Island, Puysegur Point, Milford Sound.

Dates.—Every month except January, March, and May.

Weight.—Average, 4lb.; largest recorded, 12lb., at Taiaroa Head.

Food.—Small fish, with occasionally crabs or other Crustacea, shellfish, or seaweed.

Reproduction.—The returns are not very definite, but the ova appear to be maturing in August and September, and to be ripe in October or November. Probably the immense shoals of this fish which visit Otago Harbour in November come for the purpose of depositing their ova.

30. Ling (*Genypterus blacodes*).

Number of Fish recorded—6.

Localities.—Taiaroa Head, Milford Sound.

Dates.—January, April, June, July, and October.

Weight.—Average, 17lb.; largest recorded, 26lb.

Food.—Fish: in one instance a red-cod was found in the stomach.

Reproduction.—No record.

31. *Macrurus australis.*

Five specimens of this fish were washed up on the beach at the head of Milford Sound, and were dried by Mr. Sutherland. The identification was made from the dried examples, and is therefore very doubtful. They were only 2½in. to 3in. long.

32. FLOUNDER OF PATIKI (*Rhombosolea monopus*).

Probably the yellow-belly (*R. leporina*) is included among the returns.

Number of Fish recorded.—1,490.

Localities.—Taiaroa Head, Catlin's River, Waipapapa Point, George Sound, Bligh Sound, Milford Sound.

Dates.—Every month except August and September.

Weight.—Average, 1¼lb.; largest recorded, 4lb., at Waipapapa Point.

Food.—Small fish, Crustacea, shellfish, or seaweed. Frequently the stomachs contained muddy material.

Reproduction.—From the few observations recorded, the ova seem to mature in January and February, and the fish to spawn in March.

33. SOLE (*Peltorhamphus novæ-zealandiæ*).

Number of Fish recorded.—77.

Localities.—Catlin's River, Waipapapa Point.

Dates.—December, January, February, March, and May.

Weight.—Average, 1½lb.; largest, 2lb.

Food.—Crustacea or "muddy material."

Reproduction.—Only one definite observation occurs under this head; a number of fish taken in March being either "spawned" or containing ripe ova.

34. FLYING-FISH (*Exocœtus speculiger ?*).

A single specimen, weighing 2lb., was picked up on the beach at Portland Island in December, 1887.

35. PILCHARD, OR SARDINE (*Clupea sagax*).

36. SPRAT (*Clupea sprattus*).

The recorders were mostly unable to distinguish between these species. They are only noted from Moeraki, Catlin's River, Waipapapa Point, and Milford Sound, but at these localities they occurred at certain seasons in enormous quantities. From Moeraki they are only reported as occurring in March "in enormous abundance." In Catlin's River estuary they were found in numbers in the rock-pools in June, the larger ones with the ova well advanced. From Waipapapa Point they are recorded by Mr. Ereeson as passing continuously through Foveaux Strait from November to April, usually pursued and driven ashore in great numbers by the mutton-birds. In January the ova were nearly ripe in many of the fish; while of those taken in April some were ripe and some spawned. In Milford Sound these fish are reported as occurring all the year round, being frequently driven ashore by cow-fish and other enemies. Their abundance is testified by entries like the following: "December, 1885: Tons of pilchards thrown up on the beaches at the end of this month." Fish taken in October had the ova nearly ripe, while for two years in succession they were found to be spawning during November and December.

37. Conger-eel (*Conger vulgaris*).

Number of Fish recorded.—23.

Localities.—Bean Rock, the Brothers, Moeraki, Waipapapa, Dog Island, Centre Island, Milford Sound.

Dates.—All the year round.

Weight.—Average, 19lb.; largest recorded, 37lb., from Waipapapa Point.

Food. — Fish, Crustacea, shellfish, octopus, and seaweeds.

Reproduction.—All observations under this head were negative.

38. Leather-jacket (*Monacanthus convexirostris*).

Only recorded from Mokohinou, where seven specimens were obtained during the month of September in two successive years. In every case they contained ripe ova, and seem to have approached the coast to spawn. The average weight was 1½lb., and the food consisted of Crustacea and corallines.

39. Skate (*Raja nasuta*).

Number of Fish recorded.—19.

Localities. — Cape Saunders, the Nuggets, Waipapapa Point, Dog Island.

Dates.—February, March, April, and May.

Weights.—Average, 14lb.; largest recorded, 20lb.

Food.—Crayfish, crabs, shellfish, and young cod.

Reproduction.—The ova were ripe in several fish from February to May. It would seem that the fish come into shallow water to spawn during those months.

40. STINGAREE (*Trygon thalassia ?*).

Only one specimen recorded, from Ponui Passage, in July. It was a mature female, full of ova, and weighed 20lb. The stomach was empty.

In addition to the above-named forty species of fish, the returns give the capture of numerous sharks, dog-fishes, and smooth-hounds from Puysegur Point, Portland Island, and Ponui Passage, but the identification of the species is not always possible. Well-developed embryos were found in fish taken in all the months from August to December. The fish varied in weight from 18lb. to 90lb. each.

From Portland Island a fish called "soldier-fish" is recorded, fourteen specimens having been taken in the months of May, June, August, and October. They weighed from 1lb. to 1½lb. each, and their stomachs contained fish or shellfish. No ova were found in any of them. I do not know what species is referred to under this name.*

Again, from Mokohinou Mr. Sandager records, in September, 1888, the capture of a fish which he calls "korokoropounamou." The specimen weighed 6lb., and contained Medusæ in the stomach. I do not know what fish is referred to.

I have made no attempt to draw any conclusions from the facts summarised in this paper. It seems to me sufficient in such a preliminary notice merely to state them. Several species will be found to have their range extended along the coast. The food of many kinds is here recorded for the first time, and one or two notes on the time of reproduction are worthy of attention. I think that the examination and comparison of the results obtained at the different recording stations will prove of interest to all who have in the past kept such records, and may be the means of stimulating others to habits of observation.

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* In Dieffenbach's "New Zealand," vol. ii., p. 218, a fish is mentioned under the name *Julis miles* (*Labrus coccineus*, J. R. Forster, apud Schn.; *Labrus miles*, Bl. Schn., p. 264), "named the 'soldier' by the seamen who accompanied Cook on his second voyage." Perhaps this is the fish referred to.

Art. XIV.—*On New Species of* Lepidoptera.

By E. Meyrick, B.A., F.Z.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

I am again indebted to Mr. G. V. Hudson for the following additions to the New Zealand fauna; the specimens described were kindly presented by him to me, and of all he possesses other similar specimens; they were all taken in the neighbourhood of Wellington. I am glad to take this opportunity of expressing my sense of the services rendered by Mr. Hudson to entomological science, and my thanks for the generosity with which he has assisted me in obtaining material for the elucidation of the *Lepidoptera*.

MONOCTENIADÆ.

Dichromodes petrina, n. sp.

♂ ♀. 20mm. Head, palpi, antennæ, thorax, abdomen, and legs rather dark grey, irrorated with whitish-ochreous; palpi 3½, base ochreous-white; antennal pectinations of ♂ 5; posterior extremity of thorax ochreous-white. Forewings triangular, hindmargin straight above, rounded beneath; rather dark grey, densely irrorated with whitish-ochreous; veins partially suffusedly streaked with yellow-ochreous, more strongly in ♂; a small blackish-grey spot on base of costa; lines formed by absence of pale irroration, more blackish on costa, irregularly waved, first slightly curved, second slightly curved on upper half; a small cloudy transverse dark-grey discal spot; subterminal pale, obscure, irregularly waved: cilia grey, irrorated with whitish-ochreous. Hindwings with hindmargin rounded; grey, darker and ashy-tinged posteriorly traces of a pale waved line at ⅔; cilia grey, sprinkled with whitish-ochreous.

Two specimens.

SELIDOSEMIDÆ.

For reasons which I have explained elsewhere, it is necessary to substitute the generic name *Selidosema*, Hb., for *Boarmia*, Tr., and to alter the family name to correspond.

Selidosema aristarcha, n. sp.

♂. 37mm. Head, palpi, thorax, abdomen, and legs pale ochreous, back of crown and anterior part of thorax darker;

face whitish-tinged; palpi $2\frac{1}{4}$; abdomen and legs thinly sprinkled with dark fuscous. Antennæ whitish-ochreous, pectinations 12, apical $\frac{1}{6}$ simple. Forewings rather elongate-triangular, hindmargin almost straight; 10 connected with 9, 11 free; light yellowish-ochreous, irrorated between the veins with pale fuscous and in disc with white, veins deeper yellow-ochreous; a white transverse mark near base below middle, edged anteriorly with ochreous-fuscous; lines slender, rather cloudy, dark ochreous-fuscous; first rather strongly curved; median very slightly curved, space between this and first line suffused with white on lower $\frac{2}{3}$; second very obtusely angulated above middle, on lower half wholly confluent with median to form a narrow shade; a white suffusion before second line towards angle, in which is a transverse linear dark fuscous discal mark; subterminal remote from hindmargin, running from $\frac{4}{5}$ of costa to middle of inner margin, slender, dark fuscous, edged with clear white anteriorly except towards costa, twice sinuate; a clear white longitudinal dash from subterminal line at $\frac{1}{4}$ below costa to near hindmargin, beneath which is a broad ochreous-fuscous suffusion; spaces between veins below this suffusedly streaked with fuscous. Hindwings with hindmargin rounded, waved; pale ochreous; a slender curved fuscous line beyond middle, obsolete towards costa; a small fuscous spot towards anal angle.

One specimen. A handsome and striking species, allied to the group of *Productata*, but very distinct; Mr. Hudson says that it is not variable.

CRAMBIDÆ.

Orocrambus melampetrus, Meyr.

Mr. Hudson has sent me a specimen of a form in which the pale postmedian fascia is almost wholly obsolete, but I can detect no other difference, and do not consider it specifically distinct.

GRAPHOLITHIDÆ.

Lord Walsingham has been enabled to examine the neuration of the type of *Chiloides straminea*, Butl., in the British Museum, and has kindly acquainted me that it appears to be certainly only a form of the widespread *Bactra lanceolana*, Hb. Hence the New Zealand insect, which I wrongly identified with *Chiloides straminea*, requires a new generic name, as he agrees with me that the genus is a good one; *Chiloides* being sunk as a synonym of *Bactra*. I propose for it the name *Noteraula*. The specific name may be allowed to stand, but of course it must be quoted as *Noteraula straminea*, Meyr. (*nec* Butl.).

TORTRICIDÆ.

Pyrgotis plinthoglypta, n. sp.

♂. 16mm. Head and palpi light reddish-ochreous. Antennæ fuscous, ciliations 1. Thorax reddish-ochreous, with a curved dark fuscous mark above middle. Abdomen pale grey. Legs whitish, anterior pair and middle tibiæ dark grey above. Forewings elongate-triangular, costa gently arched, apex rounded, hindmargin rather strongly sinuate, oblique; pale fuscous-reddish, irregularly spotted with ochreous; markings deep ochreous, partially mixed with black and ferruginous; a streak from base of costa to middle of inner margin; a second from $\frac{1}{3}$ of costa to $\frac{3}{4}$ of inner margin; a third from costa immediately beyond second, suddenly bent round above middle, and terminating on costa at $\frac{4}{5}$, edged above from angle onwards by a snow-white streak attenuated posteriorly; a fourth from costa, immediately beyond termination of third, obliquely inwards to disc beyond middle, thence acutely angulated to middle of hindmargin, edged on apical side throughout by a clear white streak interrupted on each side of angle, included apical space ochreous, marked with black on hindmargin; two small leaden-grey spots between second and third streaks towards costa, and two others between third and fourth, lower of these larger; an ochreous streak along lower half of hindmargin, edged with black on margin: cilia ochreous, with a dark fuscous apical bar. Hindwings pale whitish-grey, suffusedly spotted with grey; cilia grey-whitish, round apex whitish-ochreous.

One specimen. Allied to *P. plagiatana*, but very distinct.

ŒCOPHORIDÆ.

Trachypepla hieropis, n. sp.

♂. 13mm. Head, palpi, and antennæ dark fuscous. Thorax snow-white, anterior margin dark fuscous. Abdomen grey. Legs dark fuscous, posterior pair grey-whitish. Forewings elongate, apex round-pointed, hindmargin extremely obliquely rounded; snow-white; base of costa blackish; a short dark-grey streak, narrowed anteriorly, along costa from $\frac{2}{5}$ to $\frac{2}{3}$; a dark-grey trapezoidal dorsal blotch, extending on inner margin from before middle to $\frac{4}{5}$, not reaching half across wing, upper anterior angle occupied by a brownish-tinged tuft; some grey scales indicating a streak from anal angle, reaching half across wing; a cloudy dark-grey elongate-triangular spot along hindmargin; an irregular black mark running round apex: cilia grey, mixed with white towards base. Hindwings rather dark grey; cilia grey.

One specimen. A distinct and elegant species, which may be placed next *T. galaxias*.

Semiocosma caustopa, n. sp.

♀. 28mm. Head light fuscous, mixed with fuscous-whitish. Palpi ochreous-whitish, second joint suffusedly mixed with dark fuscous, terminal joint with dark-fuscous sub-basal ring and median band. Antennae rather dark fuscous. Thorax dark fuscous mixed with fuscous-whitish. (Abdomen broken.) Legs dark fuscous, ringed with whitish; posterior tibiæ whitish. Forewings elongate, costa moderately arched, apex rounded, hindmargin almost straight, oblique; fuscous-whitish, suffusedly mixed with fuscous and dark fuscous, veins remaining pale posteriorly; a dark-fuscous basal patch, its outer edge angulated on discal tuft; a large dark fuscous trapezoidal blotch occupying whole of disc, posterior edge well defined, near and parallel to hindmargin, other edges suffused; a cloudy blackish dot in disc at $\frac{1}{3}$; a cloudy black longitudinal streak from middle of disc to near apex, upper edge forming a rounded projection before $\frac{2}{3}$ of disc, posterior extremity irregular, surrounded by fuscous suffusion: cilia fuscous, mixed with fuscous-whitish. Hindwings fuscous-whitish, posteriorly sprinkled with fuscous; cilia fuscous-whitish, suffusedly mixed with light fuscous.

One specimen. Allied to *S. apodoxa* and *S. platyptera*.

Semiocosma paraneura, n. sp.

♂ ♀. 17–18mm. Head and thorax grey irrorated with white, thorax mixed with blackish anteriorly. Palpi white, second joint irrorated with blackish, terminal joint with blackish median ring. Antennæ and abdomen grey. Legs dark grey, irrorated with white, apex of joints white. Forewings elongate, costa moderately arched, apex obtuse, hindmargin slightly rounded, oblique; vein 9 rising out of the stalk of 7 and 8; grey, finely irrorated with whitish-ochreous, and suffusedly mixed with white: a rather broad angulated white or whitish-ochreous band at $\frac{1}{4}$; about five irregular black dots arranged in an oval ring in disc, and sometimes additional scattered black scales; the white suffusion forms a cloudy angulated line from $\frac{2}{3}$ of costa to anal angle; some black scales tending to form dots on hindmargin and apical part of costa: cilia grey, irrorated with white. Hindwings grey; cilia grey-whitish, with a cloudy grey basal and faint subapical line.

Three specimens. An inconspicuous species, but not closely approaching any other. It differs from all others of the genus in having vein 9 of the forewings rising out of the stalk of 7 and 8, instead of separately; but, as it agrees in all other structural characters, it is neither necessary nor expedient to form a new genus for its reception.

TINEIDÆ.

Erechthias erebistis, n. sp.

♂. 12mm. Head, palpi, antennæ, thorax, abdomen, and legs dark fuscous. Forewings elongate-lanceolate; dark fuscous; scales in disc and posteriorly more blackish-fuscous, with fine fuscous-whitish tips; two or three scattered whitish scales towards costa before middle; a whitish dot on costa before apex, and another on hindmargin below apex: cilia dark grey, with two blackish lines (imperfect). Hindwings fuscous, becoming dark fuscous towards apex, thinly scaled and semitransparent on basal third; cilia dark grey, with indications of two black lines round apex.

One specimen. Although obscure, it cannot be confused with any other; it may be placed near *E. charadrota.*

Art. XV.—*Catalogue of the Described Species of New Zealand* Araneidæ.

By A. T. Urquhart, Corr. Mem. Royal Society of Tasmania.

[*Read before the Auckland Institute, 2nd November, 1891.*]

The subjoined list of the described species of New Zealand spiders—which has been compiled at the suggestion of Mr. T. F. Cheeseman, F.L.S., Curator of the Auckland Museum—may be taken as exhaustive, as the probabilities are that all the species described in foreign memoirs have been recorded by Dr. L. Koch in his great work "Die Arachniden Australiens" (referred to in the list as "D.A.A.").

With one exception, all the late Dr. L. Powell's examples of *Attidæ*—described in the Transactions of the New Zealand Institute (referred to as "vol."), have been retained for the present—where he, perhaps, only provisionally placed them—in the Latreillean genus *Salticus.*

More field and descriptive work needs to be done before any comparison can be drawn between the spider-fauna of New Zealand and that of better-worked countries—Great Britain for example; but, as many of the larger forms yet remain undescribed, and the *Micro-araneæ* are apparently well represented, the probabilities are that the *Araneidæ* will prove as comparatively rich as most of the other orders represented in New Zealand.

It may be worth recording that within the last few years—as far as my district is concerned—there has been a marked decrease of orb-weavers; several of the more brightly coloured species and varieties, that were not uncommon at one time, I have failed to meet with since I became more specially interested in them. No doubt the introduced birds are mainly answerable for it, but the rapid increase of late years of *Pompilus* (possibly an introduced species) must tend to their destruction.

Ordo ARANEÆ.

Tribus TERRITELARIÆ.

Fam. THERAPHOSIDÆ.

Gen. NEMESIA, Latr.

Nemesia gilliesii, Cambr., vol. x., 284.

Gen. HEXATHELE, Auss.

Hexathele petrerii, Goyen, vol. xix., 207.
„ *hochstetteri*, Auss., D.A.A., 459.

Gen. ARBANITIS, L.K.

Arbanitis huttonii, Cambr., Proc. Zool. Soc., 1879, 682.

Gen. MIGAS, L.K.

Migas paradoxus, L.K., D.A.A., 588.
„ *distinctus*, Cambr., Proc. Zool. Soc., 1879, 683.
Male des. by P. Goyen, F.L.S., vol. xix., 210.
„ *sandageri*, Goyen, vol. xiii., 123.

Sub-Fam. THERAPHOSINÆ.

Gen. MACROTHELE, Auss.

Macrothele huttonii, Cambr., vol. vi., 200.

Tribus TUBITELARIÆ.

Fam. DYSDERIDÆ.

Gen. SEGESTRIA, Latr.

Segestria suterii, Urq., vol. xxiv., 230.

Gen. OONOPS, Templ.

Oonops septem-cincta, Urq., vol. xxiii., 128.

Fam. DRASSIDÆ.

Gen. HERPYLLUS, mihi.

Herpyllus formicarius, Urq.
Drassus formicarius, Urq., vol. xix., 109.

Gen. DRASSUS, Walck.

Drassus pretiosus, L.K., D.A.A., 385.
„ *erebus*, L.K., D.A.A., 387.

Gen. Chiracanthium, C. Koch.

Chiracanthium stratioticum, L.K., D.A.A., 408.

Gen. Clubiona, Walck.

Clubiona cambridgei, L.K., D.A.A., 416.
„ *peculiaris*, L.K., D.A.A., 427.
„ *viridicoma*, Urq., vol. xxiv., 233.
„ *chevronia*, Urq., vol. xxiv., 231.

Gen. Zora, C. Koch.

Zora frenata, L.K., D.A.A., 440.

Fam. Agelenidæ.

Gen. Amaurobius, C. Koch.

Amaurobius finschii, L.K., D.A.A., 339.
„ *maritima*, Cambr., Proc. Zool. Soc., June, 1882.

Gen. Robsonia, Camb.

Robsonia marina, Cambr., Proc. Zool. Soc., 1879, 687.
Argyronetra marina, Hector, vol. x., 300; C. H. Robson, *l.c.*, 299.
Robsonia submarina, Cambr., MS., 1877.

Gen. Tegenaria, Latr.

Tegenaria foliata, L.K., D.A.A., 356.
„ *arboricola*, Urq., vol. xxiii., 129.

Gen. Cambridgea, L.K.

Cambridgea fasciata, L.K., D.A.A., 359; vol. vi., 202.

Tribus RETITELARIÆ.

Fam. Theridiidæ.

Gen. Argyrodes, E. Simon.

Argyrodes lepida, Cambr., Proc. Zool. Soc., 1879, 688.
„ *conus*, Urq., vol. xvii., 40.

Gen. Ariamnes, Thor.

Ariamnes conifera, Urq., vol. xix., 96.
„ *triangulatus*, Urq., vol. xix., 97.
„ *attenuatus*, Urq., vol. xix., 98.
„ *flavo-notatus*, Urq., vol. xxiv.

Gen. Mimetus, Hentz.

Mimetus mendicus, Cambr., Proc. Zool. Soc., 1879, 697.
„ *sennio*, Urq.
Linyphia sennio, Urq., vol. xxiii., 137.
„ *atri-cinctus*, Urq., vol. xxiv., 234.

Gen. THERIDIUM, Walck.

Theridium tepidariorum, C. Koch.

Theridium lunatum, Sund. sv. spindl. Beskr. in Vet. Akad. Handl., f. 1831, p. 52.

Theridium tepidariorum, C. Koch, "Die Arachniden," Bd. viii., p. 75.

Steatoda tepidariorum, Thor., Rem. on Syn. of European Spid., n. 1, p. 80.

Theridium tepidariorum, Blackw., Spid. of Great Brit. and Ir., ii., p. 80.

Theridium varium, Urq., vol. xviii., 187. Port Mackay, Bowen (Port Denison), Rockhampton.

"Novara" expedition captured examples in New Zealand and St. Paul's Island. Thorell received specimens from St. Paolo, Brazil. The name occurs in Cambridge's Catalogue of Ceylon Araneidea, and I am indebted to Mr. Nathan Banks for examples from the United States of America. There is some uncertainty as to the original habitat of this species. It has evidently been imported into Northern Europe from a warmer climate, for C. Koch, Blackwall, and other writers who mention it state that it is only found in hothouses, and not out in the open air. Specimens have been captured in Sweden, Finland, and Southern Russia.

Theridium veruculatum, Urq., vol. xviii., 188.
" *blatteus*, Urq., vol. xviii., 190.
" *calyciferum*, Urq., vol. xviii., 192.
" *cruciferum*, Urq., vol. xviii., 193.
" *triloris*, Urq., vol. xviii., 194.
" *squalide*, Urq., vol. xviii., 195.
" *setiger*, Urq., vol. xviii., 196.
" *zantholabio*, Urq., vol. xviii., 197.
" *sericum*, Urq., vol. xviii., 198.
Male des. in vol. xxii., 258.
" *melanozantha*, Urq., vol. xix., 102.
" *tuberculatum*, Urq., vol. xix., 104.
" *maculopes*, Urq., vol. xix., 105.
" *viridana*, Urq., vol. xix., 106.
" *flabellifera*, Urq., vol. xix., 106.
" *venustulum*, Urq., vol. xix., 107.
" *albo-guttatum*, Urq., vol. xix., 108.
" *nigrofolium*, Urq., vol. xx., 112.
" *helvolum*, Urq., vol. xx., 113.
" *truncatum*, Urq., vol. xx., 115.
" *exornatum*, Urq., vol. xx., 115.
" *brunnea-folium*, Urq., vol. xxi., 142.
" *niger-punctillum*, Urq., vol. xxi., 143.
" *porphyreticum*, Urq., vol. xxi., 144.
" *gracilipes*, Urq., vol. xxi., 145.
" *zebrinia*, Urq., vol. xxii., 256.
" *pusillulum*, Urq., vol. xxii., 257.

Theridium punica-punctata, Urq., vol. xxiii., 147.
" *apiatum*, Urq., vol. xxiii., 148.
" *literatum*, Urq., vol. xxiii., 150.
" *ampliatum*, Urq., vol. xxiv., 237.
" *albo-cinctum*, Urq., vol. xxiv., 236.
" *argentatum*, Urq., vol. xxiv., 235.

Gen. ERYCINA, Urq.

Erycina violacea, Urq., vol. xxiii., 152.

Gen. LATRODECTUS, Walck.

Latrodectus scelio, Thor., D.A.A., 279.
" *katipo*, Powell, vol. iii., 56.

I was unable to procure fresh specimens of katipo to compare with the Australian form: judging from old examples the comparative difference between them is not of specific value. I received specimens from *Mr. Arthur Vogen*, captured by him three hundred miles inland of Croyden, Gulf of Carpentaria; am indebted to *Mr. Alex. Morton*, curator of the Tasmanian Museum, for Tasmanian examples; and I procured specimens in the vicinity of Sydney.

Latrodectus katipo, var. *attritus*, Urq., vol. xxii., 259.

Gen. LITHYPHANTES, Thor.

Lithyphantes lepidus, Cambr., Proc. Zool. Soc., 1879, 690.

Gen. ATKINSONIA, Cambr.

Atkinsonia nana, Cambr., Proc. Zool. Soc., 1879, 691.

Gen. PHYCOSOMA, Cambr.

Phycosoma œcobioides, Cambr., Proc. Zool. Soc., 1879, 692.

Gen. LINYPHIA, Latr.

Linyphia subdola, Cambr., Proc. Zool. Soc., 1879, 693.
" *peramœna*, Cambr., Proc. Zool. Soc., 1879, 694.
" *melanopygia*, Cambr., Proc. Zool. Soc., 1879, 696.
Female des. in vol. xix., 101.
" *diloris*, Urq., vol. xviii., 184.
" *trispathulata*, Urq., vol. xviii., 186.
" *blatifer*, Urq., vol. xix., 99.
" *rufocephala*, Urq., vol. xx., 109.
" *lagenifera*, Urq., vol. xx., 111.
" *purpura-punctata*, Urq., vol. xxi., 134.
" *nitidulum*, Urq., vol. xxi., 136.
" *rufo-lineata*, Urq., vol. xxi., 137.
" *nemoralis*, Urq., vol. xxi., 140.
" *multicola*, Urq., vol. xxiii., 140.
" *cruentum*, Urq., vol. xxiii., 142.
" *albi-apiata*, Urq., vol. xxiii., 143.
" *pellos*, Urq., vol. xxiii., 146.
" *absidata*, Urq., vol. xxiv.

Gen. ERIGONE, Sav. et Aud.

Erigone atriventer, Urq., vol. xix., 102.

Gen. STEGOSOMA, Cambr.

Stegosoma quadratum, Cambr., Proc. Zool. Soc., 1879, 698.

Gen. CORNICULARIA, Menge.

Cornicularia crinifrons, Urq., vol. xxiii., 155.

Gen. WALCKENAERA, Blackw.

Walckenaera cristata, Blk., Spid. of Great Brit. and Ir., 309; Cambr., Proc. Zool. Soc., 1879, 693.

The Rev. O. P. Cambridge, who received specimens of both sexes from Mr. A. S. Atkinson, of Nelson, states: "I have carefully compared them with types of the species found both in England and in various parts of the Continent of Europe, and (with the exception of being a little larger) can find no structural differences whatever."

Fam. ENYOIDÆ.

Gen. HABRONESTES, L.K.

Habronestes marinus, Goyen, vol. xxii., 269.
" *celeripes*, Urq., vol. xxiii., 132.
" *scitula*, Urq., vol. xxiii., 135.

Gen. HUTTONIA, Cambr.

Huttonia palpimanoides, Cambr., Proc. Zool. Soc., 1879, 685.

Tribus ORBITELARIÆ.

Fam. TETRAGNATHIDÆ.

Gen. TETRAGNATHA, Latr.

Tetragnatha gulosa, L.K., D.A.A., 176. Island of St. Paul.
" ? *daindrigei*, White, Ann. and Mag. of Nat. Hist., 1846, p. 46; L. Koch, D.A.A., 106.
" *typica*, Urq., vol. xxii., 251.
" *herbigrada*, Urq., vol. xxii., 252.
" *arborea*, Urq., vol. xxiii., 172.
" *multi-punctata*, Urq., vol. xxiii., 176.
" *flavida*, Urq., vol. xxiii., 177.

Gen. ISCHALEA, L.K.

Ischalea spinipes, L.K., D.A.A., 197.

Fam. EPEIRIDÆ.

Gen. ARGIOPE, Sav. et Aud.

Argiope syrmatica, L.K., D.A.A., 213. Port Denison.

Gen. Epeira, Walck.

Epeira extuberata, L.K., D.A.A., 61.
" *crassa*, Walck., Hist. Nat. des Ins. Apt., t. xi., 127, D.A.A., 63.
" *undata*, L.K., D.A.A., 73.
" *verrucosa*, Walck., Hist. Nat., t. xi., 135 ; D.A.A., 112.
" *feredayi*, Cambr., D.A.A., 122.
" *brounii*, Urq., vol. xvii., 32.
" *attenuata*, Urq., vol. xvii., 33.
" *corrugatum*, Urq., vol. xix., 72.
" *pocillator*, Urq., vol. xix., 74.
" *oblitera*, Urq., vol. xix., 77.
" *tri-tuberculata*, Urq., vol. xix., 78.
Male des. in vol. xx., 120.
" *orientalis*, Urq., vol. xix., 79.
See note, *l.c.*, 121.
" *bi-albimacula*, Urq., vol. xix., 81.
" *saxitalis*, Urq., vol. xix., 82.
" *subcompta*, Urq., xix., 83.
" *viridatus*, Urq., vol. xix. 85.
" *discolora*, Urq., vol. xix., 86.
" *verutum*, Urq., vol. xix., 87.
" " var. *veruina*, Urq., vol. xix., 88.
" " var. *hastatum*, Urq., vol. xix., 89.
" " var. *lineola*, Urq., vol. xix., 89.
" *linea-acuta*, Urq., vol. xix., 90.
" *purpura*, Urq., vol. xix., 91.
" *viridicans*, Urq., vol. xx., 116.
" *mulleola*, Urq., vol. xx., 118.
Male des. in vol. xxi., 14.
" *helveo-guttata*, Urq., vol. xx., 119.
" *dumicola*, Urq., vol. xxi., 146.
" *flavo-maculata*, Urq., vol. xxii., 239.
" *albo-stricta*, Urq., vol. xxii., 240.
" *guttatum*, Urq., vol. xxii., 242.
" *ostri-brunnea*, Urq., vol. xxii., 243.
" *albi-scutum*, Urq., vol. xxii., 244.
" *dubitabilis*, Urq., vol. xxii., 246.
" *tri-notata*, Urq., vol. xxii., 247.
" " var. *olivinia*, Urq., vol. xxii., 249.
" *atri-apiata*, Urq., vol. xxiii., 156.
" *acincta*, Urq., vol. xxiii., 158.
" *nigro-hastula*, Urq., vol. xxiii., 159.
" *atri-hastula*, Urq., vol. xxiii., 162.
" *galbana*, Urq., vol. xxiii., 163.
" *venustula*, Urq., vol. xxiii., 165.
" *melania*, Urq., vol. xxiii., 166.

Epeira similaris, Urq., vol. xxiii., 168.
„ *lævigata*, Urq., vol. xxiii., 171.
„ *invisibilis*, Urq., vol. xxiv., 239.
„ *sublutia*, Urq., vol. xxiv., 241.
„ *leucisca*, Urq., vol. xxiv., 245.
„ *simulata*, Urq., vol. xxiv., 242.
„ *ventriosa*, Urq., vol. xxiv., 243.

Gen. META, C. Koch.

Meta granulata, Walk., Hist. Nat., t. xi., p. 222, D.A.A. 136. Port Dorey, New Guinea; Port Mackay, Brisbane, and Rockhampton; Sydney.

Gen. NEPHILA, Leech.

Nephila argentatum, Urq., vol. xix., 92.

Gen. ARACHNURA, Vinson.

Arachnura longicauda, Urq., vol. xvii., 34.
„ *nigritia*, Urq., vol. xvii., 37.
„ *obtusa*, Urq., vol. xvii., 37.
„ *trilobata*, Urq., vol. xvii., 37. Tasmania.
„ „ var. *a*, Urq., vol. xvii., 39.

Fam. CELÆNIDÆ.

Gen. CELÆNIA, Thor.

Celænia atkinsonii, Cambr.
Thlaosoma atkinsonii, Cambr., Proc. Zool. Soc., 1879, 699.
Celænia hectori, Cambr.
Thlaosoma hectori, Cambr., Proc. Zool. Soc., 1879, 700.
Celænia olivacea, Urq.
Male des. in vol. xix., 95.
Thlaosoma olivacea, Urq., vol. xvii., 39.
Celænia pennum, Urq.
Thlaosoma pennum, Urq., vol. xix., 94.
Celænia tuberosa, Urq.
Thlaosoma tuberosa, Urq., vol. xxi., 169.

Fam. EPISINIDÆ.

Gen. EPISINUS, Walck.

Episinus antipodianus, Cambr., Proc. Zool. Soc., 1879, 701.

Tribus LATERIGRADÆ.

Fam. THOMISIDÆ.

Gen. STEPHANOPIS, Cambr.

Stephanopis angulatus, Urq.
Sparassus angulatus, Urq., vol. xvii., 42.
Male des. in vol. xxii., 260.
Stephanopis angularis, Urq.
Sparassus angularis, Urq., vol. xvii., 43.

Gen. Diæa, Thor.

Diæa albo-limbata, L.K., D.A.A., 588.

Fam. Philodromidæ.

Gen. Philodromus, Walck.

Philodromus ambarus, Urq., vol. xvii., 43.
Male des. in vol. xix., 112.
" *sphæriodes*, Urq., vol. xvii., 44.
Male des. in vol. xix., 111.
" *ovatus*, Urq., vol. xix., 113.
" *rubro-frontus*, Urq., vol. xxiii., 179.

Gen. Hemiclœa, Thor.

Hemiclœa rogenhoferi, L.K., D.A.A., 637.
" *plantus*, Urq., vol. xviii., 199. Probably identical.
Male des. in vol. xix., 110.

Tribus CITIGRADÆ.

Fam. Lycosidæ.

Gen. Lycosa, Latr.

Lycosa senica, L.K., D.A.A., 915.
" *hilaris*, L.K., D.A.A., 920.
Female des. *l.c.*, 979.
" *umbrata*, L.K., D.A.A., 921.
" *virgata*, Goyen, vol. xix., 201.
" *canescens*, Goyen, vol. xix., 203.
" *taylori*, Goyen, vol. xix., 206.
" *æresccns*, Goyen, vol. xix., 206.
" *uliginosa*, Goyen, vol. xx., 136.
" *bellicosa*, Goyen, vol. xx., 138.
" *proxima*, Urq., vol. xviii., 201.
" *adumbrata*, Urq., vol. xix., 114.
" *arenaria*, Urq., vol. xxiii., 182.
" *maura*, Urq., vol. xxiv., 246.

Gen. Pardosa, C. Koch.

Pardosa vicaria, L.K., D.A.A., 965.

Gen. Anoteropsis, L.K.

Anoteropsis flavescens, L.K., D.A.A., 971.

Fam. Ctenidæ.

Gen. Cycloctenus, L.K.

Cycloctenus fugax, Goyen, vol. xxii., 267.
" *lepidus*, Urq., vol. xxii., 261.
" *pulcher*, Urq., vol. xxiii., 188.

Fam. OXYOPIDÆ.

Gen. OXYOPES, Latr.

Oxyopes gregarius, Urq.
Sphasus gregarius, Urq., vol. xvii., 51.

Tribus SALTIGRADÆ.

Fam. ATTIDÆ.

Gen. SALTICUS, Latr.

Salticus appressus, Powell, vol. v.
" *atratus*, Powell, vol. v.
" V-*notatus*, Powell, vol. v.
" *fumosus*, Powell, vol. v.
" *mustilinus*, Powell, vol. v.
" *albo-barbatus*, Powell, vol. v.

Gen. MARPISSA, C. Koch.

Marpissa leucophæum, Urq., vol. xx., 121.
" *arenaria*, Urq., vol. xx., 123.
" *æri-hirta*, Urq., vol. xx., 124.
" *cineracea*, Urq., vol. xxiii., 188.
" *armifera*, Urq., vol. xxiv., 248.
" *nemoralis*, Urq., vol. xxiv., 250.

Gen. BALLUS, C. Koch.

Ballus compactus, Urq.
Salticus compactus, Urq., vol. xvii., 50.

Gen. PLEXIPPUS, C. Koch.

Plexippus minax, Powell.
Salticus minax, Powell, vol. 5.
Plexippus herbigradus, Urq., vol. xxi., 150.
" *capillatus*, Urq., vol. xxii., 265.
" *silvarus*, Urq., vol. xxiv., 252.

Gen. ATTUS, Walck.

Attus tabinus, Urq.
Salticus tabinus, Urq., vol. xvii., 46.
Attus curvus, Urq.
Salticus curvus, Urq., vol. xvii., 46.
Attus furvus, Urq.
Salticus furvus, Urq., vol. xvii., 47.
Attus alpinus, Urq.
Salticus alpinus, Urq., vol. xvii., 48.
Attus albo-palpis, Urq.
Salticus albo-palpis, Urq., vol. xvii., 49.
Attus tenebricus, Urq.
Salticus tenebricus, Urq., vol. xvii., 51.

Attus auricomus, Urq., vol. xviii., 202.
" " var. *hirta*, Urq., vol. xviii., 204.
" *zanthrofrontalis*, Urq., vol. xviii., 203.
Male des. in vol. xvii., 45.
" *saxatilis*, Urq., vol. xviii., 204.
" *aquilus*, Urq., vol. xix., 115.
" *bimaculosus*, Urq., vol. xix., 116.
" *sub-fuscus*, Urq., vol. xix., 117.
" *pullus*, Urq., vol. xx., 263.
" *scindus*, Urq., vol. xx., 264.
" *montinus*, Urq., vol. xxiii., 184.
" *monticolus*, Urq., vol. xxiii., 186.
" *valentulus*, Urq., vol. xxiii., 187.

Art. XVI.—*Descriptions of New Species of* Araneæ.

By A. T. Urquhart.

[*Read before the Auckland Institute, 2nd November, 1891.*]

Fam. Dysderidæ.

Gen. Segestria, Latr.

Segestria suterii, sp. nov.

Fem.—Ceph.-th., long, 4; broad, 2·2; facial index, 1·8. Abd., long, 4·2; broad, 2·8. Legs, 1, 4, 2, 3 = 10, 9, 8·5, 7 mm.

Cephalothorax brownish-ochreous, fore-half suffused with lake-brown; hairs short, erect, black, sparse; clathrate; convex, moderately dilated; lateral compression beyond coxæ of first pair of legs slight; frontal line rounded; *clypeus* inclined somewhat forwards, height exceeds space occupied by fore-central eyes by one-half; contour of profile arched.

Eyes rather small, opalescent; form a recurved row on verge of caput; in three groups, centre pair sensibly the largest, oval, divided by an interval equalling one-half their diameter, posited subobliquely on a fuscous oval spot, which projects a strongish bristle, separated from side-eyes by less than twice their space; laterals broad-oval, subtouching, placed on a low dark tubercle; posterior eye directed somewhat backwards.

Falces brownish-lake; sparsely haired; transversely rugose; conical, directed moderately forwards; stout, about twice as long as broad.

Maxillæ brownish-ochreous, reddish reflections, pale apex separated from the darker hue by a conspicuous oblique line;

curve over lip; of somewhat even breadth, apices truncated, subtouching.

Labium shade deeper than maxillæ, two-thirds their length, triangular-oval.

Sternum ochraceous, margins stained with lake-brown; oval perceptible eminences opposite coxæ.

Legs orange-ochreous, perceptible lake reflections; moderately stout, do not differ much in strength. Hairs black, strong, arranged somewhat in lines. Superior tarsal claw—first pair, strong, well-curved; inner claw, 21 long, open comb-teeth, basal shortest; outer claw, 16 teeth; inferior claw, stout, sharply bent, 1 long curved tooth.

Palpi orange-ochreous, radial and digital joints suffused with brown-lake; moderately haired; no claw.

Abdomen oviform; stone-colour, tinged with olive-green; dorsal aspect exhibits a series of olive-brown chevrons, apices directed forwards, more or less evanescent on anterior half; tolerably well clothed with short, stiff, black hairs, springing from reddish papillæ; ventral region stone-colour; hairs fine. *Corpus vulvæ* (somewhat damaged) lake-brown; represents, apparently, an oval eminence indented by two moderate-sized, circular foveæ, divided by a septum their equal in breadth.

I have much pleasure in connecting the name of *Mr. H. Suter* with this handsome species, captured at Dyer's Pass, Canterbury. The female was accompanied by two immature males, who do not differ essentially from her in form or coloration.

Fam. DRASSIDÆ.

Gen. CLUBIONA, Walck.

Clubiona chevronia, sp. nov.

Mas.—Ceph.-th., long, 5; wide, 3·8. Abd., long, 5·2; wide, 3. Legs, 4, 1, 2, 3 = 18, 17, 15, 13·3 mm.

Cephalothorax brownish-fulvous, deepening in tone over cephalic region; few black hairs on caput; broad-oval; cephalic part convex, constriction occurs rather beyond coxal joints of first pair of legs; depth of *clypeus* equals three-fourths of space occupied by anterior centre eyes; thoracic groove longitudinal; radial and caput striæ well defined; profile-line slopes posteriorly with a somewhat prominent curve.

Eyes on dark spots; represent two somewhat evenly procurved rows; four centrals form a trapezoid widest behind, subequal; posterior line separated by nearly equal intervals, median pair closest, divided by a space fully equalling their own breadth and one-half; anterior centrals smaller than posterior pair, sensibly more distant from them than they are from each other—barely an eye's diameter; laterals largest of eight, posited obliquely, separated by an interval scarcely equalling the radius of fore-eye, which is suboval, one-third larger than hind-eye.

Falces have the deep tone of caput; transversely rugose; elliptic-conical; conspicuous plano-conical process on outer margin; directed forwards and outwards, base projects prominently beyond plane of clypeus.

Maxillæ dark-ochraceous; dilated, superior angle rounded, inferior obliquely truncated, curves over lip.

Labium colour of maxillæ; conical, abscinded.

Sternum yellow-brown, stained with a darker shade round margins; cordate.

Legs yellow-ochreous; hairs dusky; few black spines on femora; tibiæ of first and second pairs 2, 2, 2, 2, 1 side-spine; metatarsi 2, 2, 2, 1 side-spine; about 9 on posterior tibiæ; more numerous on metatarsal joints.

Palpi and legs concolorous; pars humeralis longer than two following joints together; cubital joint somewhat campanulate; pars radialis orange tone; rather shorter than former article; outer side developed into a flattish, elongated wing, margin involute, free and truncated, extends somewhat beyond joint; inferior surface drawn out into a similar but more pointed process. Clava as long as humeral joint; lamina ochraceous, lightly clouded; hairs fine; ovate, tapering; genital bulb represents a membranous, elongate-oval, concave shell, subfree, attached by outer side to fore-end of lamina; posterior inner margin drawn out into a fine, forward-curved apophysis, exceeding palpus clava in length; anterior end prolonged into a fine curved apophysis, lying close round forepart of bulbus; superior aspect of bulb developed into an ochraceous elongate-oval lobe, bearing on its face a lake-brown S-shaped callus; fore-curve of callus divides two diaphanous, outward-curved, short apophyses; posterior apophysis slender, anterior dilated at extremity.

Abdomen elongate-oviform; hairs tolerably thick; yellow stone-colour, dorsal aspect dark olive-green; colour and markings on fore-third evanescent; posterior two-thirds exhibit a series of seven centrally interrupted yellow-stone chevrons, apices directed forwards; anterior pair pyriform; few oblique stripes on lateral margins; spinners orange.

Fem.—Ceph.-th., long, 5; broad, 3·2. Abd., long, 6; broad, 3·5. Legs, 4, 1, 2, 3 = 13·7, 12, 10·7, 9·8 mm.

Cephalothorax and *eyes* do not differ essentially from male's.

Falces reddish-ochreous; hairs fine, sparse; directed moderately forwards and outwards; in length equal radial and digital joints of palpus.

Maxillæ yellow-ochreous; *lip* shade darker.

Sternum yellow-ochreous; oval, abruptly compressed and prolonged between coxæ of fourth pair.

Legs colour of sternum; armature resembles male's.

Palpi colour and armature of legs.

Abdomen elongate-oviform; coloration and markings closely resemble the male form.

Two examples, male and immature female, Riccarton Bush, Canterbury. *H. Suter.*

Clubiona viridicoma, sp. nov.

Fem.—Ceph.-th., long, 2·1; wide, 1·5. Abd., long, 3·7; wide, 2·1. Legs, 4, 1, 2, 3 = 6, 5·3, 5, 4·5 mm.

Cephalothorax yellow-ochreous, fuscous clouding over eye-area, marginal zone brown, narrow; hairs whitish, very sparse, few black, erect, on frontal region; oval, moderately compressed beyond coxæ of first pair of legs; convex; cephalic part roundly truncated; *clypeus* in depth nearly equal to breadth of a fore-centre eye; thoracic indentation represented by a short longitudinal groove; normal striæ shallow; contour of profile ascends from thoracic junction at an angle of 60°, inclined moderately forwards with a perceptible curve.

Eyes of nearly equal size; posterior row rather strongly procurved, median pair smallest of eight, separated from each other by more than an eye's radius, and from laterals by quite their diameter and a quarter; anterior row sensibly procurved, centrals perceptibly more distant from hind-pair than they are from one another, an interval equalling fully the radius of an eye; laterals posited on low, separate, dark tubercles; about one-half the breadth of hind-eye apart; fore-laterals largest of eight, sub-touching anterior centrals.

Falces brownish amber-colour; conical, inclined slightly forwards, base projects rather beyond plane of clypeus; length equals their space, which surpasses breadth of ocular area.

Maxillæ dark amber-colour; basal half prominently convex, second half rapidly dilated, round-pointed.

Labium shade deeper than maxillæ, scarcely one-half their length; oval, apex beaded.

Sternum brownish-yellow; broad-ovate.

Legs have a lighter tone than cephalothorax; hairs fine, very sparse; well armed with black spines; claw-tuft well developed; scapula moderately so.

Palpi and legs concolorous; pars humeralis projects 1 spine; radial joint 11 at base, inner side; digital 11, 11 inner side.

Abdomen inversely-oviform, base somewhat truncated; large transverse oval fovea on boundary of second quarter;

fulvous, approximating to stone-colour; hairs olive-green, short, very scant; patchy on dorsal aspect; arranged on lateral margins in somewhat horizontal lines. *Corpus vulvæ* represents a pale straw-coloured, cordate elevation, occupied by a large, yellow-ochreous, triangular-cordate, rugose, depressed area, bounded by a longitudinally-wrinkled, involute costa, studded with small papillæ; latter more thickly grouped on a dark-brown arch which crowns the apex of the above-mentioned area; immediately below the arch, contiguous to costa, are two pale, plano-convex, semi-oval lobes; posterior third of area exhibits a wide depressed septum, whose prolonged lake-brown margins are revolute at anterior end, involute above the rima genitalis; former project beyond latter.

Mount Cook. *H. Suter.*

Fam. THERIDIIDÆ.

Gen. MIMETUS, Hentz.

Mimetus atri-cinctus, sp. nov.

Mas.—Ceph.-th., long, 1·8; broad, 1·1. Abd., long, 1·5; broad, 1·6. Legs, 1, 2, 4, 3 = 15, 8·5, 6·7, 5 mm.

Cephalothorax creamy-ochreous, speckled and stained with a light yellow-brown; cephalic band yellowish, margins brown; broad; basal fourth oval, bluish centre spot; bifurcates to hind-row of eyes; outer margin concave sinuate; few strong black hairs; oval, lateral constriction at caput moderate; pars cephalica convex, eye-eminence broad, prominent; *clypeus* inclined forwards, projects over falces, height equal to more than one-third depth of facial space; thoracic fovea blue-black, oval, longitudinal, fairly deep; radial striæ tolerably well marked; caput grooves faint; contour of profile represents a prominent arch, posterior incline somewhat steeper than anterior.

Hind-row of *eyes* slightly procurved, median pair placed on lake oval spots, separated by an interval equal to three-fourths of an eye's diameter, about twice that space from laterals; anterior row strongly recurved, centrals smallest of eight by one-third, encircled by dark rings, posited somewhat obliquely, form with posterior pair a trapezoid much wider in front than behind, more than their breadth from side-eyes; laterals have the pearl-grey lustre of hind-centrals, do not differ essentially from them in size, seated obliquely on well-developed lake-coloured tubercular prominences, contiguous.

Falces fulvous, second half suffused with olive-green; nearly one-fourth shorter than the pars humeralis of palpus, slender, of somewhat even breadth, vertical.

Maxillæ ochraceous, green tinge; long, slender, sensibly enlarged forwards, round-pointed.

Labium deeper tone than maxillæ, fully one-half their length, oval; breadth somewhat surpassed by length.

Sternum colour of coxæ, brown stains between the slightly-developed eminences; cordate, attenuated between coxal joints of fourth legs.

Legs creamy-ochreous, spots brownish-orange, stained more or less with olive-green; indications of annuli. Armature consists of erect black hairs and few long bristle-like spines. Superior tarsal claws—first pair, slender, well curved, 5 close teeth increasing in length and strength; inferior claw ?

Palpi colour of legs; length, 2·3mm. Humeral joint slender, straight, rather longer than cubital and radial together; pars cubitalis very much shorter than pars radialis, which is gradually incrassated, extremity truncated, roundly emarginate on outer side; lamina light-ochreous, somewhat sparingly furnished with hairs; projects three strong bristles; broad-oval, base produced on outer side into a large, forward-curved, spathulate process; bulbus genitalis yellow-ochreous, basal third subcircular, convex, upper part lake-colour, dilated into a revolute cutaneous fold; central portion of lobe shade darker, rugose, somewhat undulating, forms a deep backward-curved loop above; anterior submargins membranous—viewed from outer side, exhibit three processes directed forwards; upper ochraceous, border dark; broad, compressed into a sharp point; immediately behind it is an obtusely-pointed brownish process; lower projection greenish hue, margin fuscous; wide, convex beneath, apex acute, upcurved.

Abdomen triangular-ovate, aplanate; humeral tubercles project upwards and outwards; contour of profile triangular; spinners well developed, yellowish; olive stone-colour, spotted with creamy-stone lobate flecks varying in form and size; few blue-black stains interspersed amongst the latter; series of chocolate-brown spots connect humeral tubercles; the somewhat undetermined, more or less unspotted, dorsal stripe widens out on posterior incline, intersecting a blue-black chevron; between the extremities of this mark and the blackish stains above spinners are two elongate creamy spots enclosing brownish dots.

Two male specimens captured in the forest near Stratford. *A. T. U.*

Gen. THERIDIUM, Walck.

Theridium argentatum, sp. nov.

Fem.—Ceph.-th., long, 1·2; broad, 1. Abd., long, 2; broad, 1·6. Legs, 1, 2, 4, 3 = 7, 5·7, 4, 3 mm.

Cephalothorax fulvous, median band slightly mottled with dark olive-green, bifurcates from fovea, extends to posterior row of eyes; lateral borders mottled with similar tone; clathrate; almost glabrous; ovate, lateral compression at caput moderate; cephalic part convex, ocular prominence well developed; *clypeus* nearly vertical, depth equals diameter of a fore-centre eye; thoracic part moderately dilated, fovea sub-oval, deep; radial striae somewhat shallow; caput grooves more strongly marked; profile-line ascends from thoracic junction at angle of 50°, slopes forwards with a perceptible curve.

Eyes do not differ much in size, fore-centrals smallest, hind-centrals largest of eight; posterior row sensibly procurved, median pair on black oval spots, rather more distant —barely an eye's breadth—from one another than they are from laterals; anterior row recurved, centre pair encircled by dark rings, separated from each other by a space visibly exceeding the diameter of an eye, and from side-eyes by a somewhat shorter interval; laterals posited on a tolerably strong, dark, tubercular prominence, subtouching.

Falces yellow-ochreous; conical, strongly convex, base projects beyond plane of clypeus, vertical, about twice as long as broad.

Maxillæ, fuscous base divided from bluish extremity by a yellow stripe; perceptibly longer than broad, dilated, obtusely pointed, inclined towards each other.

Labium dark chocolate-brown; subquadrate, more than twice as wide as long, margin tumid, everted.

Sternum, centre brown, fuscous margin; broad-ovate.

Legs light-brown; anterior pairs tolerably stout; armature fine hairs, few slender bristles.

Palpi yellowish, radial joint greenish, digital reddish-brown.

Abdomen inversely-oviform, laterally rugose; dorsum and sides studded with silver and golden contiguous flecks, former occur chiefly on median aspect; dorsal streak brown; two fore-thirds traversed by three somewhat arcuate bands of similar hue; posterior third dilates very abruptly into a wide quadrate band figured with a few golden dots, sub-border dark-brown; inferior half—rather more—of sides have a deep yellowish-brown tone, streaked with fine dark-brown lines. Ventral shield oval, normal brown, margin yellowish, sub-margin fuscous. *Vulva* blackish-lake, moderately convex elevation, transversely rugose, inferior margin beaded, somewhat pointed, dilated beneath into a moderately wide)(-shaped septum, separating two large, transverse, oval foveæ.

Single example, captured near Hawera. *A. T. U.*

Theridium albo-cinctum, sp. nov.

Fem.—Ceph.-th., long, 1·8; wide, 1·4. Abd., long, 2·3 wide, 1·7. Legs, 1, 2, 4, 3 = 8·7, 5·5, 5·1, 4 mm.

Cephalothorax orange-ochreous; sparsely haired on caput; oval, moderately constricted forwards, convex; cephalic part prominently rounded; *clypeus* vertical, height rather less than one-half facial space; thoracic fovea oval, longitudinal, deep; normal grooves well defined; profile-contour ascends from thoracic junction at an angle of 45°, slopes forwards with a sensible curve.

Eyes rather small, do not differ much in size, on dark rings; posterior row visibly procurved, median pair perceptibly further from laterals than they are from each other—an interval exceeding their own diameter; anterior row recurved, centrals dark, largest of eight, form with hind-pair a nearly quadrilateral figure, narrowest behind; lateral eyes smallest, posited obliquely on moderate-sized lake-coloured tubercular eminences, contiguous.

Falces shade lighter than cephalothorax; sublinear, directed visibly forwards, barely project beyond plane of clypeus; stouter than the pars femoralis of a fore-leg, one-fourth longer than the cubital + radial joints of palpus.

Maxillæ pale stone-brown; acute-spathulate, inclined over *labium*, which has a broad-oval form, visibly everted; yellowish-orange.

Sternum light yellow-brown; broad-cordate.

Legs yellow-ochreous, orange reflections; tolerably stout; anterior pairs of nearly equal strength; fine, erect, dusky hairs; bristles long, sparse.

Palpi colour and armature of legs; pars cubitalis projects a long bristle.

Abdomen oviform, elongated; tolerably well clothed with hair; ground-colour light-brown, shade of olive-green, closely speckled with creamy-brown flecks; dorsal band of somewhat uniform breadth, tapers at either end, somewhat evanescent, irregularly notched; central part creamy-white, stained with chrome-yellow; encloses on fore-half three small greenish elongated marks. *Corpus vulvæ* moderately elevated, transversely rugose, projects forwards; displays a broad, ochraceous, dusky-bordered medial band, which terminates at a fair-sized amber-coloured depressed area, semicircular on inferior (anterior) side; superior subquadrate, projecting, gradually compressed in centre, margin beaded, brown; comprised within the area are two longitudinal oval foveæ, separated by a septum whose breadth is visibly narrower than their transverse diameter.

Single specimen, taken in the forest near Stratford. *A. T. U.*

Theridium ampliatum, sp. nov.

Mas.—Ceph.-th., long, 2; wide, 1·5. Abd., long, 1·8; wide, 1·8. Legs, 1, 2, 4, 3 = 13, 10·3, 9, 6·8 mm.

Cephalothorax orange-ochreous, reflecting reddish and metallic-orange fine, close radii; caput stripe wide, olive-green, fades away towards eyes; broad-oval, sensibly compressed from hind-row of eyes; somewhat depressed; pars cephalica round-pointed, projects moderately over *clypeus;* latter vertical, plainly more than one-half depth of facial space; thoracic part rises into two somewhat prominent ridges, which slope rather abruptly to cephalic grooves; contour of profile inclined to stalk.

Hind-median and lateral *eyes* opalescent, of tolerable and nearly equal size; posterior row sensibly procurved, distributed at about equal distances, centre pair nearly an eye's interval apart; anterior row recurved, median pair on dark rings, smallest of eight by fully one-half, form with hind-pair a quadrilateral figure; removed from side-eyes by a space equalling their own diameter; laterals posited obliquely on a common lake-brown slight elevation.

Falces light brownish-ochreous; sublinear, retreating, scarcely one-fourth longer than clypeus; plainly stouter than the femur of a fore-leg.

Maxillæ colour of falces; short, of somewhat even width, round-pointed, curve over labium; latter organ ochraceous; large, broader than long, rounded, everted.

Sternum glossy, yellow amber-colour; cordate.

Legs creamy-ochreous, faint indications of olive-green central and distal annulations on femoral, tibial, and metatarsal joints; slender; armature fine, erect, dusky hairs; superior tarsal claws—first pair well curved, somewhat upright, 10 tolerably long open comb-teeth; inferior claw rather strong, sharply curved, 2 close teeth, fore-tooth longest.

Palpi and legs concolorous; pars humeralis linear, long, more than twice length of two following articles together; cubital joint somewhat oval; radial perceptibly the shortest, cup-shape, furnished with long dark hairs; digital joint well developed, nearly as long as humeral, viewed from outer side ovate; laminæ bulbi directed somewhat towards each other, ovate, exhibit a conspicuous dark-margined circular notch near extremity, outer side; hairs fine, rather sparse; genital bulb ovate, colour varies in shade from pale-straw to amber-colour. Of the rather complicated parts the following will most attract attention: basal end exhibits a large lake-brown fovea; a strong membranous apophysis runs parallel and in touch with lower border of clava, about its equal in length, margin somewhat incurved, apex slender, curved, yellowish; springing from about centre of upper border is a long, black, bristle-like apophysis following margin of bulbus backwards and forwards; immediately in front of base of the latter organ is a semi-pellucid apophysis somewhat S-shaped, apex ovate, hanging downwards, separated by a convoluted bulb from an articulated appendage of similar colour, but somewhat thicker, attached at both ends; a dark, triangular, acute process projects from extremity of bulbus.

Abdomen broad-ovate, depressed, projects moderately over cephalothorax; impressed spots deep, conspicuous, form a trapezoid narrowest in front; sparingly clothed with light and black coarse hairs projecting from yellowish spots; ground-colour light-yellowish olive-green—in fresh specimens probably light olive-green, figured with large and small creamy lobate flecks—resolved into streaks along basal margins of the unspotted dorsal band; dash of blue-black occurs on either side of medial band on basal third; posterior third is traversed by an interrupted chevron of similar colour, each half representing an acute-oval figure; one example exhibited two blackish spots forming a transverse line midway between the chevron and spinners.

Two examples, taken in the forest, Stratford. *A. T. U.*

Fam. Epeiridæ.

Gen. Epeira, Walck.

Epeira invisibilis, sp. nov.

Mas.—Ceph.-th., long, 2·5; broad, 2·1. Abd., long, 3·8; broad, 3. Legs, 1, 2, 4, 3 = 13·7, 12, 10·2, 7 mm.

Cephalothorax light ochreous-brown, deeper tone about grooves; somewhat sparingly clothed with light adpressed hairs; pars cephalica depressedly convex, sides low, ocular prominence moderately developed; lateral index equal to two-thirds facial; pars thoracica convex, dilated; indentation longitudinal, deep, reddish; normal grooves somewhat shallow; profile-contour represents a low arch.

Eyes tinged with lake, fore-centrals dark; on mahogany-coloured rings; form two somewhat evenly-recurved rows; posterior median pair separated by fully an eye's breadth, visibly more than that interval from fore-pair, less than their space and one-half from side-eyes; anterior centrals slightly exceed hind-pair, form with them a trapezoid widest in front, rather less than their space from side-eyes; laterals one-third smaller than posterior centrals, posited on separate mahogany-coloured tubercles, more than an eye's breadth apart.

Falces light ochreous-brown; subconical, vertical, divergent, inferior border convex.

Maxillæ colour of coxæ; perceptibly longer than wide, round-pointed, inclined towards each other.

Labium light olive-green, margin fulvous; broader than long, roundly pointed, margin tumid.

Sternum fulvous, greenish reflections; cordate; visible eminences opposite coxæ.

Legs pale ochreous-brown, femora stained with green; faint indications of annuli on tibiæ and metatarsi; slender; tibiæ cylindrical; hairs whitish, sparse; spines long, yellowish, dark base, tolerably numerous; femoral spines limited mostly to superior aspect; first pair project a group of five long spines from inner side.

Palpi pale-brownish straw-colour; hairs light; pars humeralis somewhat incrassated forwards; pars cubitalis—viewed from above, broad-oval; projects two long strong bristles; radial joint surpasses former article in breadth, of a brownish tone, somewhat angular on inner side, produced into a stout conical process on outer; pars digitalis nearly equal to three former articles in length; lamina pale-brown, stained with green; linear-oval, base prolonged on outer side into a stout lake-brown incurved process; cap of genital bulb separated from lamina by two somewhat elongated lobes, of a chestnut-brown and pale straw colour, latter in contact with lamina; most prominent parts of bulb—projecting downwards from base is a large, greenish-yellow, rugulose lobe, convex behind, concave in front; projects forwards from its own basal extremity a wide, acute, fuscous process; fore-end produced into a similar but stronger projection; between the two processes the lobe is developed into a large, semicircular, flat enlargement; immediately in front is a large, tumid, somewhat ear-shaped, brownish lobe, reaching downwards nearly to extremity of first lobe; bulbus terminates in a long, stout, backward-curved, tapering process, basal half amber-colour, tumid grooved, fore-end fuscous, membranous, convex on outer side; visible between the second and third appendages is a red-brown, cylindrical, abscinded, rather large process, fore-margin produced into a wide, acute, fuscous apophysis. The above-mentioned appendages, except basal, capped by a chestnut-brown, rugose, somewhat quadrate lobe, anterior border emarginate, grooved.

Abdomen triangular-ovate; humeral tubercles slight; pale-bluish flesh-colour, somewhat stained, with light brownish-yellow, green tinge, spotted; folium tapers to base, deeper shade than lateral margins, border fuscous, broken, acute-crenate; somewhat sparingly clothed with short, pale-yellow, and bristle-like hairs.

Fem.—Ceph.-th., long, 3·2; broad, 3; facial ind., 1·9. Abd., long, 5; broad, 4. Legs, 1, 2, 4, 3 = 15·6, 13·7, 12, 8 mm.

Cephalothorax light ochreous-brown, eye-prominence slaty; hairs yellowish, tolerably thick; cephalic part depressedly convex, roundly truncated, ocular prominence low; depth of *clypeus* equals breadth of a fore-centre eye; thoracic part moderately convex, well dilated; indentation and normal grooves shallow; contour of profile rises from thoracic junction at an angle of 40°, slopes moderately, with a perceptible curve, across occiput, dips more abruptly over eye-area.

Posterior row of *eyes* sensibly recurved; centrals separated by an interval visibly exceeding an eye's diameter, nearly their space and one-half from laterals; anterior row rather more distinctly recurved; median eyes slightly larger than hind-pair, less than twice their diameter apart, rather more than their space from side-eyes; laterals have the lake tinge of posterior median pair, divided by an interval fully equalling their diameter.

Falces creamy-ochreous; conical, vertical, length equals the pars digitalis of palpus.

Maxillæ pale-drab, mottled with olive-green.

Labium greenish; margins tumid, everted.

Sternum pale-drab, greenish reflections.

Legs brownish straw-colour, annuli evanescent; armature does not differ greatly from male's.

Palpi colour and armature of legs.

Abdomen triangular-ovate, subaplanate; humeral tubercles low; coloration and markings do not differ very essentially from male's. Ventral shield greenish. *Vulva* light-brown; sub-reniform, projects strongly, subcircular above; posterior half transversely rugose; lateral margins of superior half show about six broad longitudinal ridges, divided by a brown-lake fovea; truncated in front, concave and transversely wrinkled within, discloses a prominent median ridge.

Mr. P. Goyen, F.L.S., to whom I am indebted for this interesting species, states that "it is found on whitish cliffs of calcareous sandstone, and is a fine example of protective coloration. Whether resting on, or in its web before, the rocks, it is so like the surface upon or before which it rests that it is most difficult to see when one is looking for it." Dunedin.

Epeira sublutia, sp. nov.

Fem.—Ceph.-th., long, 2·3; broad, 2. Abd., long, 4·2; broad, 2. Legs, 1, 2, 4, 3 = 9·5, 8, 6·5, 5 mm.

Cephalothorax light ochreous-brown; somewhat sparingly clothed with whitish pubescence; length equal to the pars patellaris + tibialis of fourth leg; cephalic part moderately convex, roundly truncated; lateral index fully equals three-fourths facial; height of *clypeus* less than diameter of a fore-central eye; thoracic part moderately dilated; fovea sub-circular; normal grooves tolerably shallow; contour of profile perceptibly arched across caput, dips rather abruptly to stalk.

Eyes represent two somewhat equally recurved lines; median pair of posterior row divided by an interval perceptibly less than an eye's breadth and a half, less distant from fore-centrals, separated from laterals by their space and a quarter; centre eyes of anterior row sensibly larger than hind-pair, rather further apart, closer to each other than they are to side-eyes; laterals have the opalescence of posterior median eyes, scarcely equal them in size, posited obliquely; fore-eye on a strongish tubercle.

Falces yellow-ochreous; conical, vertical, base projects well beyond plane of clypeus.

Maxillæ brownish-yellow, green tinge, base clouded with olive-brown; dilated, round-pointed, inclined towards each other.

Labium and maxillæ concolorous; visibly wider than long, roundly pointed.

Sternum pale brownish-yellow, shaded with olive-brown; angular-cordate; eminences opposite coxæ.

Legs light ochreous-brown; moderately strong; armature sparse light hairs, and yellowish dark-based spines; latter only moderately numerous.

Palpi colour and armature of legs.

Abdomen broad-ovate; humeral tubercles low; ground-colour light yellowish-brown, folium lightly suffused with olive-brown, rather faintly outlined by a brown, acute-crenate border. *Corpus vulvæ* light brownish-yellow; subreniform, sides project prominently, tumid, centrally grooved, extremities acute, curved towards each other, and beneath corpus above the rima genitalis; median area transversely rugose; scape curves over corpus, spoon-shape; basal two-thirds rather broad, flat, transversely wrinkled; fore-third pointed, prolonged somewhat beyond lateral lobes.

The above-mentioned observations refer as well to this species, which affects the same localities as *E. invisibilis*. *P. Goyen.*

Epeira simulata, sp. nov.

Fem.—Ceph.-th., long, 3·5; wide, 3; facial ind., 2. Abd., long, 6; wide, 5. Legs, 1, 2, 4, 3 = 15, 13, 11, 7·6 mm.

Cephalothorax brown, approximating to brown-pink, suffused and veined with fuscous-purple. Hairs yellowish, short, sparse. Cephalothorax in length equal to patella + tibia of hind-leg; moderately depressed; lateral compression of cephalic part nearly parallel, frontal line visibly rounded, ocular eminence prominent, mammiform elevations moderately developed, depth of *clypeus* rather shorter than space occupied by anterior centre eyes; sides of thoracic part tolerably well rounded, fovea oval, transverse; normal grooves shallow; profile-contour represents a low arch, rises perceptibly at ocular prominence.

Four centre *eyes* of equal size, posited at about equal distances on face of prominence; posterior row visibly recurved, median pair quite their space and a half from side-eyes; laterals one-third smaller than centrals, separated by an interval scarcely equalling their own breadth.

Falces brown, clouded; moderately haired; conical, retreating, divergent, base projects beyond plane of clypeus; fully as stout as the pars femoralis of a fore-leg, length equals space.

Maxillæ fuscous, apices greenish-yellow; length rather surpasses breadth, round-pointed, prominently dilated outer side.

Labium similar coloration, large, visibly wider than long, pointed.

Sternum fuscous; hairs light, rather sparse; heart-shape, eminences opposite coxæ.

Legs approximate to brown-pink, fuscous-purple stains; thighs of anterior legs armed on inner side; patella + tibia somewhat aplanate, grooved. Hairs short, yellowish. Legs fairly well armed with short, irregular spines, base orange-brown, fore-half whitish.

Palpi and legs concolorous; penultimate and digital joints furnished with numerous hairs and spines.

Abdomen angular-oviform, depressed, sides wrinkled; humeral tubercles moderately developed; first row of posterior tubercles do not differ much in length, conical, centre tubercle twice as broad as lateral; tubercle of second line more prominent and acute than upper, lower fairly well developed; moderately haired; ground-colour fulvous; folium constricted, sides obtusely-crenate, mostly covered with brown patches, stained and bordered with dark-brown; lateral margins stained with light fuscous-green; ventral shield dark olive-green, border brownish-buff. *Vulva* greenish, yellowish towards fore-end; represents a transversely-wrinkled scape, rather longer than wide, second half tapers somewhat rapidly, perceptible bead round margins, projects backwards from a moderate elevation.

Single example, contained in a small collection from Stewart Island. *T. Kirk, F.L.S.*

Epeira ventriosa, sp. nov.

Fem.—Ceph.-th., long, 7·1; wide, 6; facial ind., 3·1. Abd., long, 12·5; wide, 11. Legs, 1, 2–4, 3 = 25, 23, 15 mm.

Cephalothorax deep amber-colour, brown-lake reflections;

hairs tolerably thick, but patchy, straw-colour, passing into orange over superior aspect of caput; pars cephalica depressedly convex, squarely truncated, eye-eminence prominent; lateral index equal to two-thirds facial; occiput exhibits near centre a plainly visible triangular depression; depth of *clypeus* rather surpasses interval dividing fore-centre eyes; pars thoracica well dilated; fovea deep, circular; caput and radial striæ well defined; profile-line ascends from thoracic junction at an angle of 25°, dips across occiput with a visible curve.

Eyes on dark spots; represent two moderately and somewhat equally recurved rows; posterior centrals separated by an interval perceptibly exceeding an eye's breadth, nearly twice their space from laterals; anterior median pair visibly larger than hind-pair, rather more distant from each other—an eye's diameter and a half—than they are from posterior centrals, scarcely their space and one-half from side-eyes, which are less than half as large as centrals, divided from one another by an interval scarcely equal to their radius; a short tumid process curves over fore-eye.

Falces deep amber-colour, clouded with olive-green; sparingly haired; conical, base projects beyond plane of clypeus, somewhat retreating; length equals their space, as stout as the femur of a fore-leg.

Maxillæ brown-pink, passing into light yellow-brown on margins; breadth nearly equals length; dilated, round-pointed; inclined towards each other.

Labium shade darker than maxillæ; rather wider than long, semi-oval, margins turgid.

Sternum brown-pink, suffused with deep chocolate-brown; hairs golden, somewhat thick; cordate; well-defined eminences opposite coxæ.

Legs somewhat lighter shade than cephalothorax; moderately stout; first and hind pairs do not differ greatly in strength; sparingly armed with yellowish hairs; spines yellowish, base fuscous, short, fairly numerous.

Palpi fulvous; slender; armature similar to legs.

Abdomen broad-oviform, projects over base of cephalothorax; studded with lake-brown papillæ, projecting short yellowish bristles; sparingly clothed with yellowish hairs; ground-colour light olive-green, approximating to stone-colour on medial line and lateral margins; closely spotted—except on the lighter-tinted parts—with creamy-yellow, lake-spotted, lobate flecks; humeral tubercles mammiform, apices teat-like, brown; posterior tubercle brownish-lake; lateral margins and ventral surface somewhat suffused with lake-brown. *Corpus vulvæ* represents a broad-oval, yellow-brown elevation; exhibits two or three dark, heart-shaped, low costæ, whose apices terminate close to margin of the rima genitalis; a long, tolerably wide, tapering, transversely-wrinkled, yellowish scapus springs from above, curves closely over the corpus; extends beyond superior margin of the latter for more than one-third its length.

This fine specimen was kindly sent to me by *Mr. E. J. Savage*, from Raglan.

Epeira leucisca, sp. nov.

Mas.—Ceph.-th., long, 4·1; wide, 3·7. Abd., long, 4·5; wide, 3·5. Legs, 1, 2, 4, 3 = 14·5, 14, 11·5, 7·7 mm.

Cephalothorax mahogany-brown, clouded and figured with a deeper shade; glabrous; rugulose; depressed; broad-ovate; cephalic part moderately convex, lateral compression somewhat sharp, well-defined subcircular fovea in centre; ocular eminence very prominent; thoracic indentation large, deep, exhibits within a lake-brown cruciform figure; normal grooves irregular; profile-line represents a tolerably even low arch.

Central *eyes* on dark rings, posited obliquely on ocular prominence, form a trapezoid rather longer than broad behind, widest in front, anterior pair largest by one-fourth; laterals much the smallest of eight, placed on tolerably prominent elevations, interspace separating them equals their radius.

Falces lake-brown; slender, vertical, profile sensibly concave, fore-third divergent, nearly twice as long as broad at base.

Maxillæ greenish-yellow, clouded with fuscous-green; breadth visibly surpassed by length, somewhat obtusely pointed, inclined towards each other.

Labium fuscous-green, margins pale; nearly as wide as long, oval, apex very perceptibly pointed.

Sternum fuscous-green; narrow-cordate.

Legs greenish-fulvous, suffused with a light coffee-brown, passing into fuscous-brown on fore-part of femora; indication of three annuli on tibiæ + metatarsi; almost glabrous; spines yellowish, short, slender, tolerably numerous, irregular; curved process on coxæ of first legs; femora of anterior pairs stout, slightly compressed; tibia of first leg slight, gradually incrassated forwards; of second leg somewhat clavate, well armed with spines, strong and numerous on inner side of second half.

Palpi yellow-brown, suffused with olive-green; pars humeralis short, prominently turgid beneath; inferior surface projects a few strong bristles; cubital joint angular-oval, bristle at extremity; radial more than twice as wide as long, subcylindriform, exhibits three longitudinal grooves; lamina yellow-brown, clouded with olive-green; finely haired; linear-ovate, apex tapers somewhat rapidly; base prolonged into a rather long lake-coloured process, extremities sharply bent forwards; bulbus genitalis consists chiefly of curved lobes or cutical folds of various ochraceous shades, clouded with fuscous-lake; most noticeable—anterior lobe wrinkled, terminates in a very conspicuous crimson conoid projection, directed backwards, subtouching the orange-yellow somewhat oval fore-end of posterior lobe; lower half of anterior lobe divided from upper by a transverse fold, curves backwards and upwards; base of bulbus displays a large fuscous-lake membrane, extremities free, lower tapering, upper outward-curved, furcate.

Abdomen oviform, depressed; sides abrupt, longitudinally wrinkled, studded with small pits in vertical lines; humeral tubercles small, obtusely-conical, directed outwards; first row of posterior tubercles slightly developed, central strongest; tubercle of second row somewhat prominent; integument metallic stone-colour or dull silver, few well-defined olive-brown clouds; folium sensibly suffused with brown; basal and posterior extremities fade away into ground-colour; margins brown, acute-crenate; six pairs of impressed spots, four central brown, conspicuous, represent a trapezoid fully as long as broad in front, widest behind; anterior set form a trapezoid relatively and comparatively broader; posterior foveæ represent a quadrilateral figure; ventral region occupied by a fuscous shield, centrally traversed by a light bar.

Single example of this rather handsome species was contained in *Mr. H. Suter's* Hastwell collection.

Fam. Lycosidæ.

Gen. Lycosa, Latr.

Lycosa maura, sp. nov.

Mas.—Ceph.-th., long, 7·3; broad, 5·7. Abd., long, 6·5; broad, 4. Legs, 4, 1–2, 3 = 34, 29, 26·5 mm.

Cephalothorax pitch-black, bluish-purple reflections; somewhat sparingly clothed with light and erect black hairs; fringe of former round margin; broad-ovate, lateral margin of caput sharply constricted; lateral index of cephalic part slightly exceeds one-half facial; depth of *clypeus* barely equals intervening space between fore-centre eyes; thoracic groove longitudinal, deep; radial and caput striæ well defined; contour of profile visibly curved over eye-region, slopes sensibly to verge of posterior incline, which dips abruptly at an angle of 60°.

Anterior row of *eyes* procurved, median pair sensibly larger than laterals, trifle further from them than they are from each other; eyes of second line large, interspace between them scarcely one-fourth wider than their diameter; dorsal eyes more than half size of former pair, separated by double the interval that divides them from second row.

Falces dusky purple-lake, passing into a more pronounced purple at fore-end; hairs light, long, moderately thick; transversely rugose; subconical, divergent, project forwards, length equals breadth of caput.

Maxillæ light yellow-mahogany; moderately haired; elliptic-spathulate, subtouching.

Labium chocolate-brown, apex light; oval, sensibly truncated, nearly one-half length of maxillæ.

Sternum brown-pink, clouded with a deeper tone; short, light, and erect black hairs; oval.

Legs mahogany-colour, fuscous clouds, purple-lake reflections; well armed with dull straw-coloured and fine erect black hairs; femora have 5 spines, 3 of which form a transverse line at fore-end; patellary joints 1, 1 side-spines; tibiæ of first and second legs, 8; metatarsi, 7; the respective joints of hind-pairs have about 9–15.

Palpi colour and armature of legs; pars humeralis compressed, second half incrassated; cubital joint short, subcampanulate; radial similar in form, perceptibly longer; digital joint surpasses penultimate in length by about one-third; lamina ovate, well-haired, projects nearly one-half its length beyond bulbus; genital bulb lake-brown, transversely rugose; semi-globose; inner aspect turgid, fore-half furcate, outer horn broad, subtriangular, inner surface aplanate, exhibits on margin a lunulate ochreous mark; superior surface convex, incurved, gradually dilated forwards, outer border prolonged into a short yellowish process, directed inwards; inner horn shortly truncated, projects a greenish-black, membranous, rather wide, tapering apophysis, inclined inwards, curved sharply backwards, subtouching apex of outer horn at point of curvature.

Abdomen oviform, base truncated; olive stone-colour; thickly clothed with dull straw-coloured and erect long black hairs.

Fem.—Ceph.-th., long, 6; broad, 4·3. Abd., long, 6. Legs, 4, 2, 1–3 = 23·5, 18·2, 17·5 mm.

Cephalothorax and *legs* yellowish-brown, clouded and splashed with black-brown.

Abdomen olive-green, suffused with fuscous-green. Legs and abdomen less haired than male's.

This fine male example, which was contained in *Mr. H. Suter's* collection, was captured near Mount Cook by *Mr. G. H. Mannering.* It was accompanied by another specimen, apparently the female: owing to the shrivelled state of the abdomen it was not possible to determine whether the example was mature.

Fam. Attidæ.

Gen. Marpissa, C. K.

Marpissa armifera, sp. nov.

Mas.—Ceph.-th., long, 2; broad, 1·2. Abd., long, 2; broad, 1·2. Legs, 1, 4, 2, 3; 1st and 4th about 3·5 mm.

Cephalothorax mahogany-colour, fuscous clouds, bluish reflections; moderately clothed with whitish and orange-red hairs; clypeus fringe thick, projects well over falces; cephalic part aplanate, limited by an oval fovea, sensibly compressed forwards, lateral margins retreating; height of *clypeus* equal to diameter of a lateral eye; thoracic part very slightly dilated, barely one-third longer than cephalic; profile-line ascends from thoracic junction at an angle of 60°, somewhat level over occiput, inclined across eye-region.

Anterior row of *eyes* perceptibly recurved, median pair subtouching, laterals removed from them by an interval visibly shorter than their own radius; dorsal eyes scarcely surpass laterals in size, interval separating them slightly exceeds space dividing the latter pair; posterior eyes about one-third further from each other than they are from lateral border; eyes of second row nearly intermediate between fore- and hind-eyes.

Falces red-mahogany, clouded; perceptibly shorter, and less stout, than the pars patellaris of first leg, retreating.

Maxillæ yellowish-mahogany; elliptic-spathulate, inclined towards *labium*, which is oval, base dark.

Sternum brownish; haired; oval.

Legs, thighs suffused with black-brown; patellæ of first and second yellow-mahogany; tibiæ fuscous; metatarsi and tarsi yellowish; second half of former article dark-brown; patellary and tibial joints of third and fourth legs brownish-yellow, broad distal fuscous annuli; metatarsi and tarsi yellowish, fore-half of penultimate joint fuscous; spine armature does not differ materially from female's.

Palpi yellowish-mahogany; pars humeralis subcylindrical, scarcely surpasses clava in length; cubital joint yellowish, of somewhat even breadth, nearly one-third longer than radial; latter article projects from outer side a strong process, curving forwards and inwards; lamina ovate, apex abscinded; sparingly haired; genital bulb greenish tone; viewed from beneath, subcordate, depressed, base incised prominently, especially on outer side; projecting between bulb and lamina, inner side, is a plainly visible membranous process, sharply compressed into a dark spine-like apex.

Abdomen ovate; hairs white and orange-red, somewhat sparse; specific pattern resembles that of the more obscurely-marked female.

Fem.—Ceph.-th., long, 2·4; wide, 1·7. Abd., long, 3·2; wide, 2. Legs, 4, 1, 2, 3 = 4·6, 4·2, 4, 3 mm. Measured from beneath.

Cephalothorax chestnut-colour, fuscous clouds; hairs white and orange-red, tolerably thick; fringe on clypeus white; complanate; cephalic part scarcely one-half shorter than thoracic, limited by a shallow V-shaped mark; perceptibly inclined, projects well over falces; lateral margins slightly compressed; height of *clypeus* equals two-thirds diameter of a side-eye; thoracic part moderately dilated, sides abrupt.

Anterior row of *eyes* moderately recurved, centrals plainly closer to each other than they are to laterals, an interval nearly equalling radius of a side-eye; dorsal pair do not differ essentially from fore-pair, posited somewhat further apart, so that the ocular region diverges very visibly posteriorly; eye-area one-third broader behind than long.

Falces yellowish-mahogany; somewhat slighter and shorter than the pars patellaris of a front leg; retreating.

Maxillæ yellow-brown; about twice length of *labium*, which is similar in colour, base fuscous.

Sternum light-brown, deepening in tone about border; oval, half as wide as long.

Legs: Femoral, genual + tibial joints of first pairs yellow mahogany-colour; metatarsi + tarsi yellowish; reddish-brown distal rings on penultimate article; hind-pairs approximate more to a yellowish tone; except tarsal joints, display apical annulations of a fuscous colour; coxæ of fore-pair less than breadth of lip from each other; anterior legs most robust; femur dilated, compressed; patella + tibia cylindrical, of about equal length; metatarsus + tarsus much shorter and slighter than two former articles; tarsus sensibly shorter than metatarsus. Hairs white, somewhat sparse; femora spined; tibiæ of anterior pairs, 2, 2, 2 beneath, 1 side-spine; metatarsi, 2, 2 inferior surface; tibiæ of third and fourth legs, 5 spines; distal ring on metatarsi.

Palpi mahogany-colour; hairs white; pars humeralis somewhat dilated and compressed; three following joints do not differ much in length.

Abdomen elongate-ovate, clothed with white and bright orange-red hairs; brownish stone-colour, flecked with a few tolerably large brown spots, which are resolved into longitudinal streaks on lateral borders; on base are two subtouching light-brown elongate-ovate marks, apices directed backwards; dorsal line exhibits on centre third a rather large fuscous arrow-shaped figure, apex directed forwards; on posterior third is a somewhat smaller hastate mark of similar colour, point reaches to spinners; inferior surface faintly spotted, a tapering dusky stripe extends from vulva to spinners. *Corpus vulvæ* represents an oval or sub-diamond-shaped moderately-depressed area; within are two large reddish-brown tumid sublunulate (plano) lobes, whose convexities are directed outwards, separated by an oval space nearly their equal in breadth.

These examples were accompanied by two mature females one-third smaller than the type specimen; pattern less defined. *Mr. W. W. Smith*, to whom I am indebted for this interesting species, states: "I discovered the species amongst the limestone rocks at Albury, and they appeared to be not uncommon. The cocoons hang in grape-like clusters in dry niches of the rocks, and are certainly interesting objects; they were perforated by a parasite."

The cocoons, which are connected by numerous fine lines, are globose, about 12 millimetres in diameter; consist of a double case, composed of a somewhat close felty texture; the inner, which is white, contains a flossy wadding; the outer cover grey.

Marpissa nemoralis, sp. nov.

Mas.—Ceph.-th., long, 1·8; wide, 1·2. Abd., long, 2; wide, 1. Legs, 1, 4, 2–3 = 4·4, 4, 3 mm.

Cephalothorax light-brown; fuscous spots, bluish reflections above lateral eyes; V-shaped mark of a lighter tone connects indentation with dorsal eyes; hairs pale straw-colour and orange-red, short, adpressed; irides orange-red; clypeus hairs short; cephalic part aplanate, limited by a subcordate indentation, projects well over *clypeus;* depth of latter equals radius of a fore-centre eye; thoracic part moderately dilated, sides steep, surpasses pars cephalica in length by one-third; profile-contour rises from stalk at an angle of 55° to fovea, from thence slopes moderately forwards with a visible curve.

Anterior row of *eyes* moderately recurved, median pair subtouching, laterals separated from them by an interval barely equalling their own radius; dorsal eyes do not differ essentially in size from laterals, scarcely as distant from each other; about one-third further from one another than they are from lateral border; eyes of second row posited midway between fore- and hind-eyes; breadth of square exceeds length by one-third.

Falces brownish-ochreous; moderately haired; inclined forwards and outwards, nearly twice as long as broad; inner margin of fore-half turgid, grooved, appears as if the extremity had been elongated and folded back.

Maxillæ light yellow-brown, base clouded with olive-green; well developed, gradually dilated, rounded, second half curved outwards.

Labium deeper tone; roundly conical, about half length of maxillæ.

Sternum colour of legs; ovate.

Legs yellow-ochreous; femora + tibiæ exhibit evanescent olive-green basal and distal annuli; metatarsi of hind-pairs have rather wide apical rings; femoral joints compressed and dilated, armed with 4 spines on superior surface; patella + tibia of first leg cylindrical; tibial joints of anterior pairs have 2, 2, 2 spines beneath; metatarsi, 2, 2; tibiæ of third and fourth, 5; metatarsi 2, besides apical ring.

Palpi deep straw-yellow; pars humeralis somewhat incrassated, about double the length of two following articles together; cubital joint campanulate; radial of somewhat even breadth, one-half length of preceding article, projects a strong spine-like process on outer side, and a cluster of bristles from inner; pars digitalis exceeds humeral joint in length; lamina ovate, brownish about margins; moderately furnished with light and dusky hairs; genital bulb passes into a pale slate-colour at apex, projects a few black hairs; turgid, subconoid, reaches back to cubital joint; superior profile-line represents a very obtuse angle.

Abdomen elongate-oviform; spinners prominent; rather sparingly clothed with whitish and orange-red hairs; ground-colour light yellow-ochreous, moderately flecked with irregularly-shaped light-brown spots; the more pronounced markings, which have a deeper tone, consist of a pair of inverted comma-shaped figures on basal end; two procurved, continuous, transverse, arcuate chevrons—margins undulating—occur in centre, and the posterior third is traversed by somewhat similar lines; a series of more or less confluent oblique stripes are displayed on lateral margins; ventral region exhibits a lanceolate figure enclosed within a series of dots, terminating at spinners in a large quadrate spot.

Fem.—Ceph.-th., long, 1·9; wide, 1. Abd., long, 2·1; wide, 1·2. Legs, 4, 1, 2–3 = 3·7, 3·5, 3 mm.

Cephalothorax reddish-mahogany, approximating to brown on margins, fuscous spots above lateral eyes; hair armature and form do not differ essentially from male's.

Eyes in form and position resemble male's.

Falces lake-ochreous.

Maxillæ orange-brown, *lip* shade darker.

Sternum and maxillæ concolorous.

Legs brownish-orange; femoral + tibial joints have olive-green basal and apical annulations, very faint on two first pairs; rings on hind-pairs more pronounced; armature resembles male's.

Palpi pale-orange; sparingly furnished with white hairs; radial + digital joints somewhat turgid.

Abdomen elongate-ovate, depressedly convex; hairs somewhat sparse, short, white and orange-red, former predominate; light olive-green; fore-part of dorsal region occupied by an ovate, somewhat rapidly attenuated figure, whose apex reaches to posterior third, of a denser tone than normal ground-colour, spotted with more or less coalescing fuscous flecks; anal third and inferior half of lateral margins have similar streaks and spots; evanescent brownish lanceolate mark on ventral aspect. *Corpus vulvæ* lake-brown; represents a rather large, slightly-elevated, transverse oval area, acutely emarginate above the rima genitalis, occupied by two mussel-shaped foveæ, divided by a broad septum.

Captured in the forest near Stratford. *A. T. U.*

Gen. Plexippus, L. K.

Plexippus sylvarus, sp. nov.

Max.—Ceph.-th., long, 2·6; wide, 1·9. Abd., long, 2·2; wide, 1·3. Legs, 1, 4, 2, 3 = 7, 5·6, 5·1, 4·5 mm.

Cephalothorax mahogany-brown, fuscous clouds, bluish reflections; fairly well clothed with straw-coloured and orange-red adpressed hairs; irides orange-red; clypeus fringe light, projects well over base of falces; thoracic part slightly dilated, about one-fourth longer than caput, slopes visibly away from dorsal eyes, dips at an angle of 45° to stalk; cephalic part plane, inclined forwards, limited by a subcircular depression.

Central *eyes* of anterior row rather closer to each other than they are to laterals, an interval less than one-half the radius of a side-eye; dorsal and lateral eyes of about equal size, former posited further from each other than are the latter pair, by rather more than an eye's diameter; eyes of second row placed somewhat nearer to hind-pair; ocular square about one-fourth wider than long.

Falces mahogany-brown, clouded; rugose; subovate, more prominently rounded on inner side, somewhat flat, project well forwards, length exceeds breadth by about one-third, as long as the pars patellaris of second leg.

Maxillæ reddish-brown, base clouded with chocolate; gradually dilated, rounded.

Labium yellow-brown, clouded; elliptical, fully half length of maxillæ.

Sternum yellow-brown, dusky clouds; oval.

Legs yellowish-ochreous; thighs of anterior pair have an olive-green tone, fuscous shading; tibiæ, metatarsi + tarsi reddish-brown; metatarsi of two hind-pairs, and tibiæ of fourth, have dusky distal rings; form and armature normal; claws of first pair well curved, outer 1 tooth; inner claw 18 close teeth, terminal tooth strongest.

Palpi yellow-brown, clouded; pars humeralis incrassated forwards, about one-third longer than two following articles together; cubital joint gradually dilated, nearly twice as long as penultimate article; radial joint, viewed laterally, of even breadth, nearly as broad as long above; projects from a somewhat circular enlargement—outer side—a strong, lake-brown, down-curved tooth-like process; digital joint rather shorter than two former articles together; lamina olive-brown, elongate-ovate; hairs somewhat sparse, except on inner margin, which is furnished with a thick fringe; genital bulb yellowish-brown; globosely-conical, fore-end depressed; lying close to lamina is a reddish-brown elongated lobe of somewhat even width, sharply recurved at anterior end.

Abdomen elongate-ovate; tolerably well clothed with straw-coloured and orange-red hairs, former predominate; ground-colour light burnt-umber, mottled with a dark shade; deeper tone prevails on lateral margins; ventral region marked with three dark stripes, converging to spinners; latter organs long, superior pair stone-colour, inferior approximating to olive-green.

Taken in the forest near Stratford. *A. T. U.*

ART. XVII.—*On New Zealand* Araneæ.

By P. GOYEN, F.L.S.

[*Read before the Otago Institute, 10th November, 1891.*]

Plate XIX.

Fam. ATTOIDÆ.

Gen. MARPTUSA, Thor.

Marptusa marina, sp. nov. Plate XIX., fig. 1.

Femina.—Length of cephalothorax about 3mm., of abdomen about 5mm.

Cephalothorax dark-brown at and near the margin and the posterior slope, with a triangular central area of a red-brown colour, and covered, except the posterior slope, with silky greyish and reddish-brown hair; legs brown, with pale- and reddish-brown annulations, and hairy; falces, lip, and maxillæ brown; sternum pale-brown; abdomen above brownish-yellow interspersed with flecks of brown, but without a well-defined pattern, covered with greyish appressed hair, and having two pairs of small reddish-brown spots, the hind-pair being situated about half-way between the extremities, and the fore-pair, which are nearer together, about half-way between the hind-pair and the anterior extremity; ventral surface of a much lighter hue than the dorsal and lateral surface; near the base are two pale oval areas, one on each side, and in mature examples there are two darkish lines beginning behind the genital aperture and converging towards the spinners. Young examples are of a much lighter hue throughout than old ones.

Cephalothorax about a third as long again as broad, and slightly narrower in front than behind; quadrangulus oculorum flattish, and much broader than long; eyes of the third row near the edge of the quadrangle, and as distant from each other as are the laterals of the front row; eyes of the second row very minute, and placed almost in the middle between those of the third row and the front laterals, and in line with them; centrals of the front row very large, projecting over the clypeus and completely concealing the falces; the laterals of this row do not differ much in size from the eyes of the third row; under this row there is a very dense fringe of hair.

Falces nearly of the same width throughout their length, sparingly hairy, and having two teeth on one side of the groove, and one on the other; fang rather slender, and not much longer than its falx is wide.

Maxillæ narrowest at the base and widening towards the extremities, where they are rounded on the outer and obliquely truncated on the inner side, not divergent.

Labium not quite half as long as the maxillæ, oval in outline, and almost truncated in front.

Sternum oval in outline, truncated in front and somewhat bluntly pointed behind.

Abdomen oblong-ovate; spinners of nearly equal length and compactly grouped, the inferior pair being the strongest.

The legs are strong, hairy, armed with spines, and furnished with a dense hair-tuft under the claws.

The genital aperture has a dark-brown horny process on each side placed thus—\ /; the convergence being towards the posterior of the orifice.

In general appearance the male resembles the female.

This little spider is found along the coast of Otago, on cliffs and rocks just above, at, or just below high-water mark. On these rocks and cliffs are found in great abundance two or three species of Diptera, which the spider resembles in colour and mode of progression. So striking is this resemblance that for some time I mistook the spider for a fly. In moving along the face of the rocks it runs very briskly for an inch or two, then stops, rubs its palpi just as a fly rubs its fore-legs, examines the surface of the rock within its view, then again runs briskly for an inch or two, again stops, rubs its palpi, and "spies out the land;" and so on till it comes within view of its prey—or what it takes to be such, for it seems to have some difficulty in distinguishing members of its own species from the flies on which it lives. It now advances exactly like a cat approaching a bird, stealing forward at a pace so slow that one can scarcely see it advancing, until within about an inch of its prey, when it springs swiftly upon the unsuspecting fly, and pinions it with its falces and palpi. Within springing-distance its aim is so sure and its bound so swift that the fly has no chance of escape. Having captured its prey it generally carries it to a depression in the rock, and there, if undisturbed, sucks its juices at leisure. Half the spiders one sees are thus in hiding with a fly in their jaws. Very often the fly is much larger than the spider; but the latter, if discovered by another spider, makes off with the captured fly with the greatest ease. It will even leap across a crevice an inch or so wide, and if its covetous brother is persistent in his pursuit, to escape him it will spring into space and hang, head downwards, suspended by a strand of web, but never parting with its prey. In every case I observed the pursued was successful in eluding the pursuing spider.

This little spider is exceedingly interesting as affording, in a class of animals in which it has not, I believe, been before observed, a striking example of aggressive mimicry.

Fam. THERAPHOSOIDÆ.

Gen. ARBANITIS, Koch.

Arbanitis huttonii, Cambr. Plate XIX., figs. 2 and 3.

Femina.—Length of cephalothorax from 4½mm. to 6mm., of abdomen from 8½mm. to 10mm.

Cephalothorax with its appendages brown, the falces being of a very dark colour; abdomen above of a somewhat paler hue than the cephalothorax, and below of a much lighter hue than above. The dorsal surface is marked with dark more or less continuous bands, running somewhat obliquely from the median line down the sides, and the ventral surface is also marked with dark spots that in some examples form a fairly distinct pattern, consisting of two transverse bands, greatly enlarged in the middle on the basal side, one in line with the posterior pair of pulmonary orifices, and the other about half-way between these and the spinners. It is only in mature examples that these ventral markings are very distinct.

Cephalothorax elliptical in outline, truncated in front and behind, nearly half as long again as broad, prominent and convex between the back of the eyes and the fovea, which is transverse and deep, and low on the posterior side of the fovea; lateral indentations very distinct.

Ocular area prominent, eyes compactly grouped, the front row curved backwards, and the hind row very slightly forwards.

Falces prominent, knee-shaped, stout, furnished with parallel longitudinal bands of stout hairs, and on the upper side of the fore extremity armed with numerous tooth-like spines; groove on the inner side furnished with strong teeth, and on the outer side with a dense fringe of reddish hair; fang long and strong. Maxillæ nearly parallel at the sides, somewhat pointed at the outer side of the basal extremity, and furnished with short spines on the inner side of the basal half.

Labium wider than long, triangular in outline, convex, truncated in front, where it is furnished with a band of bristly hairs.

Sternum cordate, slightly emarginate in front, and bluntly pointed behind.

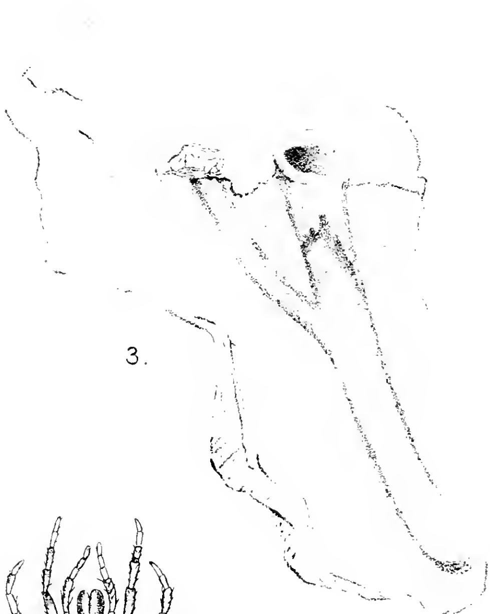
Legs hairy, armed on the under-side with a large number of spines, and terminated with three hooked claws, each superior claw having at its base a tooth nearly as long as the inferior claw; the tarsi and metatarsi of the first and second pair furnished with a scopula. The armature of the palpi is similar to that of the legs, and each is tèrminated with a strong claw, which, like the superior claws of the tarsi, is furnished at its base with a long tooth.

Abdomen ovate; superior pair of spinners many times as large as the inferior pair; genital aperture a simple transverse slit.

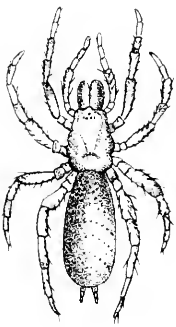
Hab. Dunedin. *P. G.*

This spider strongly resembles *Nemesia gilliesii*, Cambr., differing from the latter chiefly in its habits and more slender build. The male was figured and described by the Rev. O. Pickard-Cambridge in 1879 from a specimen sent from Dunedin by Captain Hutton (see Proc. Zool. Soc., 1879, p. 682, and pl. lii., fig. 1), but no information as to its habits was sent to Mr. Cambridge. It is chiefly owing to this defect that I have described the female.

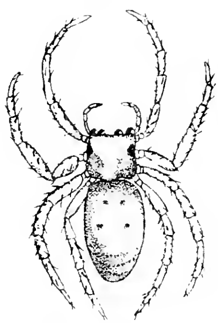
Its nest (Pl. XIX., fig. 3) is of the branched type, but without a door or any sort of cover to the entrance of the main tube. The branch is smaller than the main tube, makes with the latter a more or less acute angle, and extends to the surface of the ground, where it is completely covered with particles of soil and other material, bound loosely together with web, and attached to the lining of the tube in such a way as



3.



2.



1.

A. H. del. N. Z. ARANEÆ. C. H. P. lith.

to form a rude sort of lid, which, both as to form and colour, is on its exterior side so absolutely perfect an imitation of its surroundings that it is impossible to discover the mouth of the tube without disturbing the surface of the ground. The mouth of the main tube is very conspicuous, and seems designed to invite the entrance of the animals upon which its fabricator preys. The spider, though strong, is yet very sluggish, and in the open wholly incapable either of escaping its enemies by flight or of capturing by pursuing its prey. It needs some special contrivance to protect it from the former, and to enable it to capture the latter, and its nest seems to me to be admirably adapted for both these purposes.

When the entrance of the main tube is disturbed, the spider, regarding this as the signal for the entrance of its prey (beetles) or an enemy, immediately betakes itself to the branch tube, and from this vantage-ground attacks its prey or its enemy, as the case may be, in flank while it is passing, or in rear when it has passed, the branch. In such a position its advantage over an intruding animal is obviously very great; and, as I take it, very few animals capable of entering the tube could be successful against an enemy so advantageously posted. Should, however, the intruder prove more than a match for the occupant, the latter would still enjoy a position of comparative security. The intruder could not attack it without turning in the nest—a matter of some difficulty. The branch tube is always narrower than the main tube, and therefore more difficult to enter; and, finally, the spider is able to back up the branch, and, if hard pressed, to push aside the loose cover, and thus effect its escape. From the behaviour of the spiders I have captured, I have no doubt that this is the correct interpretation of the design of the nest. The whole contrivance is most ingenious, and affords another striking example among the lower animals of what strongly resembles man's reasoned adaptations of means to ends.

The plate was kindly prepared for me by Mr. A. Hamilton, Registrar of the Otago University.

EXPLANATION OF PLATE XIX.

Fig. 1. *Marptusa marina*, sp. nov.
Fig. 2. *Arbanitis huttonii*, Camb.
Fig. 3. „ „ „ nest.

Art. XVIII.—*Notes on some New Zealand Amphipoda and Isopoda.*

By Chas. Chilton, M.A., B.Sc.

[*Read before the Otago Institute, 10th November, 1891.*]

During the six years that have elapsed since the publication of a critical list of the New Zealand Amphipoda and Isopoda by Mr. G. M. Thomson and myself,* much new material has been collected of which no account has yet been published, while the publication of the reports on the "Challenger" Isopoda and Amphipoda, by Beddard and Stebbing respectively, has shown that there are many things that need alteration in the nomenclature of the species already known, and many points concerning them that require more fully working out. To do this properly it would be necessary to begin at the beginning of the list, and to take the species one by one and work each out fully. This, however, would be a work of very considerable magnitude, and would require the continuous attention of the worker for a long time. In the present paper I shall content myself with giving a number of miscellaneous additions to our knowledge on the subject. I describe some new forms, record others already known elsewhere, but new to New Zealand, and draw attention to a few of the changes and additions made in the "Challenger" reports.

For material, besides what I have collected myself, I am indebted to Mr. R. M. Laing, of the Boys' High School, Christchurch; to Mr. H. Suter, of Christchurch; and particularly to Mr. G. M. Thomson, Science Master of the Dunedin High Schools, who, feeling unable at the present time, through pressure of other matters, to work at the subject himself, has very kindly handed over to me all the undescribed Amphipoda and Isopoda in his collection, together with many of his own notes and drawings. Among the specimens that I have thus received are many collected by Mr. J. F. Ereeson, of Waipapa Point, and by Mr. F. S. Sandager, of Mokohinou, both of whom have in this way rendered valuable assistance. Only a small part of the material thus placed at my disposal has been used in the preparation of this paper; I hope to be able to make use of the remainder on some future occasion.

In the case of species previously described, I have endeavoured as far as possible to give the reference to our Critical List,* and to any papers published since, but I have

* Trans. N.Z. Inst., vol. xviii., p. 141.

not repeated the references already given in the Critical List. In the case of some species I have given only short diagnoses, hoping to supplement these at some future time with fuller descriptions and figures. In other cases I have mentioned species merely to state what questions require solution.

AMPHIPODA.

Talorchestia tumida, G. M. Thomson.

Talorchestia tumida, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 145; Stebbing, Trans. Zoological Society (London), vol. xii., p. 202, pl. xxxix.; Thomson, Trans. N.Z. Inst., vol. xxi., p. 260, pl. xiii., figs. 4–8.

This species was first briefly described by Mr. Thomson in the *New Zealand Journal of Science*, vol. ii., p. 577. This description was reproduced in the Proceedings of the Zoological Society for the 19th January, 1886 (p. 4), by Mr. Stebbing, who afterwards fully described and figured the male in the Transactions of the Zoological Society, and Mr. Thomson supplemented this by a description of the female in the Transactions of the New Zealand Institute, vol. xxi., p. 260.

The species was originally taken at Purakanui, near Dunedin. I afterwards took it on the Ninety-mile Beach, a few miles north of Timaru; and in Mr. Thomson's collection there is one specimen from Waipapapa Point, collected by Mr. J. F. Ereeson. The form of the second gnathopod of the male varies very considerably, apparently according to the growth of the animal, and its development needs working out in this as in many other species of the Orchestidæ.

Stenothoe adhærens, Stebbing.

Stenothoe adhærens, Stebbing, "Report on the 'Challenger' Amphipoda," p. 748, pl. xxxix.

I have for some years had specimens from Lyttelton Harbour that I now refer without much doubt to this species, which is described by Stebbing from two female specimens taken off Cape Agulhas, South Africa. My female specimens agree very closely with his description; the males, which he had not seen, differ in having the peduncles of the antennæ longer, and especially in the second gnathopoda, which have the propodos very large—about as large as all the rest of the limb; the anterior edge is convex; the posterior edge is straight, and produced distally into a sharp tooth, at the base of which is a small projection on the inferior margin. The dactylos is fully as long as the propodos, and has a slight enlargement on the inner margin, at some distance from the base; its inner margin, and the whole of the posterior margin of the propodos, against which it impinges, are fringed with numerous short stiff setæ.

I had previously thought that this species might perhaps be identical with *Montagua marina*, Spence Bate, and it certainly appears to resemble that species pretty closely, but whether it is identical or not I cannot venture to say until I have an opportunity of comparing specimens of both species. It may perhaps be the same as *Montagua longicornis*, Haswell,* but the description of that species is too brief to enable one to decide.

I have lately taken this species at Port Chalmers also.

Seba saundersii, Stebbing.

1875. *Seba saundersii*, Stebbing, Ann. and Mag. Nat. Hist., ser. 4, vol. xv., p. 2, pl. xv., figs. 2, 2*a*–2*c*.

1884. *Teraticum typicum*, Chilton, Trans. N.Z. Inst., vol. xvi., p. 257, pl. xviii., figs. 1, 1*a*–1*f*.

1885. *Seba typica*, Chilton, N.Z. Journal of Science, vol. ii., p. 320.

1886. *Seba typica*, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 148.

1888. *Seba saundersii*, Stebbing, "Report on the 'Challenger' Amphipoda," p. 783, pl. xlix.

In the full description given of this species by Mr. Stebbing in the "Challenger" Report he unites my *Teraticum typicum* with his *Seba saundersii*, saying that he thinks it must be identical with it. I originally had three specimens of my species, and I still have two of them (now mounted in Canada balsam), and, after having carefully compared them with Stebbing's full description and figures, I am quite convinced that he is right in making *Teraticum typicum* a synonym. The only point in which they differ is the one referred to by Stebbing—viz., the length of the first joint of the upper antenna. In both my specimens this is only as long as the second, while in his specimen, described in 1875, the second joint is "a little the longer," and in the "Challenger" specimen "decidedly longer."

His "Challenger" specimen is a female; and so, probably, therefore, was my third specimen, which resembled it in the shape of the first gnathopoda. This specimen was sacrificed for dissection in drawing up my original description. My two remaining specimens differ very considerably in the form of the first gnathopoda, and are probably males.†

The "Challenger" specimen was taken off Patagonia, and Mr. Stebbing's original specimen either from South Africa or

* Catalogue Australian Crustacea, p. 226.

† For description see Trans. N.Z. Inst., vol. xvi., p. 257.

from Western Australia, and mine from Lyttelton, so that the species, though so small, evidently has a wide range.

Elasmopus subcarinatus, G. M. Thomson.

Mœra subcarinata, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 146.

Elasmopus subcarinatus, Stebbing, "Report on the 'Challenger' Amphipoda," p. 1019, pl. xcviii.

This species is very fully described by Mr. Stebbing, and is by him placed in the genus *Elasmopus*, Costa, which comes close to *Mœra*. By the "Challenger" Expedition the species was taken at the following stations:—

"Station 161, off Melbourne, 1st April, 1874; depth, 33 fathoms; bottom, sand. Two specimens.

"A specimen of this species was labelled as having been taken, '3rd June, 1874, off Port Jackson, 30 to 35 fathoms.'

"Station 168, off New Zealand, 8th July, 1874; lat. 40° 28′ S., long. 177° 43′ E.; depth, 1,100 fathoms; bottom, blue mud; bottom temperature, 37·2°. One specimen."

In New Zealand this species is pretty common among seaweed, &c., at about low-water mark. I have taken it at Lyttelton and at Port Chalmers, and also on seaweed washed up on the Timaru beach. Mr. Thomson has taken it at Stewart Island; and Mr. Haswell records it from "Port Jackson (very common at low water among Algæ, &c.), Botany Bay; Port Stephens."

Vibilia propinqua (?), Stebbing.

(?) *Vibilia propinqua*, Stebbing, "Report on the 'Challenger' Amphipoda," p. 1279, pl. cxlvii.

I have a few specimens of a *Vibilia* taken in Port Chalmers that I refer to this species with some doubt. The genus has not been previously recorded from New Zealand, though it is very widely distributed. It contains a large number of species, many of them very much alike, and I have found considerable difficulty in endeavouring to identify my specimens. On the whole I prefer to put it down to *V. propinqua*, the species which Mr. Stebbing describes in the greatest detail in his "Challenger" report. The only point in which it differs materially from this species is in the telson, which is not "pear-shaped," but almost circular, being just about as broad as long; the broadest part, however, is a little nearer the base than the end, so that the telson is slightly oval. In the telson my specimens more nearly resemble *V. milnei*, Stebbing; but the details of that species, as drawn by Stebbing, differ considerably. They are, however, he says, perhaps taken from a young specimen. *V. viator*, Stebbing, again, has the telson more like that of my specimens than *V. propinqua* has, and seems to be intermediate in this respect between the two, having the telson somewhat triangular, with the corners well rounded, instead of "pear-shaped" or "circular." Of *V. viator* Stebbing says, "The uropods and telson are in very close agreement with those of *V. propinqua*," though his figures do not agree quite so closely. It is very easy, however, to make a considerable difference in figures drawn even as accurately as possible, when taken from different specimens of the same species; and Mr. Stebbing's remarks lead me to think that possibly the telson of *V. propinqua* is not always so distinctly pear-shaped as shown in his figure, but may sometimes approach somewhat to a more circular form. Certainly the several species mentioned are very closely allied, and probably should be looked upon as local varieties of a widely-dispersed species rather than as distinct species.

Vibilia gracilis, Bovallius, resembles *V. milnei* in having a round telson; but I have not been able to get a description of this species.

I give the following description of the telson and uropoda of my specimens:—

Telson as broad as long, nearly circular but broadest towards the base, margins quite entire. First uropoda with the peduncle reaching as far as the end of the peduncle of the second uropoda, its outer margin serrated towards the end, rami subequal, outer one with outer margin rather coarsely serrate, inner margin with two large serrations near the end and the rest minutely serrate, inner ramus with both margins serrate towards the end: second uropoda with rami subequal, shorter than those of first uropoda, outer ramus with its outer margin somewhat coarsely serrate, inner margin minutely serrate; inner ramus with outer margin minutely serrate, inner margin entire except towards the end, where it is minutely serrate: extremities of the rami of first and second uropoda acute: third uropoda with the peduncles broad but narrowed at the base, margins entire, rami about as long as those of second uropoda but broader; outer ramus with outer margin convex, entire, inner margin minutely serrate, one or two minute setæ placed at the rather blunt extremity; inner ramus with its outer margin minutely serrate throughout, inner margin with minute serrations, which increase towards the extremity, which is acute, and tipped with a minute seta.

The fifth and sixth segments of the pleon appear completely coalesced.

Colour.—The *Vibilia* is reddish in colour, the colour being found chiefly on the body, and being somewhat irregularly scattered. The eye, which is fairly large, is of a darker and more brilliant red.

Hab. Taken in Otago Harbour in company with a *Salpa* that is common on Ocean Beach and in Otago Harbour usually about March. The *Vibilia* appears to be associated with the *Salpa*, perhaps as a commensal, for I have never taken it except in company with the *Salpa*, and one specimen was taken actually in the branchial cavity of the *Salpa*.

Euthemisto thomsoni, Stebbing.

Euthemisto thomsoni, Stebbing, "Report on the 'Challenger' Amphipoda," p. 1414, pl. clxxiv., clxxv.

Themisto antarctica, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 151 (*non* Dana).

This species differs, according to Mr. Stebbing, from *Themisto antarctica*, Dana, as in that species the back is not dentate, and the third peræpods are very strikingly longer than the fourth and fifth. Mr. Stebbing has therefore renamed it in compliment to Mr. Thomson. The name of the genus was altered by Bovallius in 1887, as the name *Themisto* was preoccupied. The species appears widely distributed in the southern seas. By the "Challenger" it was taken "between Marion Island and the Crozets," "off Crozet Islands," "in the Southern Ocean," and "south of Australia." It is sometimes washed up on Ocean Beach, Dunedin, in great numbers.

Mr. Stebbing draws attention to some specimens which vary in some slight respects from the more typical specimens.

ISOPODA.

Idotea lacustris, G. M. Thomson.

[For synonymy see Trans. N.Z. Inst., vol. xxii., p. 194.]

This species was originally taken from the Tomahawk Lagoon, near Dunedin, in fresh water. Specimens that apparently belong to the same species are in the British Museum collections from Port Henry, Straits of Magellan (Dr. R. P. Coppinger). In January, 1891, Messrs. William Cron and D. Strachan brought me, from the Mihiwaka Creek, specimens that appeared to belong to the same species; and I have since taken it there myself in considerable abundance. The specimens were found near the place where the creek flows under the railway line at the mouth of the Deborah Bay Tunnel, near Port Chalmers. This place is perhaps about 200ft. above the sea; but the animal was also found both above and below this spot, and probably inhabits the whole creek, which flows down from Mount Mihiwaka, a mountain nearly 2,000ft. high.

I have since taken it also in a stream at Waitaki, some miles from Mihiwaka, and on the opposite side of Blueskin Bay.

On examination these specimens proved to differ from the Tomahawk specimens in several small points. I have already briefly mentioned these in the *New Zealand Journal of Science*, vol. i. (new issue), p. 131 (1891), but it will be as well to give them here in greater detail.

1. In the front margin of the head there is a small depression in the centre, which makes the middle portion appear more deeply emarginate than the rest of the front margin.

2. The eyes are much smaller, being only about half as large.

3. The inner antennæ (antennules) are rather more slender, and are longer, usually reaching to the end of the third joint of the peduncle of the outer antennæ; while in the Tomahawk specimens they do not usually reach beyond the end of the second joint.

4. The outer antennæ are more slender both in the peduncle and in the flagellum.

5. There is only one pair of sutures on the terminal segment of the abdomen. In the Tomahawk specimens there are two: the anterior one, though quite distinct, is small, and extends only a short distance towards the median line. The second one is more distinct, and extends nearly to the centre. It is the anterior pair of sutures that is wanting in the Mihiwaka specimens, while the second one, too, is somewhat less distinct. In this respect the Mihiwaka specimens agree with the figure given by Miers of a Magellan specimen, in which only one pair of sutures is shown.

6. The extremity of the abdomen is slightly more narrowed, not quite so broadly rounded as in the Tomahawk specimens.

7. The colour is usually much lighter, being a light-brown with darker spots and markings. The specimens from Tomahawk Lagoon are usually of a uniform dark greenish-grey.

It is also worthy of note that in none of the Mihiwaka specimens have I found the characteristic setæ found on the outer antennæ and on the second pair of legs of the males of the Tomahawk specimens.*

The differences between the two forms, though not great in amount, are thus seen to be somewhat numerous, and I have found them to be constant by the examination of a considerable number of specimens from each locality. Instead of erecting the Mihiwaka form into a distinct species, it will, I think, in this case be more convenient and less misleading if it is given the same name but is considered as a separate

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* See Trans. N.Z. Inst., vol. xxii., p. 195.

variety. The Tomahawk form might be denoted *Idotea lacustris*, var. *α*, and the other *I. lacustris*, var. *β*.

Cleantis tubicola, G. M. Thomson.

Cleantis tubicola, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 156; Thomson, Trans. N.Z. Inst., vol. xxi., p. 264, pl. xiv., figs. 5–8; Chilton, Trans. N.Z. Inst., vol. xxii., p. 203.

This species has hitherto been known from a single specimen only, collected at Auckland by Mr. R. Gillies. In Mr. Thomson's collection I find one (damaged) specimen from Waipapapa Point, collected by Mr. J. F. Erecson, and three specimens taken by Mr. Thomson himself "on the beach, Judge's Bay, Auckland." All are considerably larger than the type specimen, and are about 16mm. in length. Of the three specimens from Judge's Bay, Auckland, one is a male, and the other two females. I have compared these specimens with the description as given in my "Revision of the N.Z. Idoteidæ,"* and make the following notes:—

The front margin of the head is very slightly concave, and the head is only slightly produced backwards into the first segment of the thorax. The fourth and fifth joints of the antennæ are subequal, and rather longer than the preceding joints; the flagellum consists of a single joint, about as long as the last joint of the peduncle, and bears a thick tuft of short setæ on the inner side. The legs of the male are not quite so short as in the type, which is probably a young specimen, but the fourth pair is short as described. The epimera of the second to fourth segments are small, oblong; the others produced acutely backwards. Colour dark-brown, nearly black, much darker than the type.

In the female bearing young in the brood-pouch the body is of the same width throughout, and not expanded as in some species of *Idotea*, but the fourth and fifth pairs of legs are considerably shorter than the sixth and seventh, and somewhat shorter than in the male.

The third specimen is a female, with small brood-plates developed on the fourth and fifth segments. The legs are rather short, as in the other female.

The type specimen was found in a tube, which appears to be part of the hollow stem of some plant; but these specimens were taken "on the beach," and no mention is made of any tube; hence the occurrence of the type specimen in the tube was no doubt accidental, though it is perhaps worthy of note as showing how a habit of dwelling in tubes may be commenced.

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* Trans. N.Z. Inst., vol. xxii., p. 203.

Iais pubescens, Dana.

1852. *Jæra pubescens*, Dana, United States Exploring Expedition, Crustacea, vol. ii., p. 744, pl. xlix., figs. 9A–9D.
1883. *Jæra novæ-zealandiæ*, Chilton, Trans. N.Z. Inst., vol. xv., p. 189.
1886. *Jæra neo-zelanica*, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 157.
1886. *Iais pubescens*, Bovallius, "Notes on the Family Asellidæ," Bihang till K. Svenska Vet.-Akad. Handlingar, band xi., No. 15, p. 50.
1886. *Jæra pubescens*, Beddard, "Report on the 'Challenger' Isopoda," part ii., p. 19, pl. ii., figs. 6–10.
1888. *Iais neo-zelanica*, Thomson, Trans. N.Z. Inst., vol. xxi., p. 265.

I have little doubt that my *Jæra novæ-zealandiæ* is the same as *Jæra pubescens*, Dana. When I described it I was not acquainted with Dana's species, but subsequently I saw his figure in the copy of his atlas in the library of the Canterbury Museum; and, as there is no copy of the text in that library, Mr. Alexander Morton, of the Tasmanian Museum, Hobart, was good enough to copy out the description for me from the copy in the library of the Royal Society of Tasmania. From these I judged that the two species would most likely have to be united, and this conclusion was confirmed by the fuller description given by Beddard in the "Report of the 'Challenger' Isopoda." My specimens agree very closely with Beddard's description, but his figure does not appear altogether satisfactory, and in some points does not correspond with his description. Thus, there appears no warrant for the notches shown on the sides of the head, and apparently also on the bases of the antennæ; the first segment of the pereion is not shown longer than the succeeding, as it is described, and as it really is; and the lateral margins of the segments do not show the division into lobes mentioned, nor the arrangement of setæ thereon as described.

Dana's specimens of *Jæra pubescens* were taken in a semiparasitic condition on *Sphæroma lanceolatum* at Patagonia; and specimens, which Beddard identifies with Dana's species, were obtained during the "Challenger" Expedition at Kerguelen Island in a similar condition on a Sphæromid, which Beddard identifies as *Sphæroma gigas*, a species which is, he says, hardly distinguishable from *Sphæroma lanceolatum.*

My original specimen of *Jæra novæ-zealandiæ* was not taken directly from a Sphæromid, but was found in a bottle with other Crustacea from Lyttelton Harbour, though I do not know the exact circumstances of its capture. Since then I have taken specimens of the same species at Akaroa, creeping freely on seaweed. However, in July, 1889, I found two small specimens, which evidently belong to the same species, on a large *Sphæroma* (probably *S. obtusa*, Dana) in Port Chalmers. They were on the under-surface of the body, between the ventral surface and the bases of the legs, not attached to the body, but creeping about freely. They are small, and evidently immature. The discovery of these specimens living in a semi-parasitic condition, in the same way as Dana's specimens, tends to confirm the conclusion previously arrived at as to the identity of the two species.

Mr. Thomson's specimens were taken at Auckland between tide-marks; but whether they were on Sphæromids or not is not now known.

From Akaroa I have altogether six specimens: two of them are mature females, each bearing six eggs in the brood-pouch. Even these mature specimens are small, only about 2·5mm. long. The others are smaller, two of them very nearly as small as those taken from the *Sphæroma* in Port Chalmers—*i.e.*, only 1·25mm. long. They all agree closely both with my type specimen and with Beddard's description of *Jæra pubescens*, Dana.

This species is therefore now known from Patagonia, Kerguelen Island, and New Zealand, and it appears that it may be semi-parasitic (commensal) on Sphæromids, or may live freely on seaweed, &c. Perhaps it is semi-parasitic only when young.

I leave the species in the new genus *Iais*, established by Bovallius for those species with tri-unguiculate dactyla to the pereiopoda.

Jæropsis neo-zelanica, sp. nov.

Body narrow-oblong, breadth about one-fourth the length. Head rectangular, about as broad as long, narrowing at its junction with the pereion, produced slightly into a rostrum between the bases of the antennæ; end of rostrum emarginate, and with a rounded lobe fitting into the emargination. Eyes somewhat large. Segments of the pereion subequal, widely separated laterally; lateral margins rounded and entire. Pleon broadly-ovate, rounded at the end; lateral margins serrated and bearing a few setæ. Antennæ very short, not so long as the head; inner one composed of five joints, the first very large, longer than the two succeeding, the others diminishing in size distally, the last bearing a small tuft of setæ; outer antennæ having the third joint much the largest, with the integument expanded laterally above, fourth joint narrow at the base expanding distally, bent outwards almost at right angles to the third, fifth somewhat longer than the fourth, followed by a short flagellum consisting of five or six joints which rapidly diminish in size; a few short setæ are present on the fifth joint of the peduncle and on the various joints of the flagellum. Uropoda inserted in lateral emarginations, at the end of the pleon; peduncle consisting of a somewhat large joint slightly more than filling the emargination, the rami represented by small lobes each bearing a few rather long setæ. Opercular plate under the pleon consisting of a single piece, ovate in form, bearing indistinct marks of a longitudinal suture along the middle and a transverse one towards the distal end.

Length about 2·5mm.

Colour whitish, with scanty marblings of greyish-brown.

Hab. Akaroa: a single specimen on the under-surface of a stone exposed at low tide. Lyttelton: a single imperfect specimen forwarded by Mr. R. M. Laing.

This species appears to resemble *Jæropsis marionis*, Beddard, somewhat closely, but differs in the uropoda, the antennæ, &c.

Munna neo-zelanica, Chilton, MS.

Male.—Body narrow-elliptical, length about two and a half times the greatest breadth. Head not broader than first segment of pereion, deeply notched on each side for the bases of the antennæ; front margin straight, with rounded upper lip attached; the lateral portion behind the insertion of the antennæ has the anterior angle somewhat acute, the posterior angle rounded and slightly produced and bearing the moderately-sized eyes. First four segments of the pereion subequal in length, gradually increasing in width up to the fourth, which is the widest; next three segments subequal, slightly shorter than the preceding, curving slightly backwards at the sides; all the segments having the lateral margins straight or slightly rounded. Pleon as long as the four preceding segments of the pereion, pear-shaped, narrowing posteriorly, extremity rounded.

Antennules with the first two joints stout, others slender, reaching a little beyond the end of the third joint of the antennæ. Antennæ considerably longer than the body. First pair of legs very large and strong and of peculiar shape, the basos small, ischios very thick and strong, hollowed anteriorly to receive the distal end of the limb when bent back; carpus expanding distally, mallet-shaped; propodos small and rounded. Succeeding legs of normal shape, last three pairs longer than the others, about as long as the body.

Female with the body of the same shape as in the male, not broader; differs from the male in the first pair of legs, which are short and imperfectly subchelate, carpus broader than the propodos, having the inner edge armed with six strong spiniform setæ.

Length about 3mm.

Colour brownish, more or less closely covered with darker dots and stellate markings.

Hab. Port Chalmers and Brighton, near Dunedin, between tide-marks.

A full description of this species, with numerous figures, has been sent to the *Annals and Magazine of Natural History*.

Pseudæga punctata, G. M. Thomson.

Pseudæga punctata, Thomson and Chilton, Trans. N.Z. Inst., vol. xviii., p. 153.

This species was originally taken on Ocean Beach. It has since been taken by Mr. Suter at New Brighton, near Christchurch, feeding on decaying specimens of *Mactra æquilatera*. His specimens agree closely with Mr. Thomson's description.

Sphæroma (?) **egregia**, sp. nov.

Body rather convex, smooth. Total length of pereion and pleon slightly greater than twice the greatest width. Head transverse, nearly three times as broad as long; first segment of pereion as long as any two of the succeeding, the others subequal in length. Pleon longer than the five preceding segments of the pereion, triangular, the extremity produced backwards and with the sides rolled in below so as to form a kind of funnel, a round opening being left at the end. Pleon distinctly divided into two segments, the first produced backwards on each side into the terminal segment and bearing a suture on each side. Uropoda with the outer ramus much smaller and shorter than the inner, which extends as far back as the cavity, beneath the pleon, but not to the end of the funnel. Antennæ slender, inner (upper) a little shorter than the outer, which reaches backwards nearly to the end of the first segment of the pereion. Legs subequal, short.

Colour whitish, with darker markings (slightly red in dried specimens).

Length about 3mm.

Hab. Akaroa: two or three specimens only.

The character of the pleon in this species is very peculiar, and in this it differs in a marked degree from the normal *Sphæromæ*, but I forbear increasing the confusion that already exists in that group by the addition of another genus, in the hope that some one will soon undertake a revision of the whole of the Sphæromidæ.

Art. XIX.—*Contributions to the Molluscan Fauna of New Zealand.*

By H. Suter.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

Professor F. W. Hutton, in his "Revision of the Land Mollusca of New Zealand" (Trans. N.Z. Inst., vol. xvi.), after having examined the dentition of a large number of our molluscs, was the first to see the necessity of establishing a family for those of our land-shells which represent intermediate forms between the Limacidæ and Patulidæ. This family he called Charopidæ (Trans. N.Z. Inst., vol. xvi., p. 199), including in it the genera *Gerontia*, *Pyrrha*, *Charopa* (*Ch. ida*), *Psyra*, *Therasia*, and *Thalassia*. Now, the type of the group or genus *Charopa*, Albers, is our *Patula coma*, Gray (Albers, Die Heliceen, II. Ausgabe, von E. von Martens, p. 87); and I think we should retain the name of *Charopa* for the group of *P. coma*, Gray, which belongs to the family of the Patulidæ, We therefore have to look for another name for our shells. None of the groups established by Albers or Pfeiffer can be taken into consideration. We have to deal here with evidently very old forms, showing peculiarities in their animals which hardly are met with in the Northern Hemisphere. The flora and fauna of New Zealand are well known for their peculiarities, and our land and fresh-water molluscs form no exception to the rule. How far similar forms are distributed over the Southern Hemisphere remains to be investigated. In my collection I used for several years the name of Pseudohelicidæ for this family; but I have to give it up, as Dr. O. Boettger in 1890 gave the name of *Pseudohelix* to a group of *Vertigo*, and I propose now the name of Phenacohelicidæ.

The genus *Phenacohelix* I substituted for *Fruticicola* (Trans. N.Z. Inst., vol. xvi., p. 194), as Professor F. W. Hutton fully agrees with me that none of our New Zealand shells belongs to *Fruticicola*. It includes *Ph. pilula*, Reeve; *Ph. granum*, Pf.; and *Ph. chordata*, Pf.

The generic name of *Charopa*, given by Professor F. W. Hutton to *Helix ida*, Gray, I propose to change to *Patulopsis*.

The family of the Phenacohelicidæ contains molluscs which are characterized by the heliciform animal possessing a *caudal gland;* the jaw is, with few exceptions, ribbed, stegognath; the marginal teeth show all intermediate forms from aculeate to quadrate, but even in the latter case some of the cutting-points are usually very long. The shell is that of *Helix*, spire flat or elevated, umbilicated or imperforate; peristome acute; aperture without lamellæ; epidermis smooth or ribbed, seldom hairy.

The genera I include in the family of the Phenacohelicidæ are the following: *Phacussa, Thalassia, Gerontia, Psyra, Pyrrha, Therasia, Phenacohelix, Patulopsis, Amphidoxa*, and *Calymna.* They are in such a succession that *Phacussa* stands nearest to the Limacidæ, and *Amphidoxa*, with *Calymna*, nearest to the Patulidæ.

On examining the dentition of *Diplomphalus subantialba*, mihi, and *D. biconcava*, Pf., I have satisfied myself that I was mistaken when I placed several of our shells in this genus (Trans. N.Z. Inst., vol. xxii., p. 226), as there is a jaw, and consequently the radula is quite different from that of *Diplomphalus.*

With regard to the genus *Hyalina* I am more doubtful than ever. The species *H. microreticulata*, mihi, and *H. allochroida*, mihi (Trans. N.Z. Inst., vol. xxii., p. 227, 228), very likely belong to another genus; but as long as I have not had an opportunity of examining the animal I must defer settling the question.

The examination of the dentition of *Endodonta leimonias, E. pœcilosticta*, and *E. marina* decidedly shows that these shells must be included in *Phrixgnathus*, Hutt., and do not belong to *Endodonta.* The group Laoma was established by Gray in 1849 for *Bul. leimonias*, and I propose to retain it for the shells mentioned, as a subgenus of *Phrixgnathus.* This subgenus includes those species of *Phrixgnathus* which are provided with spiral laminæ and teeth in the aperture.

I wish to give complete lists of the land and fresh-water molluscs I found in two different places of this colony, at each of which I have been collecting occasionally during about one year and a half.

I.—*Molluscan Fauna of the Vicinity of Hastwell, Forty-mile Bush, North Island.*

Class GASTEROPODA. Ord. PULMONATA.

Group STYLOMMATOPHORA.

Sec. AGNATHA.

Fam. **Testacellidæ.**

1. *Elæa coresia*, Gray. Very scarce. Found only one specimen, amongst dead leaves in the bush near Mauriceville.

Sec. GNATHOPHORA. (*a.*) HOLOGNATHA.

Fam. **Limacidæ.**

2. *Amalia marginata*, Hutt. Rare. Two specimens only were obtained, in the bush near Hastwell.

3. *Hyalina* (?) *allochroida*, Sut. Very scarce. Bush near Mauriceville.

4. *Hyalina* (?) *allochroida*, Sut., var. *sericata*, Sut. Only one specimen, in the bush near Hastwell.

5. *Hyalina* (?) *allochroida*, Sut., var. *lateumbilicata*, Sut. Scarce. Amongst dead leaves and mould, bush near Hastwell.

6. *Hyalina* (?) *microreticulata*, Sut. Very scarce. Bush near Hastwell.

Fam. **Phenacohelicidæ.**

7. *Thalassia neozelanica*, Gray. Not uncommon under pieces of rotten wood and bark in the bush.

Thalassia neozelanica, Gray, forma *pallidula*. Without markings, light-coloured. With the foregoing, but scarcer.

8. *Psyra dimorpha*, Pf. Scarce, as all the other species of the genus. Hiding in the cavities of rotten logs in damp situations in the bush.

9. *Psyra tullia*, Gray. Scarce. Under stones and rotten wood.

10. *Psyra adriana*, Hutt. More frequently found than the other species.

11. *Psyra planulata*, Hutt. Scarce.

12. *Psyra miranda*, Hutt. The rarest of the genus.

13. *Therasia celinde*, Gray. Very rare. Found a few specimens only on pieces of wood in the bush on a steep hill.

14. *Therasia thaisa*, Hutt. Occurs only on a limestone hill near Mauriceville Railway-station.

15. *Phenacohelix pilula*, Reeve. In moist and dark situations in the bush. Rather scarce.

16. *Phenacohelix chordata*, Pf. Very scarce. Only a few specimens found in the bush near Hastwell; somewhat more abundant on the Mauriceville limestone hill. Under dead leaves.

17. *Patulopsis ida*, Gray. Not common, but found throughout the bush under rotten wood in damp and dark places.

18. *Amphidoxa compressivoluta*, Reeve. Scarce. Seems to prefer high situations in the bush. Under pieces of wood and bark.

19. *Amphidoxa zebra*, Le Guillou. Very scarce, mostly hiding in the mould accumulated on rotten logs. It never attains the large size of specimens in the South Island.

20. *Amphidoxa chiron*, Gray. Found only a few specimens under rotten wood in the bush near Hastwell and Mauriceville.

21. *Calymna feredayi*, Sut. Scarce. Under rotten wood in the bush.

Fam. **Patulidæ.**

22. *Patula coma*, Gray. Common everywhere, especially under loose bark on logs.

Patula coma, Gray, forma *globosa*. Near Hastwell I found a number of *P. coma* having the general appearance of *P. lucetta*, but the umbilicus is wider and the ribs more distant than in the latter species. There are all intermediate forms to be found, from the flat normal form, whose height is 0·12in., to the globose form showing a height of 0·16in.

23. *Patula lucetta*, Hutt. Very scarce. One specimen only, near Mauriceville.

24. *Patula buccinella*, Reeve. Not common. Together with *P. bianca*.

25. *Patula corniculum*, Reeve. Scarce, especially adult specimens.

26. *Patula bianca*, Hutt. Under bark on logs, but easily overlooked, because it has almost the same colour as the wood and bark of rimu, on which it is mostly found.

27. *Patula anguicula*, Reeve. Under dead leaves and amongst mould in damp situations in the bush. As it is very minute and dark-coloured, it is difficult to find it. This species is found on both Islands, but seems to be nowhere abundant.

28. *Patula varicosa*, Pf. (= *P. timandra*, Hutt.). Under rotten wood and under bark in damp places. Rather scarce.

29. *Patula tapirina*, Hutt. Next *P. coma* the most common shell of the genus. Under rotten wood and dead leaves.

Patula tapirina, Hutt., forma *albina*. Nearly white. Found in the bush near Hastwell.

30. *Patula infecta*, Reeve. With the foregoing.

31. *Patula infecta*, Reeve, var. *irregularis*, Sut. Very scarce.

32. *Patula sylvia*, Hutt. Through the whole bush, but rather scarce. Darker in colour than specimens I have seen from the South Island.

33. *Patula colensoi*, Sut. Under rotten wood, &c. Scarce.

34. *Patula variccostata*, Sut. In the bush near Mauriceville, under rotten wood. Very scarce.

35. *Patula raricostata*, Sut. Near Mauriceville, on limestone formation, amongst mould in the bush. Rare.

36. *Patula biconcava*, Pf. In dark and damp situations in the bush. Not common.

37. *Patula huttoni*, Sut. Very scarce. Under rotten logs in the bush near Hastwell.

38. *Patula moussoni*, Sut. In the same places. Rare.

39. *Patula subantialba*, Sut. In damp, shady places in the bush near Hastwell and Mauriceville. Scarce.

Fam. **Helicidæ.**

40. *Vitrinoidea dimidiata*, Pf. Under rotten logs; prefers the outskirts of the bush. The animal is almost always found with its tail brought forward to the right side of the head. I am inclined to consider this peculiar form which the animal assumes as mimicry, imitating certain not uncommon outgrowths on logs.

41. *Phrixgnathus maria*, Gray. On rotten wood, &c. Scarce.

42. *Phrixgnathus conella*, Pf. On rotten wood, &c. Scarce, especially alive.

43. *Phrixgnathus regularis*, Pf. On rotten wood, &c. Very rare.

44. *Phrixgnathus celia*, Hutt. On rotten wood, &c. Scarce. Near Mauriceville only.

45. *Laoma marina*, Hutt. (= *L. nerissa*, Hutt.). Amongst dead leaves, on bark, &c. Not uncommon.

46. *Maoriana pseudoleioda*, Sut. Not common. Under rotten wood.

47. *Maoriana wairarapa*, Sut. Not common. Under rotten wood.

48. *Maoriana hectori*, Sut. Under loose bark, together with *P. coma*, *P. bianca*, and *P. buccinella*.

49. *Maoriana microundulata*, Sut. The rarest of the group.

Fam. **Pupidæ.**

50. *Pupa (Isthmia) neozelanica*, Pf. Rather common throughout the bush, though adult specimens are seldom met with. Under bark and pieces of wood.

(*b.*) Elasmognatha.

Fam. **Janellidæ.**

51. *Janella bitentaculata*, Q. and G. Found everywhere, especially under rotten logs.

52. *Janella bitentaculata*, Q. and G., var. *papillata*, Hutt. Rather scarce.

Ord. PROSOBRANCHIATA. Sub-Ord. PECTINIBRANCHIATA.

Group BASOMMATOPHORA.

Sec. Tænioglossa.

Fam. **Hydrobiidæ.**

53. *Potamopyrgus antipodum*, Gray. Common in creeks.

54. *Potamopyrgus cumingiana*, Fischer. In the large creek near Hastwell, on stones. The adult specimens deprived of spines. Large specimens are found in the Ruamahanga River, near Mauriceville.

Fam. **Cyclophoridæ.**

55. *Cyclophorus lignarius*, Pf. Found one specimen only, in rotten wood.

Fam. **Cyclostomatidæ.**

56. *Realia egea*, Gray. Scarce near Hastwell; more numerous on the Mauriceville limestone hill, amongst dead leaves.

Realia egea, Gray, forma *albina*. Some specimens found in the last-mentioned locality.

Sub-Ord. SCUTIBRANCHIATA.

Fam. **Hydrocenidæ.**

57. *Hydrocena purchasi*, Pf. Found in one place only, under stones in the bush near Hastwell, by the side of a creek.

Class LAMELLIBRANCHIA.

Fam. **Unionidæ.**

58. *Unio rugatus*, Hutt. In the Kopuaranga River, Hastwell, and Mangamahoe. Some specimens present a short stout form, with the posterior end very high and straight, which resembles somewhat *U. hochstetteri*. Pearly deformations in the interior of the mussels are very common.

II.—*Molluscan Fauna of the Hooker and Tasman Valley, South Island.*

Class GASTEROPODA. Ord. PULMONATA.

Group STYLOMMATOPHORA.

Sec. GNATHOPHORA. (*a.*) HOLOGNATHA.

Fam. **Limacidæ.**

1. *Pitys cryptobidens*, Sut. Amongst mould in the subalpine bush, hiding under dead leaves. Very scarce. White Horse Hill, Hooker Valley.

Fam. **Phenacohelicidæ.**

2. *Phacussa hypopolia*, Pf. Found in all the lower parts of the subalpine bush, under dead leaves and rotten wood. Crawling after warm rain on shrubs with smooth bark, frequently on dead *Panax*.

3. *Psyra tullia*, Gray. Under stones amongst small roots. Sealey Range.

Psyra tullia, Gray, forma *albina*. In the same places. Scarce.

4. *Psyra godeti*, Sut. Together with *P. tullia*. Sealey Range and Black Birch Creek valley.

5. *Therasia decidua*, Pf. In the same places as *Ph. hypopolia*.

6. *Amphidoxa feredayi*, Sut., var. *glacialis*, Sut. Under rotten wood. White Horse Hill, Hooker Valley. Rare.

Fam. **Patulidæ.**

7. *Patula buccinella*, Reeve. In the bush, amongst mould, rotten wood, &c. The most common of the land-shells.

8. *Patula corniculum*, Reeve, var. *maculata*, Sut. Very scarce. Amongst decaying leaves in the subalpine bush, Sealey Range.

9. *Patula bianca*, Hutt. Scarce. In the subalpine bush, Hooker Valley.

10. *Patula bianca*, Hutt., var. *montana*, Sut. Not common. In the subalpine bush, Hooker Valley.

11. *Patula anguicula*, Reeve. Scarce. In the subalpine bush, Hooker Valley.

12. *Patula infecta*, Reeve, var. *alpestris*, Sut. Rare. In the subalpine bush, Hooker Valley.

13. *Patula mutabilis*, Sut. Very scarce. In the subalpine bush, Hooker Valley.

14. *Patula sterkiana*, Sut. Not common. In the subalpine bush, Hooker Valley.

15. *Patula brouni*, Sut. Not common. In the subalpine bush, Hooker Valley.

16. *Patula serpentinula*, Sut. Not common. In the subalpine bush, Hooker Valley.

17. *Patula cremita*, Sut. Very scarce. In the subalpine bush, Hooker Valley.

Fam. **Helicidæ.**

18. *Phrixgnathus acanthinulopsis*, Sut. Scarce. Amongst mould in the bush, Hooker Valley.

19. *Maoriana aorangi*, Sut. Not common. Amongst mould in the bush, Hooker Valley.

(*b*.) ELASMOGNATHA.

Fam. **Janellidæ.**

20. *Janella bitentaculata*, Q. and G. Near Governor's Bush, Hooker Valley.

Group BASOMMATOPHORA.

Fam. **Limnæidæ.**

21. *Limnæa alfredi*, Sut. In a small creek near Governor's Bush, Hooker Valley, and in Birch Hill Lagoon, Tasman Valley.

22. *Amphipeplea ampulla*, Hutt., var. *globosa*, Sut. Common in Birch Hill Lagoon.

Sec. TÆNIOGLOSSA.

Fam. **Hydrobiidæ.**

23. *Potamopyrgus corolla*, Gould. Birch Hill Lagoon and outflowing creek. All the specimens I have seen were deprived of spines.

Class LAMELLIBRANCHIA.

Fam **Cyrenidæ.**

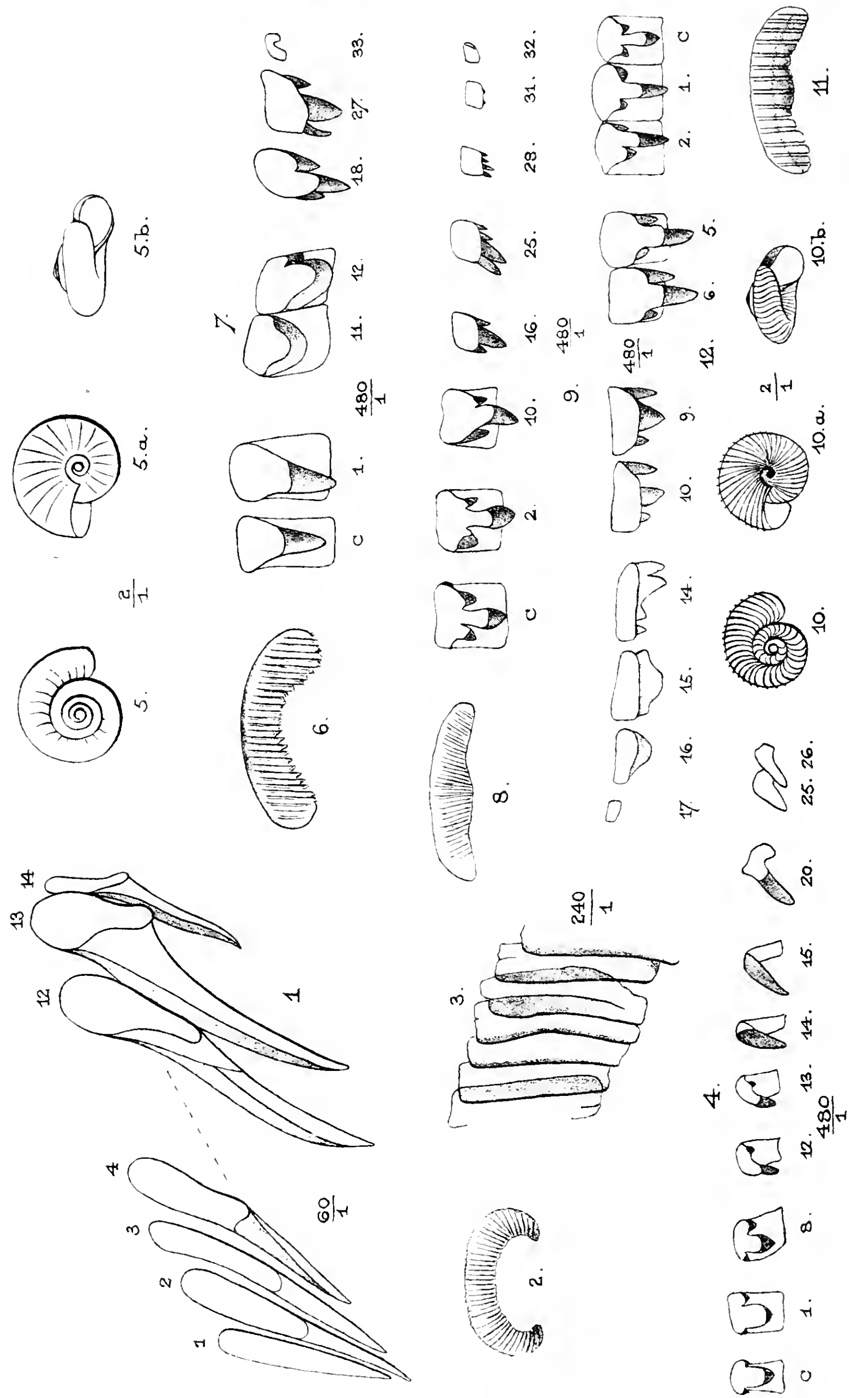
24. *Sphærium neozelanica*, Desh. Plentiful in Birch Hill Lagoon, Tasman Valley.

III.—*Molluscan Fauna of Some Parts of the Province of Auckland.*

Some time ago Mr. Charles T. Musson, F.L.S., of Richmond, New South Wales, sent me a large number of shells collected by him in the Province of Auckland, at Ohaupo, in conjunction with Dr. Rud. Haeusler, for naming; and I think it worth while to publish a list of the land-shells. The localities are the following, as given to me by Mr. Musson: 1. Heavy bush, Parua Bay, near Whangarei. 2. Whangarei Head, bush on steep hill-sides facing sea. 3. Hillyer's Creek, near Auckland. 4. Mount Wellington lava-fields. 5. Ohaupo. 6. Domain, Auckland.

—	1.	2.	3.	4.	5.	6.
Fam. *Testacellidæ.*						
Elæa coresia, *Gray*	x	..	x	x	..	..
„ jeffreysiana, *Pf.*	..	..	x	..	..	..
Rhytida dunniæ, *Gray*	x	..	..	..	..	..
Fam. *Limacidæ.*						
Hyalina (?) allochroida, *Sut.*, *v.* lateumbilicata	..	..	..	..	x	..
Fam. *Phenacohelicidæ.*						
Thalassia portia, *Gray*	x	..	x	x	..	..
„ neozelanica, *Gray*	..	x	x	x	..	..
Psyra dimorpha, *Pf.*	..	..	..	..	x	..
„ tullia, *Gray*	..	..	..	..	x	..
Therasia celinde, *Gray*	x	x	x	..	x	..
„ tamora, *Hutt.*	x	..	..	..	..	..
„ thaisa, *Hutt.*	x	..	..	..	..	..
Phenacohelix pilula, *Reeve*	x	..	x	x	x	x
„ chordata, *Pf.*	x	..	..	x	..	..
Patulopsis ida, *Gray*	..	x	x	..	x	..
Amphidoxa perdita, *Hutt.*	x	..	..	..	x	..
„ chiron, *Gray*	..	..	..	..	x	..
Calymna costulata, *Hutt.*	..	..	..	..	x	..
„ olivacea, *Sut.*	..	..	x	..	..	..

—	1.	2.	3.	4.	5.	6.
Fam. *Patulidæ.*						
Patula coma, *Gray*	x	..	..	x	x	..
„ varicosa, *Pf.*	x	..	..	x	..	..
„ corniculum, *Reeve*	x	..	..	..	x	..
„ buccinella, *Reeve*	..	..	..	..	x	..
„ sylvia, *Hutt.*	x	..	x	x	..	..
„ infecta, *Reeve*	x	x	..	..	x	..
„ egesta, *Gray*	..	..	..	x	..	..
„ subantialba, *Sut.*	..	..	..	x	..	..
„ caput-spinulæ, *Reeve*	x	..	x	x	x	x
Fam. *Helicidæ.*						
Phrixgnathus maria, *Gray*	x	..	..	..	x	..
„ conella, *Pf.*	..	..	x	x	x	x
„ ariel, *Hutt.*	x	..	..	..	..	..
„ erigone, *Gray*	..	..	..	x	x	x
„ phrynia, *Hutt.*	x	..	..	..	..	..
„ glabriuscula, *Pf.*	x	x	..	x	x	..
„ transitans, *Sut.*	x	..	..	..	..	..
Laoma leimonias, *Gray*	..	..	..	..	x	x
„ pœcilosticta, *Pf.*	x	..	..	x	..	..
„ marina, *Hutt.*	..	..	..	x	..	..
Maoriana hectori, *Sut.*	x	..	..	x	x	..
„ pseudoleioda, *Sut.*	x	..	..	x	x	..
Fam. *Bulimulidæ.*						
Rhabdotus kiwi, *Gray*	x	..	x	..	x	..
Fam. *Helicteridæ.*						
Tornatellina neozelanica, *Pf.*	..	..	..	x	..	..
Fam. *Cyclophoridæ.*						
Cyclophorus cytora, *Gray*	..	..	..	..	x	..
Fam. *Cyclostomatidæ.*						
Realia egea, *Gray*	x	..	x	..	..	..
„ turriculata, *Pf.*	x	x	..	..	..	..
„ carinella, *Pf.*	..	..	..	..	x	..
„ hochstetteri, *Pf.*	..	x	..	..	..	..
Fam. *Hydrocenidæ.*						
Hydrocena purchasi, *Pf.*	x	..	x	..	x	..



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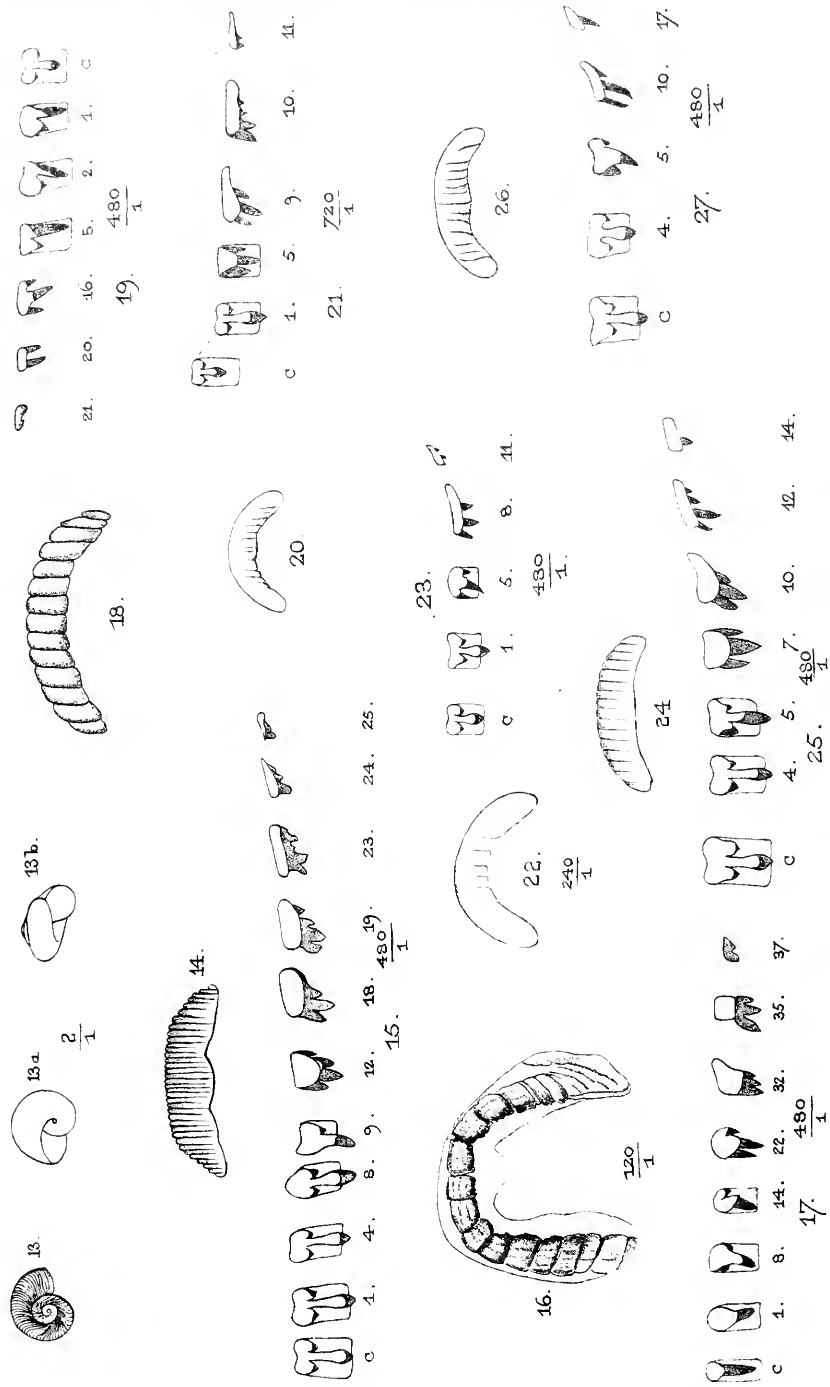

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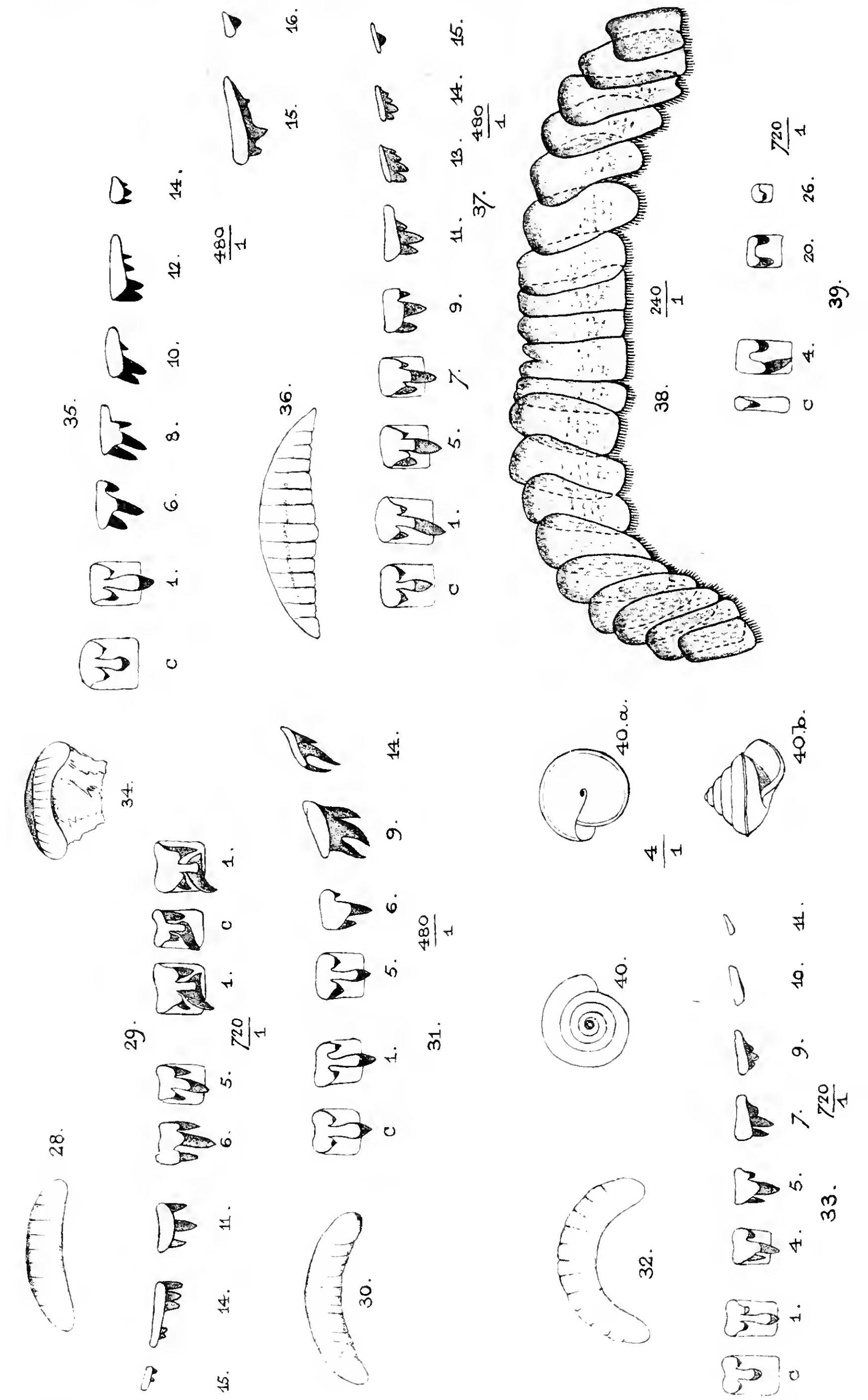

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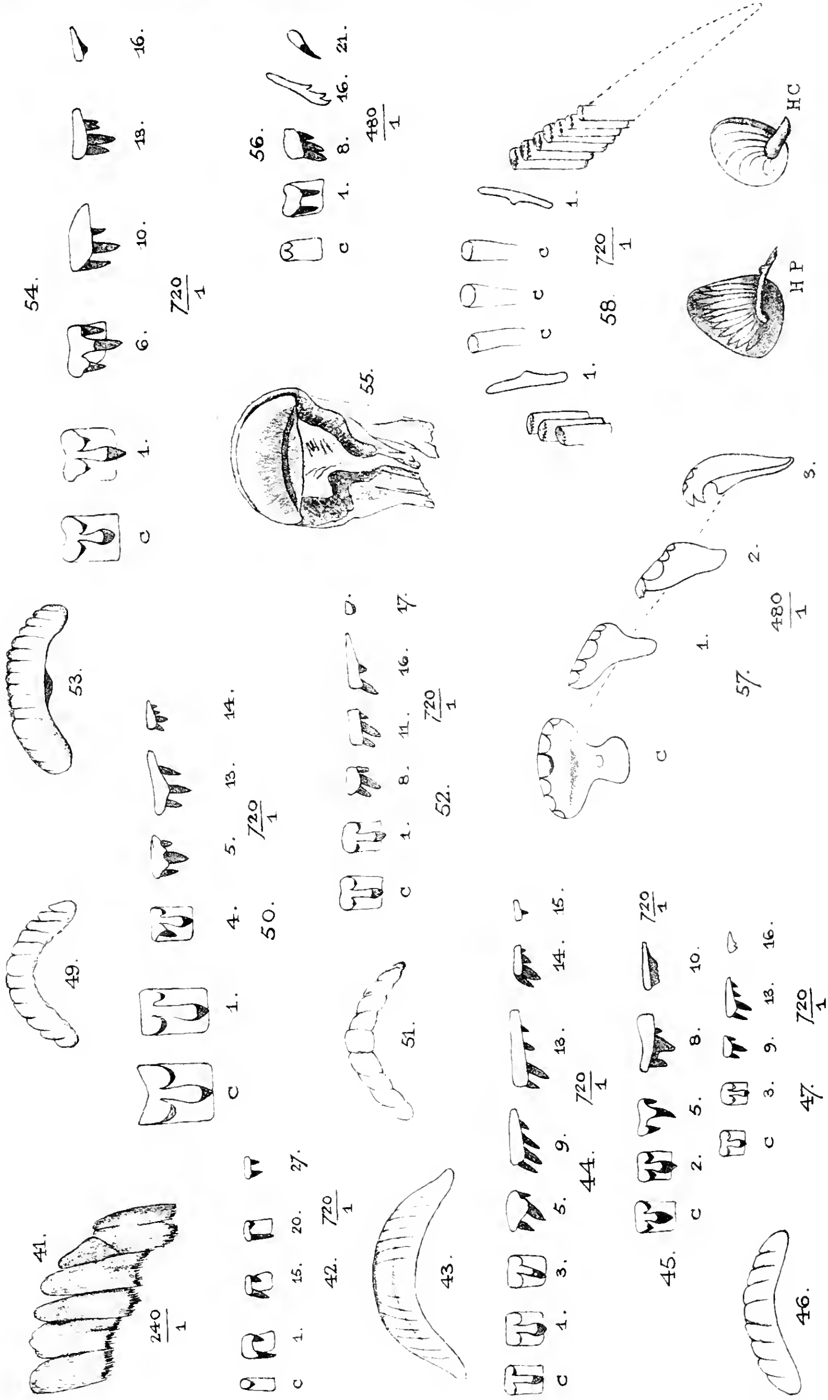

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Art. XX.—*List of the Introduced Land and Fresh-water Mollusca of New Zealand.*

By H. Suter.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

The first list of introduced species was published by Professor F. W. Hutton (Trans. N.Z. Inst., vol. xvi., p. 211, and vol. xvii., p. 57); and recently Mr. Charles T. Musson, of Sydney, has published a paper "On the Naturalised Forms of Land and Fresh-water Mollusca in Australasia" (Proc. Linn. Soc. of N.S.W., vol. v., ser. ii., p. 883), in which some additional introduced species from New Zealand are mentioned. As I have been fortunate enough to get acquainted with a few more forms, I think it may be of some interest to give now a list as complete as my present knowledge allows.

1. *Testacella*, described by Professor F. W. Hutton as *T. vagans*, is found in gardens in the vicinity of Auckland. Mr. T. F. Cheeseman (Trans. N.Z. Inst., vol. xix., p. 170) remarks that it is very likely only a naturalised species, probably *T. maugei*, Fér., which is found in Portugal and on Teneriffe, but has also been introduced into Great Britain. I think Mr. Cheeseman's supposition to be fairly correct, as the genus *Testacella* is restricted in its habitat to south-western Europe and Algeria only, and it cannot belong to our native fauna.

2. *Helicarion milligani*, Pf. Mr. T. W. Kirk found one specimen of this snail at South Karori, near Wellington, which, no doubt, has been imported from Tasmania.

3. *Limax (Agriolimax) agrestis*, L. (= *L. molestus*, Hutt.). Found almost everywhere where improvements on the native soil have taken place.

4. *Limax (Heynemannia) maximus*, L. Dunedin (F. W. Hutton).

5. *Limax (Simrothia) variegatus*, Drap. (*L. flavus*, L.). Dunedin and Greymouth (F. W. Hutton).

6. *Amalia gagates*, Drap. Common in southern Europe, scarce in England. Has, like the foregoing, been imported in many parts of the world. Ohaupo and Auckland (Charles T. Musson).

7. *Hyalina (Euhyalina) cellaria*, Müll. (*H. sydneyensis*, Cox). It is not synonymous with *H. corneo-fulva*, Pf., which is a well-characterized New Zealand species, in form of the shell nearer to *Hyalina nitens*, Mich., than to *H. cellaria*. Bay of Islands; Auckland; Napier (F. W. Hutton).

8. *Hyalina (Euhyalina) alliaria*, Miller. The shell and dentition correspond with the description; dentition, 11—3—1—3—11, one marginal tooth more than mentioned by Schepman. In Mr. R. W. Fereday's hothouse, probably introduced from England.

9. *Hyalina (Vitrea) crystallina*, Müll. Specimens from Auckland are in Professor F. W. Hutton's cabinet, Canterbury Museum.

10. *Zonitoides nitida*, Müll. Recorded by Mr. Charles T. Musson: "Lake St. John, Auckland; a dozen specimens, under logs." I feel very doubtful about the identification of these shells, which I have not seen, as they might as well be *Hyalina novaræ*, Pf. The examination of the dentition would at once settle the question.

11. *Arion empiricorum*, Fér. (*A. ater*, L.). Auckland, crawling over the roads after rain (Charles T. Musson).

12. *Arion subfuscus*, Drap. (*A. incommodus*, Hutt.). Dunedin (F. W. Hutton).

13. *Arion hortensis*, Fér. Auckland, plentiful (Charles T. Musson).

14. *Helix (Xerophila) caperata*, Mont.* Found in Nelson (J. Meeson).

15. *Helix (Tachea) hortensis*, Müll. Auckland (F. W. Hutton). Mr. Charles T. Musson erroneously gives the name of *H. nemoralis*, L. (*l.c.*, p. 895).

16. *Helix (Pomatia) aspersa*, Müll. Auckland, Nelson, Greymouth (F. W. Hutton); Wellington, Christchurch (H. S.). Common at most of the sea-coast towns. Examples from Apua, in the Bay of Islands, are exceptionally thin, whilst shells from Auckland are of the variety *conoidea* (Musson, *l.c.*).

17. *Helix (Corasia) tricolor*, Pf. Indigenous to San Christoval, Solomon Islands. The specimens I saw are in the cabinet of Mr. Kinsey, of Christchurch, and were found at the Bay of Islands. "Lives on the leaves of trees, or any plant in garden that is firm enough to hold them," says the collector's note. Formerly the Bay of Islands was trading with the Solomon Islands, and this may explain the introduction of this fine shell.

18. *Cochlostyla (Orthostyla) daphnis*, Brod. One specimen, which was found at Picton, is in Mr. Kinsey's cabinet. The species is a native of the Philippine Islands (Zebu, Siguijor).

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* I am indebted to Mr. Charles Hedley, Austral. Mus., Sydney, for the identification of this shell.

19. *Limnæa (Limnus) stagnalis*, L. River Avon, Christchurch. Introduced intentionally as food for trout (F. W. Hutton). Auckland, at the Onehunga Springs (Charles T. Musson).

ART. XXI.—*List of Land and Fresh-water Mollusca doubtful for New Zealand or not inhabiting it.*

By H. SUTER.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

1. *Elæa rapida*, Pf. (1853). Professor F. W. Hutton, in his "Manual of the New Zealand Mollusca, 1880," and in his "Revision of our Land Mollusca," has already pointed out that the New Zealand locality for this mollusc is very doubtful. Mr. Charles Hedley, in his "Notes on Queensland Shells" (Proc. Roy. Soc. of Queensl., vol. vi., p. 100), says, "*Elæa rapida* is not Australian; its only habitat is the New Hebrides, where Mr. Brazier himself has collected it. When first described it was stated to come from New Zealand." There can be no doubt now that *E. rapida* has to be omitted from the list of New Zealand land-shells.

2. *Nanina guttula*, Pf. (1853), is another land-shell very likely erroneously attributed to New Zealand by Pfeiffer. It was described by him, with the foregoing, in "Zeitschrift für Malakozoologie, 1853," and it seems that for both incorrect localities were given to Pfeiffer. Zelebor mentions it as found on the Nicobar Islands; but Lieut.-Colonel Godwin-Austen, F.R.S., who is thoroughly acquainted with the molluscan fauna of those islands, assures me that he does not know anything of the occurrence of *N. guttula* on the Nicobars. As the localities given by Pfeiffer are not always to be relied on, we might do well to place *N. guttula* amongst our doubtful species as long as it is not found by modern collectors in our colony.

Professor F. W. Hutton says (Trans. N.Z. Inst., vol. xvi., page 186), "I am not satisfied with my identification of *H. guttula*, Pf., as the shell in the Wellington Museum exceeds the dimensions given by Pfeiffer, and it can hardly be called thin; but in other respects it corresponds well with the description, and with Reeve's figure." The height of Reeve's figure is too great by about 1¼mm. if reduced to the measures given by Pfeiffer. The shells in the Wellington Museum were collected by Mr. T. W. Kirk on "mountains near Masterton."

I have seen one specimen in Professor Hutton's cabinet, Canterbury Museum, and I am quite sure that it is no New Zealand shell, but very likely from Mauritius. I have collected myself on mountains near Masterton, but never found such a shell.

3. *Trochomorpha hermia*, Hutton (1883). This shell, a specimen of which is also in Professor Hutton's collection, is another contribution to our fauna by Mr. T. W. Kirk, from the Manawatu district. It was described by Professor F. W. Hutton in Trans. N.Z. Inst., vol. xvi., p. 183. The specimen I saw corresponds quite well with *Helix (Pachystyla) inversicolor*, Fér., from Mauritius. It, also, has to be omitted from the list of New Zealand Mollusca.

4. *Neritina neozelanica*, Recluz (1843). The habitat is given: "New Zealand, on stones in mountain-streams." Professor F. W. Hutton remarks ("Manual of New Zealand Mollusca, 1880," p. 90), "The locality given is probably erroneous, but I have reproduced the description, as it has been overlooked in former lists." *Neritina neozelanica*, Recl., is found on the Fiji Islands (Gould), and is, according to Musson, the most common fresh-water shell on the Samoa Islands (Upolu, Tutuila). It has not been found by any of the recent collectors in New Zealand, and we may well exclude it from the list of our fauna.

In Trans. N.Z. Inst., vol. xiv., p. 268, Mr. T. W. Kirk mentions *Neritina fluviatilis*, L., as having been found by him in the Waikanae River. I saw the specimens in Professor Hutton's cabinet, and they perfectly correspond with typical specimens from Germany. I think Mr. T. W. Kirk must have been mistaken in labelling *N. fluviatilis* as from the Waikanae River.

5. *Helix (Rhagada) reinga*, Gray, closely allied to *H. dringi*, Pf., from North Australia, is very doubtful for New Zealand. Had it been collected by Dr. Dieffenbach at the North Cape it very likely would have been described by Gray with the other species in Dieffenbach's "New Zealand." Mr. Justice Gillies remarks (Trans. N.Z. Inst., vol. xiv., p. 169), "Doubtful if ever found in New Zealand;" and Professor F. W. Hutton holds (Trans. N.Z. Inst., vol. xvi., p. 186) that it is "very probably a New Zealand species, although no specimen exists in any of our collections." Perhaps it is a unique specimen, like *H. dringi*, Pf. A thorough exploration of the far north of New Zealand would give us more certainty in the question.

6. *Helix (Trachia) delessertiana*, Le Guillou (1842), is, according to Dr. J. C. Cox, synonymous with *Helix taranaki*, Gray, and is found on the islands of Torres Strait (Cox, Monograph of Austr. Land Shells, p. 61, No. 153). It is not men-

tioned by Gray in Dieffenbach's "New Zealand," is not in any of our museums with New Zealand as locality, and has not been found here by any collector since it was described by Gray. We therefore may place it amongst our very doubtful species, though its occurrence in New Zealand is not impossible, and would correspond with the habitat of *Therasia ophelia*, Pf., which is said to have been found also near Cape York, Queensland.

ART. XXII.—*Miscellaneous Communications on New Zealand Land and Fresh-water Mollusca.*

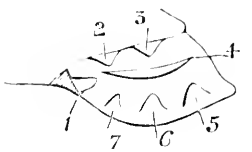
By H. SUTER.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

1. *Potamopyrgus.* In my last paper on our molluscs (Trans. N.Z. Inst., vol. xxiii., p. 94) I recorded the fact of *P. corolla*, Gould, being viviparous. I unfortunately forgot to mention that Professor F. W. Hutton had already brought this peculiarity to our knowledge in 1881 for the species *P. cumingiana*, Fischer, and *P. antipodum*, Gray (Trans. N.Z. Inst., vol. xiv., p. 144), and had also given figures of the embryonic shells. The priority of the discovery therefore belongs to our distinguished conchologist Professor F. W. Hutton. There remains only *P. pupoides*, Hutt., to be examined on its mode of propagation.

2. *Laoma marina*, Hutt., and *L. nerissa*, Hutt. Some years ago, when collecting in the Forty-mile Bush, North Island, I had the opportunity of examining a good number of the above-named shells, and I then made the observation that the lamellæ of the aperture of these shells show a great variability. I found specimens showing the three lamellæ only of *Laoma marina*, others—mostly smaller ones—with the seven lamellæ of *L. nerissa;* but I obtained also a good number of shells which were, with regard to the number of lamellæ, intermediate forms, showing more lamellæ than *L. marina* and less than *L. nerissa*. I thus became convinced that the two species are in reality but one; but it was not until some months ago that I found time for fuller investigation. Through the kindness of Mr. Charles T. Musson, of Sydney, who had been collecting in the Province of Auckland, I obtained a number of shells, and amongst them twenty-nine specimens of *L. marina* and *nerissa*, collected at Mount Wellington, Auckland. These I submitted to a close examination, the result of which I wish to give here.

As the figure shows, I give No. 1 to the columellar plait, 2 and 3 to the plaits on the penultimate whorl, 4 to the plait on the right lip above the keel, and 5, 6, 7 to the teeth on the basal lip. The lamellæ 1–4 are large, acute plaits, going some distance into the interior of the shell, whilst the three teeth on the basal lip are only blunt elevations from a white callosity extending from the keel to the columella. Now, the type of *L. marina* shows the lamellæ 1, 3, 4 only, and *L. nerissa* 1 to 7. Amongst the specimens examined, eight were *L. nerissa*, eleven *L. marina*, and ten belonged to intermediate forms. The columellar plait, 1, and the plaits 3 and 4 were found to be constant, never missing. Plait 2 was absent in twelve adult specimens, and rudimentary in seven shells, situated far back, and difficult to be seen. The callosity on the basal lip was never wanting; it could be observed even in typical specimens of *L. marina*. In fifteen shells there was only this callosity to be seen, without any denticulation. Of the teeth 5, 6, 7, the last one is the smallest, and therefore easiest reabsorbed. The teeth 5 and 6 were missing in twelve specimens, but tooth 7 in nineteen. The most frequently absent plait of all is 7; of the others, 2, 5, and 6 are equally often wanting.



The type of *L. marina* is only found in adult shells, *L. nerissa* in younger ones, which agrees well with the dimensions of the shells as given by Professor F. W. Hutton (Trans. N.Z. Inst., vol. xvi., p. 176)—0·13in. diam. for *L. marina*, and 0·11in. for *L. nerissa*.

All my observations lead me to the conclusion that in the young shells all the seven plaits are developed, but are reabsorbed later on in such a way that 7 first disappears, followed by 2, 5, 6, thus leaving for the adult shell the plaits 1, 3, 4 only.

I am of opinion that all these facts taken together show clearly that *L. marina* and *L. nerissa* are but one species; and this has been confirmed by examining their dentition. I prepared the radulæ of *L. marina*, *L. nerissa*, and an intermediate form, but all showed the very same dentition, and there is no doubt possible but that the two species must be united in one.

The name which has to be retained is *Laoma marina*, Hutt., being that of the adult shell. The diagnosis of the shell has to be slightly altered with regard to the plaits, as all the other parts of the shells are very much the same in both of the descriptions given by Professor F. W. Hutton. I propose the following diagnosis:—

Laoma marina, Hutt. (1883) (= *L. nerissa*, Hutt., 1883).

Shell conoidal, subperforated, striated; colour pale-yellowish horn, sometimes faintly banded with chestnut, and tessellated with the same colour at the keel. Spire conoidal, rather obtuse; whorls 5½, slowly increasing, rather flattened, the last acutely keeled, delicately but rather irregularly striated; suture margined; umbilicus covered; aperture vertical, subrhomboidal; peristome thin; columella with a large acute plait; in the adult specimens two parietal plaits, one on the penultimate whorl near the outer side, the other on the right lip above the keel; basal lip slightly callous. In younger shells a second plait on the penultimate whorl near the columella, and three blunt plaits on the basal lip, may be observed. Of the basal teeth the innermost is the smallest, and most frequently missing. Greatest diam. 0·13, least 0·11; height, 0·1in.

3. *Thera barbatula*, Reeve (= *Helix beta*, Pf., 1854). In the revision of our land-shells by Professor Hutton this shell is mentioned as synonymous with *Th. stipulata*, Reeve (*Helix alpha*, Pf.) (Trans. N.Z. Inst., vol. xvi., p. 193). Recent experience has shown me that this is not correct, but that the two species are very different, and each of them well characterized. Mr. A. Hamilton, of Dunedin, some time ago kindly sent me living specimens of shells collected in the neighbourhood of his town, and amongst them was a good number of *Thera stipulata*, R. On closer examination I found three specimens which differed considerably from the others, and on comparing them with descriptions they proved to be *Thera barbatula*, Reeve. In this species the diameter is only 3⅓mm., as against 4⅓mm. in *Th. stipulata;* whilst the height is nearly the same, 3⅓mm. and 3mm. respectively. Therefore *Th. barbatula* is trochiformed, and *Th. stipulata*, with a broader base, conical. The first has 7 whorls, the latter only 5 to 5½. *Th. stipulata* is lamellarly ribbed, the membranaceous lamellæ are broad, extending over the whole breadth of the whorl, and ending in a short hair. *Th. barbatula* is strongly plaited, but the membranaceous lamellæ develope only near the keel, each ending in a rather long filament.

It is very likely that no difference was made between the two species in the collections which passed through the hands of Professor F. W. Hutton, or that *Th. barbatula* was wanting altogether. Up to the present I have not seen the latter from any other place than the neighbourhood of Dunedin, and it seems to be rather scarce.

4. *Vitrinoidea dimidiata*, Pf., the slug-like mollusc, was sent to me some months ago by Mr. Cavell, of Boatman's, near Reefton, a most enthusiastic collector and conchologist, who found

it in the neighbourhood of his place. To my knowledge this mollusc was hitherto only recorded from the North Island, and its occurrence on the South Island is highly interesting. I may add that Dr. O. F. von Moellendorff, one of the highest authorities on the molluscan fauna of the Philippine Islands, &c., fully agrees with me that our mollusc belongs to the genus *Vitrinoidea*, Semper.

Art. XXIII.—*On the Dentition of some New Zealand Land and Fresh-water Mollusca, with Descriptions of New Species.*

By H. Suter.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

Plates XX.-XXIII.

Paryphanta urnula, Pf. From Lowry Bay, Wellington. Plate XX., fig. 1.

Radula about 14mm. long, 3½mm. broad at the anterior end, tapering posteriorly, with about 40 transverse rows of teeth, the rows forming an obtuse angle of about 120°, salient posteriorly.

Teeth, 14—0—14, all aculeate; the first rather small and fragile, rounded anteriorly and pointed behind. The following teeth are growing longer, with a curved ridge across the middle, thus giving them the appearance of an open knife. On the fourth tooth the forming of a median projection on the outer side is beginning, and a longitudinal ridge is running down the posterior half of the tooth. The teeth are increasing in size to the last but one. The thirteenth is long and stout, broadly rounded anteriorly, the head of the tooth sole-shaped, a longitudinal almost straight ridge along the inner side of the tooth. Last tooth only about half the length of the foregoing.

The radula of this species is remarkable for the small number of teeth, compared with *P. busbyi*.

The specimens were kindly given me by Sir James Hector. Two are kept alive, but will be used later on for further investigations.

Phacussa hypopolia, Pf. From Hooker Valley, South Island. Plate XX., figs. 2, 3, 4.

Jaw strongly arcuated at both ends, rather high, slightly tapering, with numerous narrow plaits, which denticulate both margins. Considerable magnifying shows the plaits to be imbricate, straight or slightly curved, and vertical. Cutting-margin concave, without median projection.

Radula tongue-shaped, consisting of about 110 almost straight transverse rows of teeth, 17—13—1—13—17.

Base of *central* tooth nearly rectangular, somewhat broader at the posterior margin, longer than broad. Reflection tricuspid, median cusp almost as broad as the base, with a blunt, short, broad cutting-point, not reaching to the posterior end of the base. Side-cusps very small and short, each with a rudimentary cutting-point.

Laterals asymmetrical, with a rectangular oblique base, broadest near the central, and narrower towards the marginals. Reflection tricuspid on the first ten teeth, when the inner cusp obliterates. Median cusp well developed, with a cutting-point which does not reach to the posterior end of the base; broad on the first teeth, narrower and longer on approaching the marginals. Inner side-cusp and cutting-point of the first ten teeth very small. Outer side-cusp first more developed than in the central tooth, but obliterating by degrees. Cutting-point always short.

The first *marginals* are unidentate, with a long narrow rectangular base, beyond which the thorn-shaped cutting-point reaches. All the other marginals are aculeate, stout. They diminish in size considerably towards the margin.

The radula of this species does not differ very much from that of *Ph. helmsi*, Hutt., as described and figured by Professor F. W. Hutton (Trans. N.Z. Inst., vol. xvi., p. 172), but the jaw may be used for distinguishing the species. In *Ph. helmsi* it consists of about 20–25 flat ribs, whilst in *Ph. hypopolia* there are just about double that number.

Amphidoxa corneo-fulva, Pf. From Nerger Range, South Island. Plate XX., figs. 5, *a*, *b*, 6, 7.

Jaw membranaceous, slightly arcuate, narrower in the middle, ends swollen, blunt; numerous vertical plaits strongly indentate the cutting-margin, but leave the upper margin smooth.

Radula long, tongue-shaped, consisting of about 140 straight transverse rows of teeth, 17—16—1—16—17.

Central tooth rectangular, much longer than broad, slightly contracted in the middle; reflection large, reaching to the middle of the base, unicuspid, with a large cutting-point, not attaining the posterior end of the base.

Laterals.—The first ten are very similar to the central, but the reflection is somewhat larger, and the cutting-point stouter and longer, extending a little over the following row of teeth. The following teeth are getting shorter, rhomboidal, the reflection showing a tendency to become tricuspid; the cutting-point broad, blunt, and short.

Marginals stout, first longer than broad, then broader, tridentate, the median tooth the stoutest. In the outer marginals the teeth are blunt, the last marginal minute, with two rudimentary teeth only.

For two specimens of this species I am indebted to Mr. B. Bull, of St. Albans. They were collected by Mr. G. J. Roberts in March, 1884, and accompanied by the following note: "From head of Staircase Creek, 5,300ft. above sea-level, on Nerger Range, in slush of snow, hundreds together." One of the specimens was broken, but fortunately contained the dried animal, which I used for preparing the jaw and radula. I never had a greater surprise in conchological work than when I examined the dentition of this mollusc. The shell is as near that of a *Hyalina* as it can be, but jaw and dentition are widely different, and they agree with those of our *Amphixoda*.

The *shell*, of which I give a drawing, corresponds well with Pfeiffer's description, and it differs very much from *Hyalina cellaria*, with which Professor F. W. Hutton thought it to be identical. The dimensions of the specimen from Nerger Range are: Diameter, greatest 8mm., least 6½mm.; height, 3½mm.; aperture, height 2½mm., breadth 3½mm.

Amphidoxa compressivoluta, Reeve. From Forty-mile Bush, North Island. Plate XX., figs. 8, 9.

Jaw almost straight, membranaceous, with very fine and narrow vertical striæ, one end blunt, the other slightly tapering; a short median projection on the cutting-margin. Considerable magnifying shows the latter to be finely denticulated.

Radula tongue-shaped, consisting of about a hundred almost straight transverse rows of teeth, 32—1—32. The number of laterals may be taken at about six, but they are very gradually going over in marginals.

Central tooth nearly quadrate, reflection tricuspid, the median cusp with its cutting-point reaching to the posterior end of the base, side-cusps sinuated, with a short cutting-point on each.

Laterals resembling the central, but the median cusp is stouter, and its cutting-point extends over the posterior end of the base; the inner side-cusp gets broader, its cutting-point more developed, whilst the outer one remains narrowed, and its cutting-point small.

In the *transition* teeth the reflection becomes bicuspid, the inner cusp is large, extending to the posterior end of the base, its strong cutting-point is slightly directed towards the median line of the radula. To the straight side of the median cusp a sharp, rather stout cutting-point is fastened. The outer cusp bears a short cutting-point.

Marginals not much broader than long, the anterior part rhomboidal, the inner ones with three, the outer ones sometimes with four teeth, of which the second on the inner side is the strongest. Last marginals with rudimentary teeth, minute.

Amphidoxa chiron, Gray. From Ohaupo, North Island. Plate XX., figs. 10, *a*, *b*, 11, 12.

Jaw arcuate, membranaceous, vertically plaited with about fifteen rather broad flat plaits, which are separated by narrow grooves. Upper margin smooth, cutting-margin slightly denticulated, and with a blunt median projection. A transverse striation runs from one end to the other.

Radula tongue-shaped, consisting of about 110 straight transverse rows of teeth, 12—5—1—5—12.

Central tooth rectangular, longer than broad, anterior end curved, reflection rather large, tricuspid; middle cusp long, with the short cutting-point reaching near the posterior end of the base; side-cusps slightly sinuated on the outer sides, cutting-points small.

Laterals asymmetrical, rectangular, somewhat larger than the central; reflection large, irregularly shaped, tricuspid, the median cusp in the outer teeth extending to the posterior end of the base, its cutting-point well developed, running partly over the next row of teeth; the inner side cutting-point attaining by degrees a greater development than the outer one, which remains small.

The first *marginal* tooth, together with the last lateral, may be considered as transition teeth; the other marginals broader than long, tridentate, the middle tooth broad, short, the inner one longer and narrower, the outer one short. From the 14th to the 16th tooth the denticles coalesce by degrees into one mass; the last rudimentary.

The specimens from Ohaupo, collected by Mr. Charles T. Musson, and of which I give a figure, are so strongly plaited that I first took them for a new species, closely allied to *A. chiron;* but the dentition is decidedly that of the species mentioned, as described and figured by Professor F. W. Hutton in Trans. N.Z. Inst., vol. xvi. This species seems to vary very much with regard to the plaits. Specimens I collected in the Forty-mile Bush show almost no trace of plaits, but only well-developed growth-lines. The shells from Ohaupo correspond with Gray's description, though I should not call them plaited, but ribbed.

A. chiron may be considered as an intermediate form between *Amphidoxa s.-str.* and the subgenus *Calymna*, Hutton, which includes the forms with ribbed whorls.

Amphidoxa (Calymna) olivacea, n. sp. Plate XXI., figs. 13, *a*, *b*, 14, 15.

Shell globosely depressed, perforated, shining, pale yellow-olive, without markings, thin and transparent, with very close-set arcuated ribs, which are flatly rounded, about 10 per mm., interrupted on the surface with several distinct spiral grooves. Spire slightly elevated, obtuse; apex smooth. Whorls 3, rather rapidly increasing, rounded, the last slightly flattened on the surface, rounded on the base. Suture deep. Aperture oblique, rotundly ovate, slightly excavated by the penultimate whorl. Peristome very thin, straight, regularly arched, the upper part advancing. Columellar margin not reflected, sharp, vertically slightly arcuated; outer margin strongly arched, the margins approximating. Umbilicus very narrow, not deep; umbilical region infundibuliform, faintly striated.

Diameter, greatest 5mm., least 4mm.; height, $3\frac{1}{2}$mm.; aperture, height 2mm., breadth $2\frac{1}{2}$mm.

Hab. Hillyer's Creek, near Auckland (Ch. T. Musson). Scarce.

It seems to be rather rare, as amongst the shells collected by Mr. Ch. T. Musson were only three specimens, of which only one is in good condition. This one was used for description, but I do not think it to be quite adult. Fortunately it contained the dried animal, which I used for preparing jaw and radula.

Jaw arcuate, rather solid, upper margin straight in the middle; consisting of numerous vertical plaits, which indent the upper margin. Ends tapering. On the median part of the cutting-edge a well-pronounced projection. The plaits are laid close together, not imbricating.

Radula tongue-shaped, consisting of about 100 almost straight transverse rows of teeth, 17—8—1—8—17.

Central rectangular, longer than broad, slightly broader posteriorly; reflection tricuspid, median cusp long, slender, with a short cutting-point reaching to the posterior end of the base. Side-cusps short, rounded, each with a minute cutting-point.

Laterals symmetrical, the same as the central, but the base slightly rhomboidal, the median cusp somewhat longer, and its cutting-point lying on the following row of teeth. The last two are in transition to marginals.

Marginals.—The first three with a quadrate base, reflection bicuspid, the inner cusp broad, reaching to the posterior end of the base, and its stout cutting-point over the following row of teeth. The other marginals get much broader than long, and are provided with three or four denticles, which in the last teeth are more or less coalescing, with the denticles blunt.

Therasia decidua, Pf. From Hooker Valley, South Island. Plate XXI., figs. 16, 17.

Jaw membranaceous, horseshoe-shaped, with imbricating plaits, which are very broad in the centre, narrower towards the ends; they nearly reach to the upper margin, but are rather distant from the cutting-margin, which has a pronounced median projection.

Radula long, tongue-shaped, consisting of about 150 transverse almost straight rows of teeth, 29—8—1—8—29.

Central tooth rectangular, long and narrow. Reflection small, side-cusps hardly visible, with one median cutting-point only, reaching nearly to the posterior margin of the base.

Laterals with a broader base, reflection larger, the inner teeth with one cutting-point only, three on the outer ones. The median cutting-point stout, long, extending almost to the posterior margin, the side cutting-points small.

Marginals first bicuspid, then tricuspid, rounded at the anterior margin. On the outer marginals the cutting-points coalesce in one, which is trifid. The last two or three are bidentate.

Psyra tullia, Gray. From Sealey Range, South Island. Plate XXI., figs. 18, 19.

Jaw slightly arcuate, not tapering, with about 14 flat broad plaits slightly indenting both margins.

Radula consisting of about 80 transverse straight rows of teeth, 15—6—1—6—15.

Central tooth rectangular, somewhat longer than broad. Reflection tricuspid, median cusp slender and reaching with its short cutting-point over three-quarters of the length of the base. Side-cusps rounded, short, each with a minute cutting-point.

Laterals highly asymmetrical, base rectangular, much longer than broad. Reflection bicuspid, the internal cusp bearing a strong cutting-point, reaching to the posterior margin of the base; the external cusp rather broad, with a short cutting-point.

Marginals.—The first two tridentate, resembling somewhat the last laterals, the internal cutting-point being the longest, the anterior portion nearly quadrate. The following teeth get gradually broader, and of the three well-developed cutting-points the median is the longest. The last marginals are small, bidentate.

The radula of this species differs considerably from those known of the other species of the genus.

Patula bianca, Hutt. From Forty-mile Bush, North Island. Plate XXI., figs. 20, 21.

Jaw membranaceous, slightly arcuated, not tapering, faintly vertically striated, with a slight median projection on its cutting-margin.

Radula tongue-shaped, central part of the straight transverse rows somewhat advanced. Teeth, 7—4—1—4—7.

Central tooth rectangular, longer than broad, reflection tricuspid, the middle cusp nearly reaching to the middle of the base, with a short cutting-point; side-cusps small, rounded, with a rudimentary cutting-point on each.

Laterals.—All four very much like the central, but somewhat broader and shorter; the median cusp nearly reaching to the posterior end of the base, and its well-developed cutting-point beyond it.

Marginals from quadrate to much broader than long, tridentate, cutting-points stout; the tenth tooth with four cutting-points, of which the two outer ones are very small. Last marginal small, bidentate.

The jaw and radula differ somewhat from the var. *montana*, as will be seen by comparing it with the figures given in Trans. N.Z. Inst., vol. xxiii., pl. xvii., figs. K, L.

Patula anguicula, Reeve. From Forty-mile Bush, North Island. Plate XXI., figs. 22, 23.

Jaw membranaceous, arcuate, not tapering, with a few vertical and one transverse striæ.

Radula tongue-shaped, formed of about 100 straight transverse rows of teeth, 7—4—1—4—7.

Central tooth very little longer than broad, rectangular, with a tricuspid reflection, of which the median cusp with its short cutting-point reaches to the end of the base. The side-cusps are short, rounded, one minute cutting-point on each.

Laterals quadrate, broader than the central, reflection tricuspid, middle cusp reaching to the posterior margin of the base and its short cutting-point beyond it. Side-cusps sinuated, with a short cutting-point each.

Marginals from quadrate to much broader than long, tridentate, the median tooth being the largest. Last marginal minute, bidentate.

The description and figures are from a specimen which is undoubtedly *P. anguicula*, whilst that described and figured in Trans. N.Z. Inst., vol. xvi., was to my knowledge a young form of *P. buccinella*. The difference between both, however, is not considerable.

Patula sylvia, Hutt. From Forty-mile Bush, North Island. Plate XXI., figs. 24, 25.

Jaw thin and fragile, slightly arcuate, not tapering, with strong distant vertical striæ. Both margins smooth. A faint indication of a median projection on the cutting-margin.

Radula tongue-shaped, consisting of about 80 slightly curved transverse rows of teeth, 9—5—1—5—9.

Central tooth rectangular, longer than broad, tricuspid, median cusp long, its very short cutting-point extending to the posterior end of the base. Side-cusps sinuated, with a short cutting-point on each.

Laterals.—The first three show no difference from the central, the fourth is more slender, the median cusp with a longer cutting-point, extending very little over the next row of teeth. The cutting-point on the inner side-cusp stouter. The fifth lateral is slightly rhomboidal, the median cusp shorter, but its cutting-point longer and stouter, the inner cutting-point still more developed.

Marginals.—The first ones almost quadrate, the outer ones broader than long. Three to four cutting-points, of which the second on the inner side is the longest. Last marginals small, unidentate.

Patula colensoi, Sut. From Forty-mile Bush, North Island. Plate XXI., figs. 26, 27.

Jaw arcuate, very thin and fragile, not tapering, with a faint median projection on the cutting-margin; distantly and faintly striated.

Radula tongue-shaped, covered with about 90 transverse rows of teeth, straight in the middle, slightly bent forwards towards the margins. Teeth, 13—4—1—4—13.

Central tooth large, almost quadrate, sinuated at the anterior end; reflection tricuspid, median cusp as long as the base, and its short cutting-point reaching beyond it; side-cusps extending over one-third of the base, a small cutting-point on each.

Laterals shorter than the central, quadrate, reflection much the same as in the central, tricuspid, the median cusp a little shorter.

Marginals tridentate, the head of the first ones irregularly shaped, the others much broader than long, with long slightly-curved teeth, of which the external one is short. Last marginal small, unidentate.

Patula varicosa, Pf. (= *P. timandra*, Hutt.). From Riccarton Bush, South Island. Plate XXII., figs. 28, 29.

Jaw membranaceous, very fragile, slightly arcuate, with faint and distant vertical striæ. Both margins smooth.

Radula tongue-shaped, consisting of about 70 transverse rows of teeth, straight in the middle, slightly bent forwards on both sides. Teeth, 10—5—1—5—10.

Central tooth asymmetrical, rectangular, not much longer than broad; reflection tricuspid, the central cusp narrow, reaching very little beyond the middle of the base; on its left side a stout transverse cutting-point, directed towards the left posterior corner of the base, a very small cutting-point on the right side of the cusp. The left side-cusp sinuated, with a rather long vertical cutting-point; right side-cusp rounded, with a stout and long vertical cutting-point.

Laterals.—The first four on each side of the central very similar to it, but quadrate, the reflection larger. The median cusp reaches almost to the end of the base; on its left side is a spur-like, transverse, broad and sharp cutting-point reaching beyond the base, on the right side a much smaller one. The side-cusps, which are sinuated, have a rather long vertical cutting-point on each, which is more developed on the right cusp.

In all other radulæ I have seen the teeth on the right side of the central are the inversion of those on the left side, which is not the case here. All the four laterals, on the left and right side of the central, show the very same arrangement of the cusps and cutting-points, thus rendering the median part of the radula asymmetrical, as the figure indicates it. The fifth lateral somewhat longer than broad, tricuspid, the cusps all with one strong vertical cutting-point.

Marginals broader than long, tridentate, the fourteenth sometimes with four denticles. First not very broad; the others get much broader and shorter towards the margin. Last marginal small, with two denticles.

The central tooth and the four laterals on each side of it are so widely different from all those known to me in other species that I do not know whether this radula must be considered as abnormal or not. Unfortunately, I have no animal of the same species at my disposal just now, and therefore am unable to decide the question.

Should further investigation prove it to be normal for the species, the creation of a new genus would no doubt be justified. *Patula jessica*, Hutt., is in its shell closely allied to *P. varicosa*, and an examination of its dentition, which is not known yet, would be highly interesting, as it might show similar peculiarities.

Patula sterkiana, Sut., var. *reeftonensis*, n. var.

This variety differs from the species described in last volume of the Transactions, p. 85, by its considerably-smaller size and the much more distant ribs, of which there are only about 15 per mm. Besides this there is no difference.

The jaw and radula are very much the same as in the species. Dentition, 12—4—1—4—12. The teeth of the first marginals are less oblique.

Diameter, greatest $2\frac{3}{4}$mm., least $2\frac{1}{4}$mm.; height, $1\frac{3}{4}$mm.

Hab. Boatman's, near Reefton, from whence it was sent to me by Mr. A. T. Cavell.

At first sight this shell seems to be an intermediate form betwen *P. sterkiana* and *P. brouni*, but a close examination shows it to be much more allied to the first, though the ribs are much coarser and more distant. The radula fully justifies its estimation as a variety only of *P. sterkiana*.

Patula sterkiana, Sut., forma *major*.

This shell corresponds in every respect with the species from Hooker Valley, but is somewhat larger, no doubt owing to the difference in the habitat.

Diameter, greatest $4\frac{1}{2}$mm., least 4mm.; height, $2\frac{1}{2}$mm.

Hab. Owaka (Clutha), where it was found by Mr. J. T. Bryant.

As was to be anticipated, the new species I found in the Hooker Valley are very likely distributed over many other parts of this Island, and this has been confirmed now, at least, for one of them.

Patula biconcava, Pf. From Forty-mile Bush, North Island. Plate XXII., figs. 30, 31.

Jaw slightly arcuated, membranaceous, not tapering, with one transverse and several vertical fine striæ.

Radula tongue-shaped, consisting of about 120 almost straight transverse rows of teeth, 14—5—1—5—14.

Central tooth nearly quadrate, large, with a tricuspid reflection, of which the median cusp reaches to the end of the base, the short cutting-point beyond it. Side-cusps oval, with one minute cutting-point on each.

Laterals very much the same as the central; in the first two the median cutting-point is a little longer.

First *marginals* with an irregular head, getting broad and short in the external teeth, tridentate, the median tooth strongest developed, most of the teeth slightly curved.

The presence of a jaw, as well as the form of the teeth, show clearly that Pfeiffer and I were greatly mistaken in placing this mollusc, according to the form of the shell, in the genus *Diplomphalus*.

Patula subantialba, Sut. (= *Diplomphalus subantialba*, S.). From Forty-mile Bush, North Island. Plate XXII., figs. 32, 33.

Jaw strongly arcuate, membranaceous, ends rounded, both margins smooth, faintly and distantly vertically striated.

Radula long and narrow, consisting of about 100 straight transverse rows of teeth, 7—4—1—4—7.

Central tooth rectangular, considerably longer than broad, reflection tricuspid, median cusp slender, half the length of the base, with a short blunt cutting-point; side-cusps small, rounded, each with one rudimentary cutting-point.

The first two *laterals* with the base like the central, tricuspid, median cusp long and slender, reaching with its very short cutting-point to the posterior end of the base; side-cusps sinuated, one very short cutting-point on each. In the third and fourth the reflection is larger, the median cusp shorter, its cutting-point longer and passing a little over the next row of teeth; the inner side-cusp obliterates, and there is a rather long cutting-point; the outer side-cusp is rounded, and supports a minute cutting-point only.

Marginals.—The first two with the reflected margin as broad as long, in shape like the last lateral; median cutting-point stout and rather long, the side cutting-points as in the last lateral. The following marginals get much broader than long, tridentate, the last two without visible denticulation.

Thera stipulata, Reeve. From Owaka (Clutha), South Island. Plate XXII., figs. 34, 35.

The dentition of this mollusc has already been described by Professor F. W. Hutton in Trans. N.Z. Inst., vol. xvi. The dentition of several specimens which I examined showed a great variability in the number of laterals, and especially in the form of the last marginals. Professor Hutton gives the number of teeth 12—1—12, of which three or four are laterals. In one specimen I found the dentition to be 10—4—1—4—10, and this one is figured. The twelfth tooth has four denticles, and the last three. In another specimen the dentition was 10—6—1—6—10, the last two marginals, which are figured, differing considerably from those on the other radula.

Thera barbatula, Reeve (=*H. beta*, Pf.). From Dunedin. Plate XXII., figs. 36, 37.

Jaw almost straight, convex on the upper margin, straight on the cutting-margin, but with a faint indication of a median projection; very thin, fragile, and transparent; broadly and faintly vertically striated, the cutting-margin slightly and broadly denticulated. Sometimes a transverse line crosses the vertical striæ in the middle.

Radula tongue-shaped, formed by about 100 almost straight transverse rows of teeth, 15—1—15, of which six or seven may be taken as laterals.

Central tooth rectangular, longer than broad, reflection tricuspid, median cusp reaching to the middle of the base, and its cutting-point to the posterior end of it. Side-cusps rounded, with one small cutting-point on each.

Laterals like the central, but slightly asymmetrical, more so on approaching the marginals, base slightly broader; reflection tricuspid, the median cusp somewhat longer than in the central, its cutting-point reaching over the following row of teeth; side-cusps sinuated, the inner with a rather strong cutting-point, the outer with a very small one only.

Marginals much broader than long, first tridentate, in the twelfth to the fourteenth there are usually four denticles on each; the last has a very narrow base, with a minute denticle.

Phrixgnathus glabriuscula, Pf. From Mount Wellington, near Auckland. Plate XXII., figs. 38, 39.

Jaw arcuate, consisting of about 20 broad slightly imbricating plaits, which are papillate. Both margins denticulated, the denticles of the cutting-margin fringed by the papillæ.

Radula.—Transverse rows of teeth curved, with the rows of marginals directed forwards. Teeth, 26—1—26, of which about 14 are laterals.

Central tooth rectangular, long and very narrow; reflection unicuspid, with a short cutting-point, both together extending over the anterior third of the base only.

Laterals rectangular, little longer than broad, bicuspid, the inner cusp with a long oblique cutting-point, reaching to the posterior margin of the base; the outer cusp with a short cutting-point.

Marginals quadrate, bicuspid, with two short cutting-points.

Phrixgnathus transitans, n. sp. Plate XXII., fig. 40, *a, b.*

Shell conoidal, subperforated, finely striated with growth-lines, faintly shining; colour pale yellow-horn, irregularly banded with chestnut; transparent, fragile. Spire conoidal, apex rather obtuse. Whorls 5, slowly and regularly increasing, rather flattened, the last acutely keeled, striæ very delicate, slightly arcuate; suture not deep, not margined. Aperture vertical, subrhomboidal; peristome rather thin, angulated; outer lip strongly callous, the white callosity reaching to a good distance in the interior. Columellar margin slightly deflexed, callous, short, regularly arched. Base convex. Umbilicus very narrow, partly covered.

In young specimens the callosity extends very far backwards, and the umbilicus is open.

Diameter, greatest 3mm., least 2½mm.; height, 2½mm.

Hab. Heavy bush, Parua Bay, Whangarei (Ch. T. Musson). Evidently scarce.

This species is very near *Ph. marina*, Hutt., but has no lamellæ or teeth in the aperture, and the suture is not margined. It may be considered as an intermediate form between *Phrixgnathus* and the subgenus *Laoma*.

Amongst the few specimens none had the animal left in it, and the dentition therefore remains unknown for the present.

Phrixgnathus (Laoma) marina, Hutt., from Forty-mile Bush, North Island. Plate XXIII., figs. 41, 42.

Jaw arcuate, with about 24 broad vertical plaits, which are strongly papillate, as is typical of the genus. Both margins are denticulated, the cutting-margin fringed by papillæ.

Radula tongue-shaped, formed by about 110 straight transverse rows of teeth, 30—1—30.

Central tooth rectangular, nearly three times as long as broad, reflection very short, rounded, with one short cutting-point only, the whole covering one-third of the base.

No *laterals* to be distinguished.

Marginals rectangular, a little longer than broad, reflection bicuspid, the inner cutting-point long, the outer short; last marginals small, broader than long, with two equally-developed short denticles.

The radula of *Ph. nerissa*, Hutt., is just the very same.

Maoriana pseudoleioda, Sut. From Forty-mile Bush, North Island. Plate XXIII., figs. 43, 44.

Jaw membranaceous, arcuate, slightly tapering, with faint vertical and one transverse striæ.

Radula tongue-shaped, consisting of about 90 nearly straight transverse rows of teeth, 11—4—1—4—11.

Central tooth rectangular, little longer than broad, reflection tricuspid, median cusp slender, reaching with its rather short cutting-point to the posterior end of the base; side-cusps small, rounded, no cutting-points seen.

Laterals broader than the central, but very much the same; all the cusps stouter; in the third and fourth the median cusp and cutting-point are slightly bent inwards.

Marginals much broader than long, with three to four denticles, of which the second innermost is the stoutest; last marginal small, with one denticle only.

Maoriana wairarapa, Sut. From Forty-mile Bush, North Island. Plate XXIII., fig. 45.

Jaw not seen.

Radula very minute, long and narrow, consisting of about 100 slightly-curved transverse rows of teeth, 6—4—1—4—6.

Central tooth rectangular, longer than broad, reflection tricuspid, median cusp not much longer than the side-cusps, its large cutting-point nearly reaching to the posterior end of the base. Side-cusps with very small cutting-points, one on each.

Laterals much like the central, but a little narrower, and the median cutting-point reaching beyond the margin of the base.

Marginals broader than long, the fifth and sixth with a well-developed median projection and denticle; tridentate, the last very broad and short; all the denticles coalesced in a slightly-denticulated mass.

Maoriana hectori, Sut. From Forty-mile Bush, North Island. Plate XXIII., figs. 46, 47.

Jaw membranaceous, slightly arcuate, ends blunt, with a few distant striæ starting from its upper margin.

Radula tongue-shaped, consisting of about 100 slightly undulating transverse rows of teeth, 10—6—1—6—10.

Central tooth nearly quadrate, reflection tricuspid, median cusp long, reaching with its short cutting-point to the posterior end of the base. Side-cusps rounded, with a rudimentary cutting-point on each.

Laterals very much the same as the central, but somewhat smaller.

Marginals broader than long; the first one tridentate, the following quadridentate, and the last small and bidentate. The second tooth is best developed.

Maoriana microundulata, Sut. From Forty - mile Bush, North Island. Plate XXIII., figs. 49, 50.

Jaw membranaceous, ends blunt, distantly vertically striated, and the upper margin rather strongly denticulated.

Radula tongue-shaped, with slightly undulating transverse rows of teeth, 10—4—1—4—10. Teeth larger than in any other species of the genus.

Central tooth large, rectangular, not much longer than broad, anterior end of the base sinuated, reflection tricuspid; middle cusp narrow, reaching with its short cutting-point to the posterior end of the base; side-cusps rather large, pointed on the anterior and rounded on the posterior end, each with a broad, short, blunt cutting-point.

Laterals almost like the central, but diminishing considerably in size towards the marginals; the fourth lateral with the inner side-cusp and cutting-point longer.

Marginals broader than long, with rather strong denticles; the last small, with four denticles.

The radula of this species is distinguished by the relative considerable size of the central and first lateral teeth.

Maoriana aorangi, Sut. From Hooker Valley, South Island. Plate XXIII., figs. 51, 52.

Jaw arcuate, narrow, slightly tapering, with about ten distant vertical striæ.

Radula tongue-shaped, membranaceous, consisting of about 90 straight transverse rows of teeth, 10—7—1—7—10.

Central tooth rectangular, somewhat longer than broad, reflection tricuspid; middle cusp narrow, reaching with its short cutting-point to the posterior end of the base; side-cusps short, rounded, cutting-points rudimentary.

Laterals much the same as the central, but the median cusp reaching a little beyond the base.

Marginals broader than long, tridentate. the median tooth the longest, the sixteenth very broad and short, bidentate, and the last minute, quadrate, with a rudimentary denticle.

Pupa neozelanica, Pf. From Forty-mile Bush, North Island. Plate XXIII., figs. 53, 54.

Jaw arcuate, ends blunt, with distant vertical striæ; upper margin slightly denticulated, a blunt median projection on the cutting-edge.

Radula tongue-shaped, consisting of about 90 straight transverse rows of teeth, 11—5—1—5—11.

Central almost quadrate, indented at its anterior end; reflection tricuspid, the middle cusp and its short cutting-point reaching within a short distance from the posterior end of the base; side-cusps with a small cutting-point each.

Laterals somewhat larger than the central, but, otherwise, very much like it; median cutting-point extending a little over the next row of teeth.

Marginals broader than long; sixth to twelfth tooth tridentate, the middle tooth being the largest; the thirteenth to fifteenth with four denticles, of which the second is somewhat longer; last marginal broad and narrow, with one blunt cutting-point.

The radula of our *Pupa* differs considerably from all the others of the genus I have seen.

Limnæa alfredi, Sut. From Hooker Valley, South Island. Plate XXIII., figs. 55, 56.

Jaw consisting of three pieces, as is well known for the genus.

Radula tongue-shaped, consisting of about 90 straight transverse rows of teeth, 16—5—1—5—16.

Central rectangular, twice as long as broad, narrower anteriorly, reflection minute, bicuspid.

Laterals almost quadrangular, slightly sinuated anteriorly, reflection about one-third of the length, broad, with two long cutting-points, reaching near the posterior end of the base. In the outer laterals the inner cutting-point attains a greater length.

Marginals tridentate, first broad with strong denticles, then gradually getting longer and narrower, with the denticulations on the outer side. Last marginal minute, unidentate.

Realia egea, Gray. From Forty-mile Bush, North Island. Plate XXIII., fig. 57.

Radula long, ribbon-like, consisting of about 100 transverse rows of teeth, 3—1—3. The laterals are fixed in an oblique line running backwards under an angle of 45° to the rhachidian line.

Central tooth as long as broad, constricted in the middle; anterior part very broad, oval, with seven denticles, of which the median bears a broad blunt cutting-point; posterior part much smaller, about one-half the breadth of the anterior, with one denticle in the middle.

First *lateral* broad and oval anteriorly, with a short stalk and five denticles. Second lateral much like the first, but broader posteriorly, and the sides more straight; with four denticles, of which the two innermost are sometimes united in one. Third lateral club-shaped, with two deep notches on the inner side, thus rendering it tridentate. Two minute denticles may be observed on the anterior rounded end. A ridge runs down on the interior side.

Hydrocena purchasi, Pf. From Forty-mile Bush, North Island. Plate XXIII., figs. 58, H.P., H.C.

Radula ribbon-like, consisting of very numerous transverse rows of teeth, $\infty . 1 . (1+1+1) . 1 . \infty$. The side-teeth running backwards at a sharp angle to the median line.

Central teeth three, hyaline, very difficult to be seen; they are distant from one another, long and narrow, with one reflection on each.

Laterals long and narrow, with a short tooth-like projection on the middle of the inner side.

Marginals rectangular, much longer than broad, with a denticulated reflection on the anterior side. They are very numerous, and diminish gradually in size towards the margin.

This is the typical radula of the genus *Hydrocena*, and there is now no doubt possible about the generic position of our minute mollusc. Moreover, for comparison, I give drawings of the operculi of *H. cattaroënsis* (H.C.) and *H. purchasi* (H.P.), showing their apophysis and striations.

EXPLANATION OF PLATES XX.-XXIII.

Plate XX.

Fig. 1. *Paryphanta urnula*, Pf., teeth, × 60.
Fig. 2. *Phacussa hypopolia*, Pf., jaw.
Fig. 3. " " " part of jaw, × 240.
Fig. 4. " " " teeth, × 480.
Fig. 5. *a*, *b*. *Amphidoxa corneo-fulva*, Pf.
Fig. 6. " " " jaw.
Fig. 7. " " " teeth, × 480.
Fig. 8. " *compressivoluta*, Reeve, jaw.
Fig. 9. " " " teeth, × 480.
Fig. 10. *a*, *b*. " *chiron*, Gray.
Fig. 11. " " " jaw.
Fig. 12. " " " teeth, × 480.

Plate XXI.

Fig. 13. *a*, *b*. *Amphidoxa olivacea*, n. sp.
Fig. 14. " " " jaw.
Fig. 15. " " " teeth, × 480.
Fig. 16. *Therasia decidua*, Pf., jaw.
Fig. 17. " " " teeth, × 480.
Fig. 18. *Psyra tullia*, Gray, jaw.
Fig. 19. " " " teeth, × 480.
Fig. 20. *Patula bianca*, Hutt, jaw.
Fig. 21. " " " teeth, × 720.
Fig. 22. " *anguicula*, Reeve, jaw.
Fig. 23. " " " teeth, × 480.
Fig. 24. " *sylvia*, Hutt., jaw.
Fig. 25. " " " teeth, × 480.
Fig. 26. " *colensoi*, Sut., jaw.
Fig. 27. " " " teeth, × 480.

Plate XXII.

Fig. 28. *Patula varicosa*, Pf., jaw.
Fig. 29. " " " teeth, × 720.
Fig. 30. " *biconcava*, Pf., jaw.
Fig. 31. " " " teeth, × 480.
Fig. 32. " *subantialba*, Sut., jaw.
Fig. 33. " " " teeth, × 720.
Fig. 34. *Thera stipulata*, Reeve, jaw.
Fig. 35. " " " teeth, × 480.
Fig. 36. " *barbatula*, Reeve, jaw.
Fig. 37. " " " teeth, × 480.
Fig. 38. *Phrixgnathus glabriuscula*, Pf., jaw, × 240.
Fig. 39. " " " teeth, × 720.
Fig. 40. *a*, *b*. " *transitans*, n. sp.

Plate XXIII.

Fig. 41. *Phrixgnathus marina*, Hutt., part of jaw, × 240.
Fig. 42. " " " teeth, × 720.
Fig. 43. *Maoriana pseudolcioda*, Sut., jaw.
Fig. 44. " " " teeth, × 720.
Fig. 45. " *wairarapa*, Sut., teeth, × 720.
Fig. 46. " *hectori*, Sut., jaw.
Fig. 47. " " " teeth, × 720.
Fig. 49. " *microundulata*, Sut., jaw.
Fig. 50. " " " teeth, × 720.

Fig. 51. *Maoriana aorangi*, Sut., jaw.
Fig. 52. „ „ „ teeth, × 720.
Fig. 53. *Pupa neozelanica*, Pf., jaw.
Fig. 54. „ „ „ teeth, × 720.
Fig. 55. *Limnæa alfredi*, Sut., jaw.
Fig. 56. „ „ „ teeth, × 480.
Fig. 57. *Realia egea*, Gray, teeth, × 480.
Fig. 58. *Hydrocena purchasi*, Pf., teeth, × 720.
Fig. H.P. „ „ „ operculum.
Fig. H.C. „ *cattaroënsis*, Pf., „

Art. XXIV.—*Description of a New Genus of the Family Formicidæ.**

By Aug. Forel, M.D., Professor of Psychiatry in the University of Zurich, Switzerland.

Communicated by H. Suter.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

Gen. Huberia, n. gen.

☿. Antennæ of 11 joints; the joints 2 to 6 of the funicule short, becoming more and more stout and rounded; club rather stout, consisting of four joints. Maxillary palpi five-jointed; labial palpi three-jointed. Mandibles triangular, with a large terminal margin, which is armed with two rather strong denticles anteriorly and about seven small ones posteriorly. Epistome with a longitudinal channel in the middle, without spines or denticles, prolonged between the joints of the antennæ; its posterior margin is neither elevated nor distorted. Frontal area distinct, somewhat rounded posteriorly, as in the genus *Aphænogaster*. Frontal channel distinct. Frontal spines and eyes of ordinary shape. No ocelli. Thorax strongly excavated between the mesonotum and metanotum; the pronotum and the mesonotum are hardly more elevated than the metanotum. The pro-mesonotal suture slightly impressed. Metanotum convex, with two spines. The first node of the pedicle rather prolonged petiolate anteriorly. Abdomen not truncate.

♀. Characters of the ☿. The mesonotum nearly attains the anterior limit of the thorax. The mandibles have about nine small denticles behind the two anterior teeth. Metanotum bidentate. The wings with one small cubital cell only, one great discoidal cell, and one radial cell, which is slightly

* Comptes-rendus de la Société Entomologique de Belgique, séance du 7 Juin, 1890. Translated from the French by H. Suter, Christchurch.

open (but not far from being closed). The transverse nervure unites with the external cubital branch far from the point of separation.

In aspect this genus resembles, even to confounding, the genera *Myrmica* and *Aphænogaster*, from which it differs by the antennæ of 11 joints and the wings. A close examination, however, reveals closer affinities with the genus *Monomorium;* its wings are more identical with those of *Monomorium* (relative size of cells, &c.). The channel of the epistome, which is excavated anteriorly, also indicates a tendency to the spines of *Monomorium*.

H. striata, Smith.

(Trans. Ent. Soc., London, 1876, p. 481.)

Tetramorium striatum, Smith (*l.c.*). ☿ ♀ ♂.

To Mr. Smith's description, who placed this species, one does not know why, in the genus *Tetramorium*, with which it has not the least affinity, there is to be added:

☿. L. 4·3mm. to 4·9mm. Mandibles strongly striated. The head is shining, but not quite smooth as stated by Mr. Smith. The epistome, the front, the cheeks, and the sides of the eyes are longitudinally striated; the striæ of the front are divergent; the dimples of the antennæ have semicircular striæ. The thorax has five more or less transverse striæ, often rather distant, and partly elegantly distorted, which gives it quite a peculiar appearance. The metanotum (basal face) is very convex. The nodes of the pedicle are rounded, in shape like those of *Aphænogaster*.

A reddish, rather scattered pilosity on the body, with almost no adjacent pubescence. On the feet a long, somewhat erect, coarse and distant pubescence; no dressed hairs on the tibias. On the scapes the hairs are oblique. Epistome excavated in the middle, and bisinuated on the sides.

♀. L. 7·8mm. to 8·8mm. Much stronger striated than the ☿, and subopaque. Everything is strongly striated, except the middle (channel) of the epistome, the declivous face of the metanotum, and the abdomen, which are smooth and shining. The remainder of the epistome is more wrinkled than striated. Wings finely pubescent, moderately coloured with blackish-brown. Nervures and marginal spot blackish-brown.

The ☿ and ♀ of this curious species were collected by Mr. H. Suter on the 21st October, 1889, under stones near the Hermitage, Mount Cook (2,540ft. altitude), South Island of New Zealand, together with *Monomorium nitidum*, Smith, which is abundant in the same locality. Mr. Smith (*l.c.*) also wrongly assigned *Monomorium nitidum* to the genus *Tetramorium*, a mistake already corrected by Mayr.

ART. XXV.—*On the Composite Ascidians of the North Shore Reef.*

By J. T. NOTT, M.A.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

Plates XXIV.-XXX.

PART I.—INTRODUCTORY.

ACROSS the harbour of Auckland to the north-east lies the North Shore suburb, and still further beyond in the same direction the volcanic island of Rangitoto rises, separated from the mainland by the channel of that name. Skirting the western shore of this channel for some few miles the cluster of rocks known as the North Shore Reef is reached: a favourite collecting-ground for the zoologist, and one which has already provided much interesting material for the student of our New Zealand fauna. These rocks, only a few acres in extent at the most, are quite submerged at ordinary high tides, and, except at low spring-tides, are separated from the beach by a shallow stream of no very great width. The numerous pools left at low tides, protected as they are from the violence of the waves by the outlying barriers, afford a congenial home to many of the lesser denizens of the deep. Two fields of research, at present almost, if not quite, unexplored, here offer themselves: first, the sponges, of which great numbers may be distinguished; and, secondly, the Composite Ascidians, with some of which this paper deals.

I have, for the sake of convenience, divided my subject into three parts. The first is purely introductory, and deals with the subject in its more experimental aspect, discussing the methods employed, the means available, and matters of a similar nature. The second will deal with the anatomy and histology of the various species, as far as I have been able to elucidate them. The third will then summarise the facts noted previously, and deduce therefrom any conclusions of importance such as may be, in my opinion, warrantable.

The first visit to the collecting-ground was made early in the month of July, in company with Professor Thomas, when, owing to the rapidly-rising tide, nothing was done beyond gaining a practical knowledge of the locality. A second visit, a fortnight later, resulted in my securing five distinct species.* Of these

* *Leptoclinum niveum*, *L. densum*, *L. tuberatum*, *Cystodytes perspicuus*, and *Polysyncraton paradoxum*.

five, two* could not afterwards be obtained, despite my endeavour. These forms were killed by immersion in 60-per-cent. spirit, and afterwards hardened in alcohol of various grades up to 86 per cent.: a course of treatment which gave excellent results despite its primitive character. A subsequent visit in the month of September gave three new species† (and several varieties which lack of time prevented me from fully examining), in addition to the duplicates of the earlier collection. These were all removed to the laboratory in their native element, and, after careful observation in the living condition, were killed, some by osmic acid, others by the slow spirit method (Elsig's), and others by picro-sulphuric acid. As far as the materials would allow, each species was treated in all three ways: where the colony was too small to divide, the slow spirit killing was followed, as its greater simplicity involved less risk. Good results were, however, obtained in all cases.

For staining purposes picro- and borax-carmine were chiefly employed, both being used in every case except the osmic-acid specimens, which were transferred directly to picro-carmine. The picro-carmine was used for staining the "corm" or "ascidiarium" in its entirety before imbedding and sectioning. Other subjects, previously imbedded and sectioned, were either mounted in the natural condition or stained in borax-carmine or iodine. The picro-carmine staining proved much superior under the microscope, as it gives greater differentiation in tint, and is more transparent.

It was found necessary to decalcify the three species of *Leptoclinum*—*L. niveum*, *L. densum*, and *L. tuberatum*—before any satisfactory examination could be made. This was accomplished by the use of a weak solution of hydrochloric acid in 86-per-cent. spirit, the acid being added drop by drop till small bubbles of gas began to rise, fresh acid being added when the effect of the first was neutralised. In this way decalcification took place slowly and gently with the least possible injury to the tissues. The results were, in each case, excellent. Specimens so treated were, after the removal of all traces of acid, stained and mounted in the usual way.

Sections were made both longitudinally and transversely to the axes of the zooids, or, more properly speaking, parallel and at right-angles to the surface of the colony, since the zooids are seldom arranged quite perpendicularly to the exterior boundary of the test. In all cases the sections were taken by hand. *Cystodytes aucklandicus*, on account of its larger size and the opacity of its mantle, was prepared by saturation with paraffin, &c., for sectioning in the rocking

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* *C. perspicuus* and *P. paradoxum*.

† *C. aucklandicus*, *P. fuscum*, and *L. maculatum*.

microtome, but time did not permit the completion of my intention. This is all the more to be regretted in this case as the accounts of the genus available are very meagre, and the complete examination I was able to make of the test proves in our New Zealand forms a remarkable amount of speciality, which might possibly be reproduced in the internal structure.

Canada balsam and glycerine were used as mounting media—chiefly the former, though in many particulars glycerine excels, as in the case of *Cystodytes*. Wherever any special mode of treatment gave desirable results the fact will be specified in the second part of my paper, so that any lengthened mention here is out of place.

For microscopical examination, a Crouch's student's microscope, with eyepiece 3 and Zeiss's *a** objective, was used for low powers, being useful chiefly in the case of *Cystodytes*. In all other cases a Zeiss instrument with oc. 2 and objectives A, C, E, and F was employed, every part of each section being carefully examined with obj. A, and details referred to the higher powers when necessary. As some hundreds of sections containing thousands of zooids were thus passed under review, the work was naturally tedious, but none the less interesting, and, I hope, profitable.

Drawings were made of all the species, the accompanying plates being so designed as to show all points of interest as far as possible. I believe that these plates, with their accompanying explanatory notes, will speak for themselves as to their mode of production: here, however, I may briefly state that drawings of the colony in complete section were, unless otherwise specified, made from the sections directly, using obj. A. The thickness of the colony at the point of section was carefully determined by a millimetre scale, and the drawing afterwards copied, using the scale to determine the amount of enlargement. Thus, *Cystodytes aucklandicus* measures exactly 5mm. in section naturally: the fig. (1 in Pl. XXX.) is enlarged 7 diameters. In some few instances the drawings have been made without much attention to scale, but generally an attempt has been made to so use the camera that a fair comparative test of the corresponding parts in different species may be arrived at. To this end a drawing-table was placed by the side of the microscope, and thus the distance traversed by rays of light was in all cases the same, the height of the table being constant, and such as to reduce the outlines to a suitable size. Each figure has an explanatory note giving the objective used, and stating whether the camera was employed or otherwise. A Zeiss's "Abbé" camera was the instrument thus used.

It only remains for me to notice the works of reference available. These are not numerous, nor can I suppose that my species will in all cases be found to be new, as I have had no access to most of the works dealing with the subject. Such as I have had, however, lead me to conclude that our New Zealand forms are all peculiar; but of this more must be said later on. Of general works on zoology, such authors as Rolleston ("Forms of Animal Life"), Huxley ("Anatomy of Invertebrata"), Claus ("Zoology"), were all that I had to depend upon: very little could, however, be derived from thence. More important in every sense are the papers by Professor Herdman on the Tunicata found during the "Challenger" expedition (vol. vi., pt. xvii., and vol. xiv., pt. xxxviii.). The latter deals, on the whole, exhaustively with the "Challenger" species, though incomplete in some particulars, and is of still higher value on account of the amount of information it affords with regard to general anatomical details and to classification. The latter, especially to a beginner, presents features of very great difficulty, and I must here premise that my nomenclature is merely provisional, being designed rather to serve as a convenience for reference than to remain unchallenged in the scientific world.

Three distinct genera are represented in the North Shore forms, their generic affinity being quite beyond doubt. The genus *Cystodytes*, von Drasche, is represented by two forms, which, added to the five known species, gives a total of seven. Herdman places this genus among the Distomidæ. Four New Zealand species are referable to Milne-Edwards's genus *Leptoclinum*, as also are a number of varieties, thus further extending this large family in distribution, if not in number of species. Lastly, two closely-allied but quite peculiar forms are found, which I place provisionally in a new genus, *Polysyncraton*. As to the family relationship of the latter genus, I may here remark that it is the most interesting point offered for consideration by our Composite Ascidians: further discussion may be postponed till their description is completed.

Part II.—Anatomical and Histological.

Family DIDEMNIDÆ.

Genus Leptoclinum, Milne-Edwards.

Leptoclinum niveum, n. sp. Plate XXIV.

Small colonies of this form were obtained both in July and September.

The colony is usually of small extent, the thickness varying from 1mm. to 2mm., and closely incrusts the loose stones lying about the reef, being met with only on the under-surface. It is readily distinguishable from the other three New Zealand species by its pure dense-white colour and uniform texture of surface. The position of the zooids can only faintly be recognised by a slight greyish tinge above the body of the animal. The arrangement is irregular.

The branchial pores are extremely small, and are in most instances quite indistinct. In specimens killed by Elsig's method they are visible as faint dots on the white ground, but in all other instances are inconspicuous till highly magnified. As seen in transverse section under the microscope, the aperture (fig. 5) appears faintly trilobed, the branchial siphon (*br.s.*) being quite plain-edged. A well-marked branchial sphincter (*sph.*) surrounds the anterior end of the siphon. The mantle has separated from the test in fig. 5, the limit of the latter being seen as a faint ring (*t.l.*).

The common cloacal openings are small and indistinct, none being seen on taking a surface-view, though met with at rare intervals in longitudinal sections. Cloacal canals are well developed in the upper layer of the test (fig. 2, *c.c.*), and numerous canals of large extent are also present in the lower layer below the zooids, communicating in many cases with the cloacal canals by large passages. These lower canals in some cases open on the under-surface of the colony (fig. 2), where the great accumulation of fæcal pellets suggests their acting as common cloacal openings.

The spicules (fig. 8) are fairly large, with sharply-pointed rays varying somewhat in number and size. In distribution (fig. 1) they are very numerous on the upper surface, and only slightly less numerous through the remainder of the test. Each is enclosed in a delicate membrane, which stains slightly, in decalcified sections, with borax-carmine.

Histologically, the test shows very numerous test-cells, which stain deeply with carmine. They are rather smaller and more numerous in the upper layer of the test, fewer and larger below. Under a high power (E) they are distinctly nucleated, and exhibit delicate fibrils, which sometimes anastomose (fig. 6). No bladder-cells are met with.

Test-vessels, in the form of vascular prolongations of the mantle, are frequently met with, being sometimes furnished with a terminal knob. Usually long and filamentous, they can be here and there traced up to their point of origin from the œsophageal region (fig. 2, *v.ap.*).

The zooids are small, and very distinctly separated into the so-called "thorax" and "abdomen" by a peculiar œsophageal constriction (fig. 2, *œ.c.*) just above the abdominal portion of the œsophagus, and below the vascular appendage. The abdomen slightly exceeds the thorax in size (fig. 10), and in decalcified specimens is usually found to have shrunk away from the wall of its test-cavity, leaving the mantle-epithelium and connective tissue of the mantle round the zooid, while the mantle-ectoderm (fig. 4, *m.e.*) is still attached to the test.

Fig. 4, from a specimen treated with osmic acid, also shows faintly the squamose epithelial cells in outline (*m.*).

As before mentioned, the branchial siphon is plain-edged, and widens gradually, ending in the muscular ring from which the numerous tentacles spring (fig. 4, *b.t.*). The tentacles are all of equal length, their points meeting across the buccal cavity.

The normal four rows of branchial stigmata are present, most clearly distinguishable in the young zooid (fig. 10) on account of the greater opacity of the mantle in the adult stages. Still, four rows were distinctly traceable in the mature zooid, the cilia fringing them being faintly seen. A row of large "fringing cells" (fig. 9, *f.c.*) outline the stigmata very clearly, and also indicate the limit of the longitudinal vessels (*l.v.*, fig. 9). The transverse vessels (*t.v.*) are much broader than the longitudinal. The fringing cells have large oval nuclei, which stain deeply, especially with picro-carmine. Other deeply-stained nuclei are also found (fig. 9, *nc.*) over the branchial vessels: these no doubt indicate the cellular structure of the branchial basket.

The endostyle (figs. 2, 4, and 10, *en.*) is large and distinct. In transverse section it appears square, and with obj. C the columnar epithelial cells can be discerned (fig. 4, *en.*). Its course is very undulating (fig. 2, *en.*), ceasing indistinctly near the œsophagus. When viewed from below, as in fig. 2, a clearer space appears in the centre: this is due to the fact that the epithelial cells here are not piled upon each other, being viewed endways only.

The dorsal lamina is represented by a series of long languets, situated transversely on the transverse vessels of the branchial sac (fig. 9, *d.l.*). They are broad at the base, and flattened, the edges being fringed by large cells distinctly outlined. (See note on peripharyngeal band at end of description.)

A small nerve ganglion (*n.*) and larger neural gland (*n.g.*) are seen in all transverse sections through the upper region of the branchial sac (figs. 4, *n.* and *n.g.*, and 10, *n.*).

The alimentary system is remarkably complex, and appears to offer peculiarities hitherto unrecognised. The œsophagus, after narrowing greatly at the œsophageal constriction (*œ.c.*, fig. 2), widens again, and passes soon into the cardiac division of the stomach, which is large and thick-walled (fig. 7, *st.*). In longitudinal section the stomach has a bobbin-shaped lumen (Pl. XXIX., fig. 8), and is seen to exhibit traces of columnar epithelial cells of great length composing its walls. The stomach is then continued as a pyloric sac about equal to the œsophagus in size where it leaves the stomach, but dilating distally into a bulb, in many instances, before passing through a narrow pyloric constriction into the short much-swollen intestine (fig. 7, *i.*, and fig. 2, *p.b.*). Through a second constriction the rectum is reached: this in its earlier course is largely dilated (fig. 7, *r.*) and glandular. It turns out of the plane passing vertically through œsophagus, stomach, and intestine slightly to the left, then recurves sharply as a transparent membranous tube surrounding the dark fæcal pellets to the right side of the œsophagus, round which it passes dorsally, and thence makes its exit through the œsophageal constriction. The atrial pore is seemingly plain, showing neither lobes nor languets (fig. 10, *a.p.*). Glands are present chiefly on the pyloric bulb of the stomach, where they have the form of large homogeneous cells, strongly refractive and giving the bulb a somewhat crenated appearance in its outline.

Reproduction appears to be effected chiefly by gemmation of the type called "pyloric" (fig. 10). In all cases where gemmation was observed the young zooid had exactly the position with respect to its parent figured in Plate XXIV., the dorsal surface of the former being applied closely to the ventral (endostylic) surface of the latter.

The testis consists of a single large pyriform mass, granular in appearance and deeply stained, surrounded at a varying distance by a delicate transparent membrane. The "stalk" of this mass connects with the vas deferens, which is strongly defined, and coils eight or nine times around the membranous testicular investment before springing up to pass through the œsophagus (fig. 10, *v.d.*).

A single large nucleated body, of opaque homogeneous appearance, lies near the intestine and testis in many zooids from colonies obtained in September. These I take to be ova (fig. 10, *ov.*).

Note.—All notice of the peripharyngeal band is omitted in the above account. It is present as a circlet of deeply-stained cells passing around the thorax on its inner surface, between the buccal tentacles and the branchial basket. Ventrally it unites with the commencement of the endostyle, while dorsally it is hollowed to receive the nerve ganglion (fig. 3, *pp.b.*). This band is the point from which the mantle (epithelial and connective-tissue layers) separate clearly from the body-wall; the mantle-ectoderm is represented by the lining of the test-cavity (*m.e.*).

Leptoclinum densum, n. sp. Plate XXV.

Colonies of large size were obtained on each visit for purposes of collection.

The corm is an incrusting mass varying in thickness from 1·2mm. to 4mm. In some cases the edge of a colony leaves the object of attachment, and, growing freely for some time, turns over upon itself, thus forming a double layer, reaching a thickness of 6mm. The surface is compact and minutely granular; colour varying from light-pink to a yellowish-red. Zooids quite inconspicuous and irregularly arranged.

The branchial pores are very small and indistinct. In transverse section the branchial siphon has its edge six-lobed, the lobes turning outwards (fig. 4). Inside the branchial aperture is seen closed as in *L. niveum* by three lobes, much fainter and less granular, however. The branchial sphincter is well developed in longitudinal sections.

Common cloacal openings are small and invisible without high magnification (fig. 1, *c.c.o.*). Cloacal canals are distinct even when the spicules are present (figs. 1 and 2, *c.c.*). These canals are near the surface, and, as far as present observations extend, never connect with downward passages, lower canals being also absent.

The spicules (fig. 6) are remarkable, being equal in size to those of *L. niveum*, but much denser, the rays having their ends in all cases rounded instead of pointed. They are extremely numerous, far more so than in the preceding species, and are most abundant on the upper surface and in a thin layer running parallel to the lower surface at some slight distance above it (fig. 2). Their number is so great that examination is quite impossible except in decalcified specimens, and they give a characteristic brittleness to the corm both in the natural state and in alcohol-hardened specimens. Each spicule is faintly pink in the stained sections—the only case in which colour is present. As only osmic-acid specimens were mounted without previous decalcification, I am inclined to think that the colour of the colony is due to this coloration of the spicular membrane, the colour being in other preparations removed by the alcohol employed. Specimens of *L. niveum*, also treated with osmic acid, showed no such coloration. No sections in the natural state were available after the discovery was made, otherwise the point might easily be settled.

The test differs considerably from that of *L. niveum* in its histological structure, The test-cells are far more numerous and smaller (fig. 3, *t.c.*). They are embedded in a structureless matrix, which, on careful focussing, reveals numerous clear spaces of polygonal or rounded form, separated from the matrix by a very delicate membrane. This I take to be the spicular membrane (fig. 3, *sp.m.*). The same characters are presented throughout the test, except that these spicular membranes are smaller and more numerous where the spicules are most strongly developed.

Test-vessels are present (fig. 1, *v.ap.*), in this case uniformly taking their rise near the termination of the endostyle. A terminal knob is usually present (fig. 7, *v.ap.*).

The zooids slightly exceed in length those of *L. niveum*, but show the same peculiar œsophageal constriction (fig. 7, *œ.c.*). The thorax is much smaller than in the preceding form: the abdomen is nearly equal in size in each.

The branchial siphon (fig. 5) is long and much dilated above. Its edges exhibit six lobes of small size. The mantle-ectoderm surrounding it shows very distinct nuclei. The buccal tentacles are sixteen in number, and even in length; their ends being pointed.

The branchial basket generally exhibits the same features as *L. niveum*, except that everything is proportionately reduced owing to the smaller size of the thorax.

The endostyle (fig. 5, *en.*) is remarkable for the upward extension of its pointed conical end above the muscular buccal ring from which the tentacles hang. Its course is a recapitulation in other respects of that of the previous species. The dorsal lamina also offers no distinctive features.

Nervous centres were frequently visible in many zooids as opaque bodies situated on the dorsal body-surface (fig. 7, *n.*). None were seen in transverse section.

The peripharyngeal band (fig. 5, *pp.b.*) is distinctly visible below the circle of tentacles, its connection with the endostyle being also distinct. The commencement of the peribranchial cavity at this point is also very noticeable, though visible only in zooids whose thorax has been longitudinally slit.

The alimentary tract exhibits no traces of a pyloric bulb, but a well-marked pyloric constriction divides the intestine from the stomach. The rectum is not distinctly coiled round the œsophagus as in *L. niveum* (fig. 7), but probably repeats an analogous curvature nearer the œsophageal constriction. The atrial pore is plain.

No instances of gemmation were observed, but sexual reproduction appears to be common, judging from the number of tailed larvæ present in the colonies found.

A curious feature in the testis was observed in some three or four cases, and may possibly be normal. The single vesicle characteristic of the family appeared split in two. The investing membrane surrounds both the closely-applied masses (fig. 8), and the vas deferens coils spirally around it some seven or eight times. The testis is near the intestinal loop, and usually on its right side (fig. 7).

Hard by the testis opaque bodies distinctly nucleated were observed in all colonies, greatly resembling those found in *L. niveum*. Only one was present in each zooid where they were found, and from many they are absent altogether. Similar bodies are present in the lower layer of the test in considerable numbers (fig. 9, *ov.*). They are of large dimensions, being often nearly equal to the testis in size (fig. 7, *v.d.* and *ov.*; and fig. 8, *ov.*).

The lower layer of the colony also presents numerous tailed larvæ in various stages of development. A somewhat early stage is figured in fig. 9, *l.*, close by the ovum (*ov.*). Fig. 10 shows an older larva in which the number of adhering papillæ is four, three being apparently the usual complement as in fig. 11. Two distinct pigment-spots are present in each case—an anterior, small and rounded; and an irregularly triangular posterior of larger size. These are undoubtedly sense-organs, and probably are eye and auditory organ respectively.

Leptoclinum tuberatum, n. sp. Plate XXVI.

Several colonies were obtained on both occasions. On the first visit, however, all were distinctly alike; those got subsequently differ much in colour, though, as far as I have been able to examine them at all, they are not otherwise distinct.

The type form is an incrusting mass of small thickness, 0·8mm. to 1·5mm., and of a white colour, slightly more greyish than *L. niveum*, from which it is readily distinguishable by its stellate appearance at intervals on the surface. On using a lens these starlike features become still more pronounced, and indicate the position of the zooids, which are arranged in irregular rows.

The branchial pores are large and stellate, there being six lobes of the test projecting radially into each (fig. 3). Under a high power the apertures are seen to correspond with these lobes, the six rays being however very irregular. No common cloacal apertures were observed. But cloacal canals are very largely developed (fig. 2).

The spicules vary much in size and in the number of their rays (fig. 4). They are always sharp-pointed. They are most numerous in the true surface-layer, and in the second surface-layer (fig. 1), which cuts the base of the endostyle. They are much more numerous between the zooids than above them in the superficial layer, giving the transverse sections the appearance illustrated in fig. 3.

The test histologically is characterized by its possession of extremely numerous test-cells, these being smaller and more numerous than in either of the preceding species. But in its more general features the present form diverges very greatly from all others of which I possess any account. The extreme superficial layer is thrown up into numerous small papillæ (figs. 1 and 2), the spicules being absent, thus leaving a delicate transparent membrane over the firmer portion of the colony. Around each zooid the test is very thin, and shows only a few spicules (fig. 1), except at two points right and left, where a projection of the test-matrix is found containing enormous quantities of small spicules (fig. 1, *ph.t.*). These "pharyngeal tubercles" are very frequently, though seemingly not always, met with. Between the zooids there extends usually a wide and deep cavity, arched above, but flat below, where a second layer of test parallel to the surface runs, as said above, along the colony at about the level of the œsophagus (fig. 1). The drawing (fig. 1) gives the arrangement actually seen in very many cases, which is, however, by no means universal (see fig. 2 for comparison). Beneath the second layer the test is compact, and has cavities only for the zooids and developing embryos.

Vascular appendages are uniformly present, springing from the region above the œsophageal constriction (fig. 2, *v.ap.*). They do not usually end in terminal vessels.

The zooids are remarkable for their greatly elongated thoracic region (figs. 2 and 7), and long extension of the œsophagus above its constriction.

The branchial siphon (fig. 5, and fig. 7, *b.s.*) is comparatively short, and quite narrow in spite of the large size of the stellate opening. As seen in longitudinal section it presents the form shown in fig. 5, the test-matrix containing spicules, &c., being projected downwards in the form of triangular lobes around the upper edges. The buccal tentacles are few in number, and of two sizes, all much shorter than in *L. niveum* or *L. densum*. Their ends are rounded, and not pointed.

The branchial basket is of extreme delicacy, the mantle being quite transparent usually. Owing to the vacuolated character of the test in the pharyngeal layer the zooids are usually much displaced and contorted, rendering observation as to details difficult. I have, however, succeeded in obtaining a good detail figure (fig. 6) for comparison. The stigmata are long and narrow, the fringing cells being convex and distinctly outlined on the stigmatic, but straight and faintly marked off on the vascular, surfaces. The large oval nuclei lie near the vascular border. Cilia are only faintly distinguishable. The transverse vessels are plain, and scarcely wider than the longitudinal. Only three rows of stigmata are observable in the adult, but four are always present in the young form (fig. 7).

The endostyle offers no peculiarities; it is always distinct and very undulating in outline (fig. 1, *en.*). The dorsal lamina is represented by a series of very long languets, broad at the base, but pointed distally (fig. 6, *d.l.*). More remarkable is the fact that the stigmata on either side are scarcely more widely disparted than in the remainder of the pharyngeal basket.

The peripharyngeal band is usually very distinct as a broad circlet of deeply-stained cells below the buccal tentacles (fig. 5, *pp.b.*).

The alimentary tract is distinctive, approaching the form observed in many other species more closely than that of its New Zealand allies. The stomach is large, and has walls formed of long columnar cells (fig. 7, *st.*). It communicates by a short unconstricted pyloric tube with the intestine, which is thick-walled and globular (fig. 7, *i.*). A short narrow passage leads into the dilated rectum, which is glandular in its lower half, and above encircles the œsophagus (*cf.* fig. 7 with Pl. XXIV., fig. 7). The atrial pore is plain (fig. 7, *at.p.*), and, as in other Leptoclinids, situated half-way up the branchial basket.

Reproduction by gemmation is of frequent occurrence, and is an exact counterpart of the process seen in *L. niveum* (fig. 7). In fig. 7 a young zooid is shown with stigmata, languets, and atrial pore plainly visible.

The testis presents the form characteristic of the family, there being usually only five or six coils of the vas deferens. Its position varies much with the shape of the abdominal cavity. Generally near the intestine, it may occasionally be found in contact with the rectum in a special test-chamber (fig. 1, *v.d.*).

Opaque rounded bodies supposed to be ova were met with in the test, also a few tailed larvæ (fig. 8). These are distinguishable at once from those of other species by the enormously long tail, which quite encircles the body. Two pigmented sense-organs (eye and auditory sac) were always present, also three adhering papillæ (*s.o.* and *a.p.*, fig. 8).

Leptoclinum maculatum, n. sp. Plate XXVII.

A single colony of small extent was obtained in September.

The corm varies in thickness from 1·5mm. to 2·5mm. In colour it is a light-brown, spotted with dull white above the zooids, which thus become very conspicuous for a Leptoclinid. In consistency the colony is firm and leathery, but tears easily, and adheres very closely to the rock.

The branchial pores are smaller than in any other species examined, but in the living condition can be discerned with a lens under favourable conditions. A high power used on surface-sections shows the pore to be six-lobed, but three of these lobes are very small, and wedged in the angles of the others in such a way as to create the impression that only three large lobes exist (fig. 4).

Common cloacal openings are few in number and large, though not distinct. In fig. 2 one is shown in section (*c.c.o.*), the edges being apparently lobed. Much irregularity is, however, observable, and this appearance I look upon as accidental. Cloacal canals are well developed.

The spicules are extremely small, and vary much in size (fig. 3). On a surface-view they appear most numerous around the branchial pore (fig. 4), being absent in the intervals. In longitudinal sections a layer occurs at the level of the buccal tentacles, which is fairly well supplied with spicules, most numerous round the zooid. In the lower layers they are few or quite absent (fig. 2), being met with principally near the œsophageal constriction.

Histologically, the test exhibits a structureless matrix, with very numerous nucleated test-cells throughout. The surface layer is characterized by its large oval bladder-cells (fig. 5), which, with borax-carmine, appear finely granular, nuclei being often visible in the walls (fig. 5, *nc.*). These cells are also met with rarely in the lower parts of the test.

Vacuoles (fig. 2, *v.*) of large size occur below and among the abdominal prolongations of the zooids. In some few instances these unite with the cloacal canals (*c.c.*). The thoracic region of the test also shows irregularly-quadrilateral chambers and passages, recalling those of *L. tuberatum*, as shown in fig. 2. This arrangement is, however, quite unusual, the rule being for the test to be perforated with wide cloacal canals, which here and there enlarge greatly.

Ectodermal prolongations of the mantle are of frequent occurrence, usually ending in a bulb (fig. 1, *v.ap.*).

The zooids are much elongated, occupying a relatively deeper layer of the test than in the former species considered. Most remarkable is the great length of the œsophago-rectal region, which with its mantle envelope often exceeds by one-half the length of the thorax. This region is also, in many cases (fig. 2), continued below the constriction (which is always very definite) for some distance before the abdominal dilatation commences.

The branchial siphon is of considerable length (figs. 1 and 2, *b.s.*), and of remarkable form. The edge (branchial pore) is quite plain. For some distance the siphon is fairly even in size; it then dilates greatly, forming a bottle-shaped mass (fig. 8, *b.d.*), constricting once more slightly at the muscular band from which the tentacles arise. It thus resembles a water-bottle. In fig. 8 the mantle ectoderm is shown at a slight distance. The buccal tentacles (fig. 7, *b.t.*, and fig. 8) are long and numerous. In every case the branchial pore is found occupying a depression in the surface (figs. 1 and 2).

Four rows of branchial stigmata are present: in every case they are indistinguishable in the adult except in cross-sections. The young zooids show four rows, with apparently five in each row (fig. 6, *b.st.*).

As seen in section the endostyle is peculiar. It shows an internal cavity of large size, from which arise several smaller cavities (six in number), the outer surface being thrown up into corresponding folds (fig. 7, *cn.*). The peripharyngeal band is very distinct, and is seen in fig. 7 as *ph.w.* (pharynx-wall). It is faintly visible in the young zooid (fig. 6).

The dorsal lamina is represented by a series of long languets (fig. 6, *d.l.*) arising from the transverse vessels of the branchial sac.

A small nerve ganglion (fig. 7, *n.*) and large neural gland (fig. 7, *n.g.*) are found opposite the peripharyngeal band on the dorsal surface.

The alimentary canal exhibits a return to the type found in *L. niveum*. Indeed, the only difference of moment is the absence of the pyloric dilatation met with in the former species. The œsophageal curve of the rectum is frequently displaced, being forced downwards through want of room, as shown in fig. 6. The region above the œsophageal constriction shows very clearly the rectum and œsophagus lying side by side (fig. 1, *r.* and *œ.*). As in all former cases, the lower dilated part of the rectum is distinctly glandular, being more membranous above. The atrial pore is plain.

The testis is a single mass lying near the intestine (fig. 1, *t.*), and has the vas deferens coiled nine times around it. No ova and no embryos were met with.

Family (doubtful).

Genus Polysyncraton (new).

Polysyncraton paradoxum, n. sp. Plate XXVIII.

A single colony of considerable extent was obtained in July. It was placed at once in spirit, in which it appears to be greyish-white. I have no definite recollection of its natural colour, but imagine it to be white.

The corm is a thin incrusting mass, varying from 1·2mm. to 3mm. in thickness, and is soft to the touch, tearing very easily. The surface appears more homogeneous than in the Leptoclinids examined, but slight traces of the zooids are visible in the form of darker spots. The zooids are arranged very irregularly, but much closer than is usual (see fig. 2).

The branchial pores are small, and are buried beneath the surface, so that it is almost impossible to distinguish them. The edges of the branchial siphon are faintly six-lobed.

No common cloacal openings were discovered.

Spicules are present throughout the colony; they are of fairly large size and distinctive form (fig. 3). The rays are very numerous, extremely short, and rounded at the points. Generally three or four circles of such rays are visible, gradually increasing in diameter from the centre of the spicule to its outer margin. This would indicate extreme regularity in the arrangement of the rays, as the spicule presents the same appearance from whatever point it be viewed. These spicules are evenly distributed throughout the colony, being absent only on a small portion near the surface in longitudinal sections. (Figs. 1 and 4.)

Histologically the test is distinctive. Near the surface is a thin layer of transparent matrix interspersed freely with small test-cells, whose anastomosing fibrils give a slight appearance of irregular striation (fig. 4). Below, this passes insensibly into a structure of very different aspect, the matrix being much reduced by the presence of very numerous bladder-cells, transparent and closely placed (*bl.c.*). Here, as above, the test-cells are smaller than among the Leptoclinids, but are thickly scattered through the small amount of matrix separating the bladder-cells. A few spicules (*sp.*) are also seen; but it is impossible to exactly define their position. This condition of test prevails, with slight modifications, throughout the lower layers.

A few cloacal canals of small size are observable in the test (fig. 2, *c.c.*); otherwise it is solid throughout.

The zooids (fig. 1) are small, and present features of some importance. They are distinctly divided into thorax and abdomen, but do not show any special œsophageal constriction, as met with among the Leptoclinids. The abdomen is in all cases much larger than the thorax, and far less opaque.

The branchial siphon is produced into six faint lobes at the branchial pore. It is short and fairly broad, dilating only slightly at the circlet of tentacles (fig. 1, *br.s.*, and fig. 8. *Cf.* fig. 8 with corresponding figures in other plates).

Four rows of branchial stigmata are present, and are in most cases faintly visible through the mantle. The fringing cells are very distinct (fig. 7, *f.c.*), as are also the nuclei of cells lining the branchial vessels. The transverse vessels are peculiar. A transverse lamina (fig. 7, *l.t.*) runs along the course of each, and, being of opaque nature, shuts out from view the uppermost fringing cells of the branchial stigmata immediately below. This lamina is probably muscular, as faint traces of striation are observed. The longitudinal vessels are fairly wide.

The endostyle is horse-shoe-shaped in section, and does not exhibit any traces of columnar cells. Its course is straight above and undulating below (figs. 2 and 8, *en.*). The peripharyngeal band is usually very distinct (fig. 8, *pp.b.*).

The dorsal lamina is represented by a series of languets, which are, like the buccal tentacles, short and stout (fig. 1, *d.l.*).

Nerve ganglia (*n.*) and neural glands (*n.g.*) were seen in transverse sections distinctly (fig. 8), also frequently discernible through the mantle in sections taken longitudinally.

The alimentary canal is simple. The stomach is thick-walled, the walls being columnar: its lumen is bobbin-shaped (Pl. XXIX., fig. 8). A short pyloric tube communicates with the globular intestine (fig. 1. See also fig. 8, Pl. XXIX.). A very short tube leads from the intestine to the dilated end of the rectum, which commences abruptly. For about half its length the rectum is opaque, owing to its glandular character; in the remainder it is traceable only by the numerous fæcal pellets contained. It does not appear to cross the œsophagus (fig. 1), but much variation is apparent in this particular. The atrial pore is in all cases distinct, and provided with a long languet (fig. 1, *a.l.*), which shuts against a projection of considerable size below.

The reproductive organs are striking in character. The male organs consist of a number (usually seven) of spermatic vesicles, situated near the intestine at its rectal end in such a way that their larger free ends turn towards the stomach. Each vesicle is pyriform in shape, and communicates by its small end with the vas deferens, which is very difficult to distinguish near the vesicles, but becomes exceedingly clear in its after-course. Careful focussing, however, shows on each side of the mass of sperm-bodies three small dark objects, apparently nucleated, and quite round. If observed carefully the vas deferens may be seen as a transparent thread, equal in width to the diameter of the dark bodies, and uniting them in pairs. This is the usual state, but occasionally the whole course of the vas deferens is traceable around the spermatic vesicles. It then appears to rise from the common apex of the vesicles, encircling them as a narrow transparent tube some three times, after which it dilates greatly and passes up alongside the rectum. In this part of its course it acquires a deep reddish-yellow tinge with picro-carmine (fig. 7).

Near the rectum and opposite the end of the œsophagus there lies, in a special mantle-swelling, a dark body with clear lumen, which on close scrutiny is seen to be surrounded by a ring of transparent oval bodies, differing somewhat in shape owing to pressure, and of various sizes. The dark body is composed of columnar cells, whose outlines are clearly visible (fig. 5, *ovr.*, and fig. 1). This I take to be the ovary with its ova. But if this be correct the ova are certainly not nucleated: at least, not in their present stage. No embryos were found in the colony.

A last feature, and a puzzling one, remains to be noted. This is the presence, springing from the mantle in the œsophageal region, of a large bulb, often nearly half as large as the thorax. It always arises from the side of the zooid (see fig. 2), and usually from its left side. No traces of structure were observed in any cases; it is opaque and densely granular, appearing, in fact, almost homogeneous. There is usually a

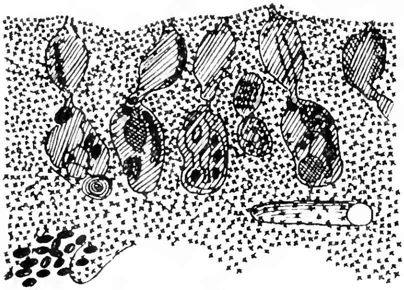


Fig 1.

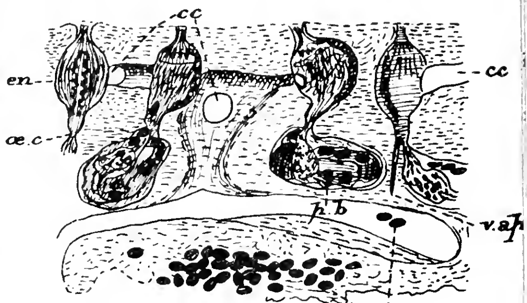


Fig 2.

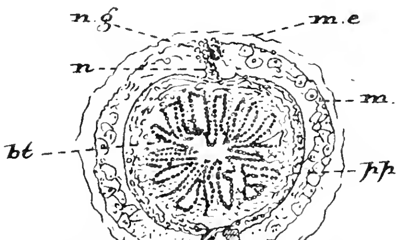


Fig 4.

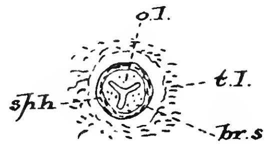


Fig 5.

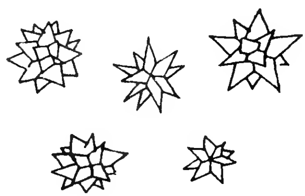


Fig 8.

Fig 6.

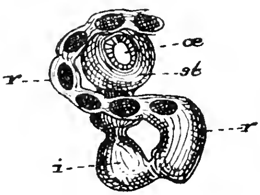


Fig 7.

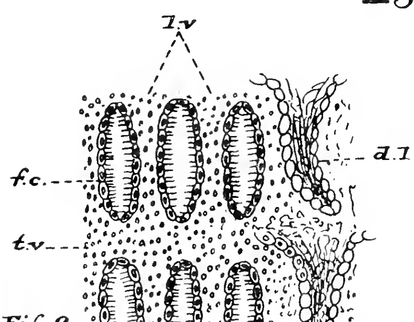


Fig 9.

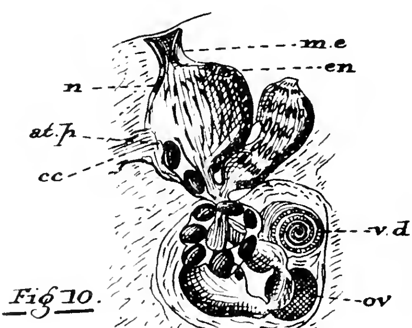
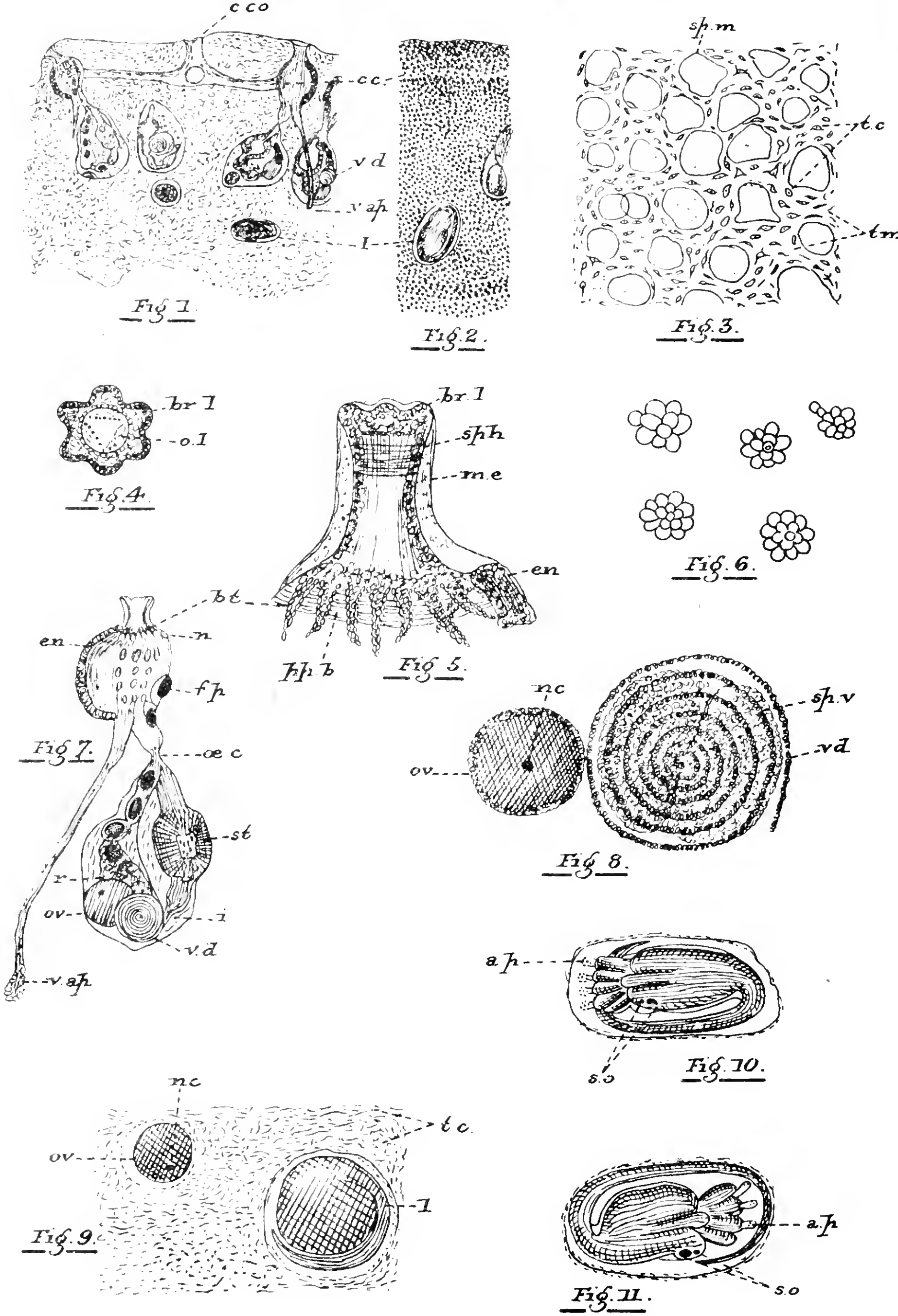


Fig 10.

J.T.N. del. N.Z. COMPOSITE ASCIDIANS. C.H.P. Lith.

Original Scale reduced 1/3.



J. T. N. del.

N. Z. COMPOSITE ASCIDIANS.
Original Scale reduced 1/3.

C. H. P. lith.

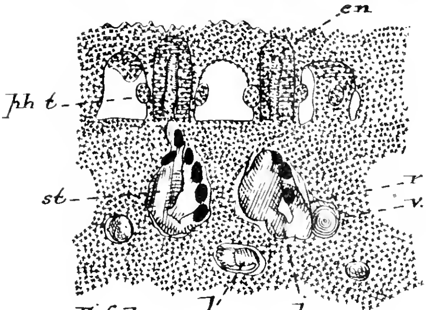


Fig. 1.

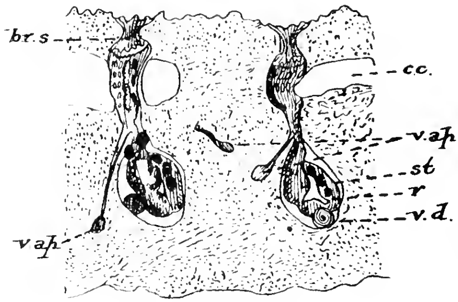


Fig. 2.

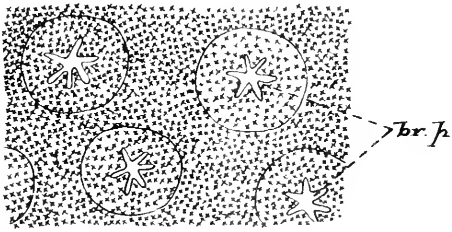


Fig. 3.

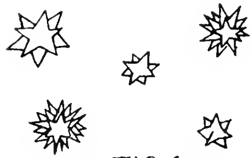


Fig. 4.

Fig. 5.

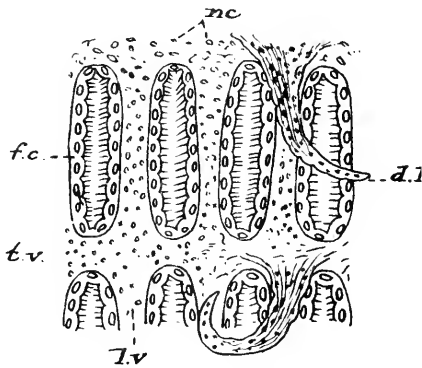


Fig. 6.

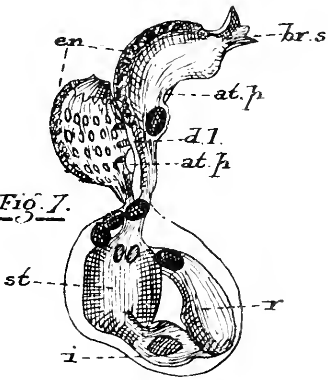


Fig. 7.

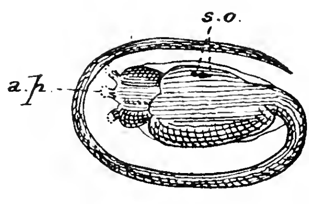


Fig. 8.

J.T.N. del.

N.Z. COMPOSITE ASCIDIANS.

Original Scale reduced 1/3.

C.H.P. lith.

small section of the distal extremity somewhat transparent, and the connecting tube is always small, and only slightly stained. My first thought was that here we had a commencing bud. But no traces of indubitable gemmation were discovered; and, moreover, even in young zooids, which had not reached the surface of the colony, these bodies were just as large and distinct as in the adult. In fact, they seem never to change. Their constancy throughout the whole of my sections, moreover, seemed to render this view untenable.

Were they highly-developed vascular appendages? This, again, seemed unlikely, for they are in all cases present only in the middle layer of the test, where the numerous zooids rendered unnecessary any such highly-developed vessels, while the lower layer, in which such prolongations usually terminate, was left vacant. Moreover, they spring from the side and not from the ventral surface as is more usual (*cf.* preceding descriptions).

Possibly it may represent a brood-pouch: but in that case its walls must be remarkably glandular; and its position is, moreover, peculiar if such be its function. In any case, no traces of ova were observed within.

For the present, then, I must leave this organ unexplained. That it has some special function of importance can scarcely be doubted; and its glandular nature, combined with its connection only with the mantle, to a certain extent may justify the term "vascular appendage" which I have applied to it in my plate, and which I retain, very unwillingly, for its provisional appellation.

Polysyncraton fuscum, n. sp. Plate XXIX.

Numerous colonies of very large extent were obtained in September.

Corm thin, fleshy and incrusting, uniform in thickness, varying from 1·5mm. to 2mm. Colour varies from deep reddish-brown to nearly black, the former colour on the whole predominating. The zooids are moderately conspicuous in position, owing to the semi-transparent nature of the test: they are not arranged in regular systems.

The branchial pores are small and not easy to distinguish: still, during life they may be discerned with a little care. The common cloacal openings, on the other hand, are very distinct, the transparent colourless outer layer of the test being raised up around them in such a way as to render them easily conspicuous. This is further aided by the cloacal canals, which ramify in all directions, as may readily be seen by the large yellow fæcal pellets within (fig. 2, *c.c.* and *c.c.o.*).

A few spicules are present, being met with only around the zooids (fig. 2). They vary extremely in size (fig. 4), but microscopically resemble those of *P. paradoxum* so closely as to require no further description here.

The test differs from *P. paradoxum* in two important points. First, the outer hyaline layer is far more extensive. Secondly, the bladder-cells are only present irregularly beneath it (fig. 7, *bl.c.*), being few in number in the layer of test above the cloacal canals, though numerous lower down. Each cell in the upper groups is oval in outline (fig. 7). Vascular appendages are common: they may be long and filamentous (fig. 1), or short and club-ended (fig. 2, *v.ap.*).

The zooids are much larger than in any species previously examined, and occupy a relatively larger amount of the common test. The abdomen is much larger than the thorax, from which it is separated by a short œsophago-rectal tube, which exhibits a slight constriction below the point of origin of the vascular appendage (figs. 1 and 2). So slight is this, however, that it can scarcely with fairness be termed a constriction.

The branchial siphon (figs. 1 and 6) has its edges faintly six-lobed. Narrowest above, it dilates gradually to the circle of tentacles, which are moderately long and of equal length. Longitudinal muscular bands (fig. 6, *l.b.m.*) run down the siphon from the oral lobes, gradually losing their distinctness till they merge in the muscular wall above the buccal tentacles. These longitudinal buccal muscles are characteristic of the species.

Four rows of stigmata are present—the branchial basket seeming to resemble that of *P. paradoxum* very closely. The lamina transversalis is, however, reduced to a mere muscular ridge.

The endostyle differs from that of its ally in being much more undulating throughout its entire length. The peripharyngeal band and nervous centre offer no theme for special comment: both are distinct. No dorsal languets were observed, but they undoubtedly exist.

The alimentary tract (fig. 8) is a repetition of that of *P. paradoxum;* the figure serves equally well for both. The upper half of the stomach has been cut away in sectioning, showing the peculiar shape of the cavity, with the passages of the œsophageal and pyloric tubes commencing. Only the glandular part of the rectum is figured. Its upper membranous portion does not cross the œsophagus, but passes out directly to the atrial pore, which is provided with a long, thick languet above and a well-marked projection below (fig. 1, *a.l.*).

The reproductive organs do not differ essentially from those of *P. paradoxum*. The testis consists of a number of spermatic vesicles, — usually seven, but ten were found in one case, —

whose products pass out by a long vas deferens, which first coils spirally four times round the mass of sperm-bodies. Its after-course is not clear as in the case of its generic relative.

The supposed ovary, which is in this case almost uniformly present, is identical in position (fig. 1, *ovr.*). But the gland itself is elongated, presenting an upper hemispherical and lower conical end (fig. 5, *ovr.*). The ova are in this species also small and transparent.

But other bodies which are undoubtedly ova are present near the vesicles in some cases. These are of large size (fig. 1, *ov.*), being equal to the intestine, and exhibit a central clearer germinal area, with a deeply-stained oval nucleus (fig. 3, *nc.*). These are probably the fully-developed ova of which the transparent bodies noted above are the originals.

One or two tailed larvæ, with a single pigment-spot and three adhering papillæ, were met with. They occupy the lower test-layer in all instances.

Family DISTOMIDÆ.

Genus CYSTODYTES, von Drasche.

Cystodytes aucklandicus, n. sp. Plate XXX.

Numerous colonies of large extent were obtained in September. It is the most numerous species met with on the reef.

Corm is moderately thick, averaging 5mm., and seldom less than 4mm. Its colour is light-brown, with darker dots where the zooids are placed. The test is fleshy and transparent, allowing the white capsules surrounding the abdominal regions of its tenants to be seen from the exterior. Over the surface runs a network of slightly lighter lines. The openings of the test, whether branchial or cloacal, are not very distinct, and are exceedingly small. There is no trace of regular systems, but not more than four or five zooids are present in each.

Great difficulty is experienced in staining. The best results are obtained from sections stained after cutting, and from sections left unstained, as the staining fluid (picro-carmine) does not readily penetrate the dense cartilaginous test. In specimens stained entire, though allowed to remain forty-eight hours in the fluid, the middle layer was only slightly tinted.

The outer test-layer is free from bladder-cells, exhibiting a structureless matrix, in which are numerous test-cells. This layer is very thin, and gives place to what at first sight appears to be simply a mass of bladder-cells throughout. Careful use of high powers, however, shows that this appearance is due to the lower cells being visible in outline through the upper. Fig. 3 gives the appearance of the test with obj. C. A test-matrix is present (*t.m.*), in which are scattered numerous nucleated test-cells of small size and with many fibrillæ. Everywhere the matrix is occupied by large bladder-cells of slightly granular appearance, and very distinctly nucleated (fig. 3, *bl.c.* and *nc.*). Towards the middle of the test the bladder-cells are not so distinct in specimens stained in their entirety, but others sectioned before staining show no difference throughout the test, except the absence of bladder-cells from the extremely thin surface-layer. In sections mounted in Canada balsam without staining the bladder-cells are scarcely visible.

The test above is broken by numerous vacuoles of large size (fig. 1, *v.*). These form vestibular chambers, into which the branchial siphons of the zooids project, the upper portions of the test being apparently never occupied by the animals. A second row of cavities occurs in the lower half of the test. These are the proper zooid capsules, the lower part —that, namely, occupied by the abdomen and upper part of the thorax—being strengthened by the large overlapping calcareous discs so characteristic of the genus (fig. 1).

Fig. 9 shows a group of these spicules seen under obj. A. They differ greatly from those figured by Herdman from the two "Challenger" species, being irregularly notched at the edges, and showing no radiating bands. On the other hand, these spicules show more affinity to those of the Leptoclinids, &c., for, if we imagine such spicules to be enormously enlarged without increasing the size of their rays, and that these small rays at the same time have their numbers multiplied greatly, we shall obtain a spherical body whose round outline will resemble that shown in the figure. I regard these projecting lobes as the counterpart of the rays in the Leptoclinids. In some cases the discs acquire a different appearance, illustrated in the upper right-hand member of the group in fig. 9, the closely-set rays forming concentric layers. A third spicule is shown from the edge, exhibiting its lens-shaped form.

But these spicules, remarkable as they are, do not exhaust our materials as far as the test is concerned. On the contrary, calcareous matter is so strongly characteristic of our New Zealand forms that the complete investigation of the test and its calcareous deposits alone might afford fruitful study for months.

In a few sections strong calcareous fibres (fig. 1, *c.f.*) are found in the upper layer of the test. These are extremely difficult to examine owing to their wonderful refrangibility. They appear purplish in colour with picro-carmine, but are white in the natural state, and are visible to the unassisted eye as white threads occurring at rare intervals through the colony. To light them satisfactorily in glycerine or Canada balsam is almost impossible, but, as far as I can make out their structure, they seem to be composed of smaller and more irregular spicules than those forming the capsule, fused together to form long and always straight rods, which seldom branch.

Next in interest come the peculiar deposits which I have figured in fig. 1 as *c.b.* These, again, are only local, and are best seen in unstained sections soaked for some hours in clove oil and mounted in Canada balsam. Such sections under high magnification exhibit the radiating branched calcareous skeleton shown in fig. 1, and given in detail in fig. 7. With this treatment they are extremely distinct, and are seen to be composed of immense numbers of small calcareous prisms, crystalline in appearance, and branching irregularly as in the figures.

Yet a third form must be distinguished, which is shown as *c.b.* in fig. 1, and again under obj. A in fig. 4. These "calcareous trees" are quite crystalline, and are found only in the layer of test in which the zooids are situated, being most numerous near and amongst the calcareous discs. In Canada balsam they are almost invisible, and would certainly be passed over did one not expect to find them. But glycerine preparations show them with remarkable clearness. Fig. 6 gives a detail view of one of these "trees" as seen in Canada balsam sections with obj. E.

Closely allied to these latter forms, but quite invisible in balsam, are the crystalline deposits seen in fig. 8, and found only around the zooids. Only one form was seen resembling the figure, but other crystals, reproducing exactly the small branches, are so common that the layer of test just outside the capsule seems to be composed of nothing else. They seldom exhibit more than two or three rays, and recall the form shown in fig. 4 but for their extremely small size.

Another curious detail in the account of the test is illustrated in fig. 10. This shows part of a surface view, and throws light upon the network of lighter lines mentioned above. With a high power these lines are seen to be surface vessels, distinct in outline and richly granular, being surrounded by a test-matrix in which are extremely abundant test-cells. Through the upper clear layer a few bladder-cells are visible. Here and there these vessels dilate, enclosing a dark granular body with a central darker portion, also granular. It thus resembles a nucleated cell of large size; but what is its function? This question, as well as the exact relation of the calcareous bodies above to one another and to the test, I must leave undecided, and deal briefly with the zooids.

These are of large size, and loosely attached in their capsules. The mantle is richly muscular, having distinct transverse and longitudinal muscle-bands. There is a very distinct thorax and abdomen (fig. 2).

The branchial siphon is short, and has its edge six-lobed. The tentacles were not observed, but the endostyle is extremely undulating (fig. 2, *en.*). There are four rows of stigmata, with wide transverse vessels and narrow longitudinal. The transverse vessels are slightly muscular. (Fig. 11 is from *C. perspicuus*, but the differences are slight.)

The stomach is thin-walled and globular, but not large. The relations of the various sections of the alimentary canal were not satisfactorily settled, but the course of the rectum is easily made out in zooids removed from the colony and mounted entire, by means of the fæcal pellets. There is a long atrial siphon near the anterior end of the body; its rim is also six-lobed (fig. 2, *at.s.*).

Numerous ova of varying size were found near the intestinal loop (fig. 2, *ov.*). Others were seen in special brood-pouches springing from the peribranchial cavity, and a few tailed larvæ were also met with occupying a clear transparent pouch through which the structure of the almost equally transparent embryo could be easily discerned.

Note.—My first conviction with respect to the calcareous matter found in this and the following species was that it could not be calcareous, for I found that in hydrochloric acid the disclike spicules dissolve readily, while the other forms do not. But on leaving a thin section in the acid (1-per-cent. solution) for five hours all traces of the deposits were removed. This anomaly I believe to be due to—(1) the different nature of the calcium crystals, and (2) the difficulty of penetrating the middle test-layer.

Cystodytes perspicuus, n. sp. (?). Plate XXX.

A single small colony was obtained in July. I am not yet convinced of its specific value, but shall consider it as such for our present purpose, and shall here merely point out the differences noted.

In external features there is considerable resemblance. But this form is slightly thinner, averaging 4mm., and is quite colourless and transparent except for the white capsules.

The spicules present no differences, but, although calcareous fibres were present, no calcareous trees were found comparable to those of *C. aucklandicus*, their place being taken by the even more peculiar crystalline forms shown in fig. 5.

Histologically the tests are identical, except as regards the calcareous deposits.

The branchial siphon is shorter than in the former species, as is also the atrial siphon. The buccal tentacles are short and blunt.

The branchial basket exhibits the same features as does that of its predecessor, but the muscular ridges of the transverse vessels are much more strongly developed.

Except the colour, no one of the above characters can be considered such as is not accountable for by simple variation. It has been seen that the calcareous elements are capricious in their distribution, if the term be appropriate to anything which we surmise to have a cause but cannot explain.

PART III.—SYSTEMATIC AND GENERAL.

It now remains for me very briefly to point out in a concluding summary the features of systematic or structural importance which the preceding descriptions appear to suggest.

Every authority upon the subject concedes the difficulty of exact classification: hence we need not be astonished to find that each new form discovered is hard to place systematically. This difficulty meets us at the outset in the forms which I assign to Milne-Edwards's genus *Leptoclinum.* Herdman ("Challenger" Rep., vol. xiv., pt. xxxviii., p. 260) sums up the features of importance in distinguishing the genera *Didemnum* (Savigny, 1816) and *Leptoclinum* (1841) as follows :—

Didemnum : Colonies thick ; atrial siphon placed far back, with no languet ; three rows of stigmata.

Leptoclinum : Colonies thin ; atrial pore further forward, with a languet ; four rows of stigmata.

Now, with one exception, our forms have four rows of stigmata, and are very thin ; but no languets were noted, the atrial pore being placed in the middle of the thorax. The one exception, however (*L. tuberatum*), can scarcely be regarded as definitely settled owing to the decalcified specimens becoming much contorted in sectioning : fairly-advanced young forms always exhibit four rows of equally well developed stigmata. The thickness of a colony seems very unsatisfactory as a test of generic affinity, but, if it is to be regarded as sound, I think we must place our four Auckland species among the Leptoclinids. My own personal convictions are strongly against the generic distinctness of Milne-Edwards's group, and, as the four species here noted furnish a strong bond of connection between it and the older genus *Didemnum*, I should prefer to amalgamate the two genera under Savigny's genus.

The question of affinity to other species is also one of great difficulty. I have only the "Challenger" species to guide me, and these, owing probably to the nature of his material, are inadequately described by Herdman. Thus, in spite of the importance he attaches to the atrial pore in classification, in only one species (*L. japonicum*) does he mention it in his descriptions, and there he says, "The atrial siphon [*sic*] is placed on the dorsal edge of the thorax half-way down"! Further, he seldom mentions the alimentary tract except very briefly, and has not noticed the peculiar œsophageal constriction. I believe I am right in considering my species quite distinct from his, whatever may be their fate with regard to those of other observers.

With regard to *Cystodytes*, I have already expressed a doubt as to the specific importance of *C. perspicuus*, and tolerate it only because I feel that I do not know it well enough to reject it. But *C. aucklandicus* is so well marked by its test-structure that there is no doubt of its complete separation from both *C. draschii* and *C. philippinensis*, Herdman. The distribution of the genus (Mediterranean, Brazil, Philippines, New Zealand) probably indicates the existence of numerous species yet undiscovered, or the previous existence in geological time of connecting links now lost. Our species approximates more closely to the Brazilian form, however; though in the vacuolated character of the upper test-layer it suggests *C. philippinensis*.

Lastly, we have to deal with the anomalous genus which I have ventured to name *Polysyncraton*. Here we scarcely know which way to turn. The thin colony, the four rows of branchial stigmata, the large atrial languets, are all features which suggest the genus *Leptoclinum* as the natural home of the two species. To this also the spirally-coiling vas deferens lends strength, as does the presence of stellate spicules in the test, and the six-lobed branchial siphon. But the structure of the male reproductive bodies is exactly that discovered by Herdman in his *Cœlocormus huxleyi*, for which he founds the family Cœlocormidæ. (See "Challenger" Rep., pt. xxxviii., p. 317.) The single species composing this family also possesses stellate spicules, but the siphon is five-lobed, there are no bladder-cells in the test, and only one common cloacal aperture placed in the bottom of the cuplike colony. The curious ovary is, as far as I am aware, quite unique in *Polysyncraton*.

But in *L. densum* I have noted a tendency to division in the single spermatic mass, characteristic of the Didemnidæ. May not this be suggestive of the state of things met with in *Polysyncraton* and *Cœlocormus*? And, if so, a still stronger link between the Cœlocormidæ and Didemnidæ would be afforded by the new species, possessing as they do the corm characteristic of the latter with the form of reproductive bodies met with in the former, but also faintly foreshadowed in the latter group.

Where then must *Polysyncraton* be placed? The most obvious method of avoiding all trouble is to at once found a new family for its reception, midway between the two groups to which it is allied. But this, though easy, is open to objection, for systematic classification, at present cumbersome enough, would speedily become a scientific nuisance were every strongly-marked genus at once constituted a family.

A second course is to unite the connected families on the common ground furnished by their connection, making the spirally-coiling vas deferens, presence of stellate spicules, and double form of the body the chief characteristics of the new group. This arrangement certainly commends itself more than the former would do; but the family Diplosomidæ would still be a difficulty, though separated readily by the straight course of its vas deferens. Moreover, the corm in Herdman's family is so highly specialised that it seems quite impossible to unite it with the Didemnidæ.

A third course is open—that, namely, of enlarging the borders of some one family so as to include the new genus. Now, to unite *Polysyncraton* with *Cœlocormus* would be open to the objection urged above. To unite it to the genera placed under the Diplosomidæ would tend to confuse that family with the Didemnidæ; and to unite it with the Didemnidæ would destroy the distinctness of that group, as a Diplosomid may have two or many spermatic vesicles provided its vas deferens be straight.

A *via media* between the two latter alternatives seems best; and in this I am further encouraged by the fact that Jourdain has proposed to unite the Didemnidæ and Diplosomidæ under the title Oligosomidæ (see "Challenger" Rep., pt. xxxviii., page 307). I propose to keep the Cœlocormidæ distinct, on account of the highly-specialised ascidiarium, and to unite the genera now ranged under the Didemnidæ and Diplosomidæ with *Polysyncraton* under the single family proposed by Jourdain but disallowed by Herdman. The genera *Didemnum* and *Leptoclinum* might then form one genus, and the *Diplosomoides* and *Diplosoma* another. The genus *Encœlium* may perhaps remain distinct.

The characters of the family Oligosomidæ would then run as follows:—

Corm thin, flat, incrusting, never pedunculated.

Systems irregular or absent. Common cloacal apertures usually conspicuous.

Zooids small, and very distinctly separated into thorax and abdomen.

Test gelatinous or cartilaginous, usually containing stellate calcareous spicules. Ectodermal prolongations well developed and muscular.

Branchial siphon variable, frequently six-lobed.

Stigmata usually in four, sometimes three rows.

Atrial pore plain or with a languet.

Reproductive organs variable. Male consisting of one or more spermatic vesicles, with a vas deferens usually spirally coiled.

Gemmation pyloric.

The genus *Diplosoma* would then probably indicate the origin of the group, its few calcareous spicules and simple reproductive organs being evidence of its generalised character. From it on the one hand have arisen the species forming the genus *Didemnum*, in which the number of spermatic vesicles is reduced to one, around which the vas deferens coils spirally, and having often very numerous spicules in the test. On the other hand, the genus *Polysyncraton* has sprung from a *Diplosoma* having several spermatic vesicles and an uncoiled vas deferens which has become spirally twisted.

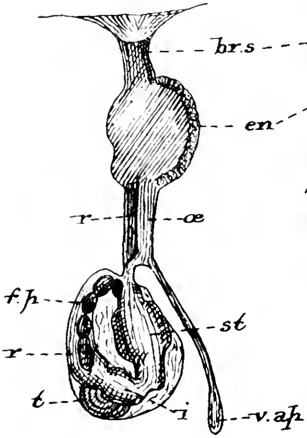
Or, perhaps better still, we may assume a common ancestor for the three genera, in which no spicules were present, and the reproductive organs were numerous, and arranged as in the Distomidæ. Gradually the power of forming calcareous bodies in the test was acquired as in *Cystodytes* among the Distomidæ, and the reproductive organs became variously specialised as we find them to-day.

Lastly, I would briefly enumerate a few points on which I think my researches shed new light.

The alimentary tract among the Leptoclinids is here more fully dealt with than by Herdman, and its variations are of undoubted specific import. Further, in *L. densum* a peculiar arrangement of the branchial pore is noted. The siphon is clearly six-lobed, but the pore itself three-lobed (*cf.* my figures and references with those of Herdman). A distinction must therefore be drawn between a plain branchial siphon (*i.e.*, one whose rim is plain) and a plain branchial pore. I have endeavoured in my descriptions to make this distinction, which is one of some value.

The question of the protogyny or protandry of the Ascidiæ Compositæ is an interesting one, about which opinions differ. Herdman contends for protogyny—the young zooids producing ova, and the older spermatozoa. But is this necessary to secure cross-fertilisation? The same result would evidently be attained if, each season, ova were produced first, and then spermatozoa when the ovaries were exhausted. In the absence of much definite information I can only speak with diffidence upon this point, but I certainly saw no ova in any young zooids, though sperm-bodies were frequently well developed, and in many cases ova were found among the viscera along with fully-developed spermatic vesicles.

The ova probably are fertilised either in the peribranchial cavity of the parent or in the cloacal canals. No oviducts were seen in any zooid, so that they must escape directly into the mantle-cavity of the thorax from the mantle-cavity of the abdomen, unless, indeed, they become fertilised in the abdomen, and pass out below through the mantle: in the Didemnids examined this seems possible, as no ova are found in



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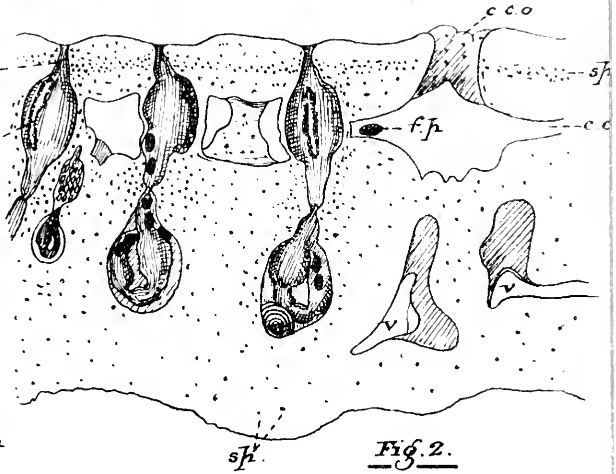

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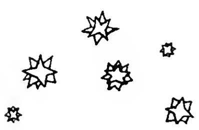

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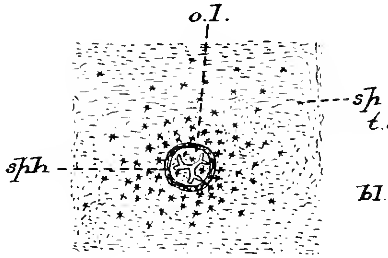

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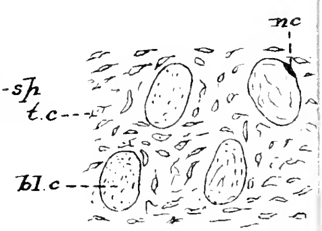

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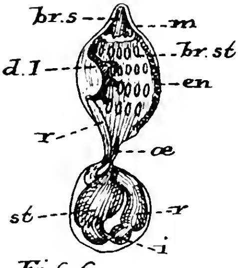

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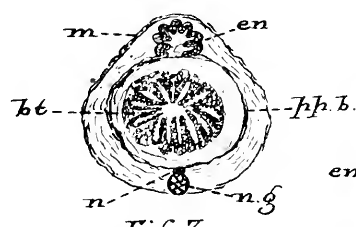

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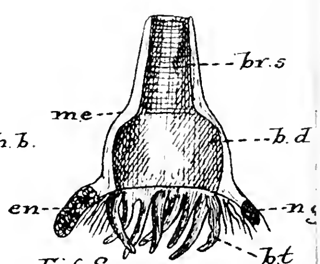


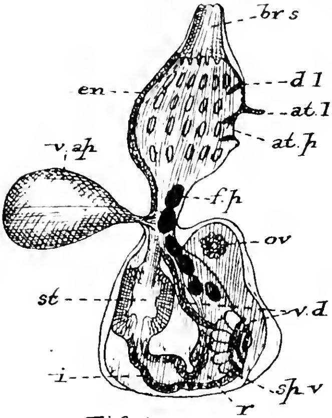
Fig. 8.

J. T. N. del.

N. Z. COMPOSITE ASCIDIANS.

Original Scale reduced 1/3.

C. H. P. lith.



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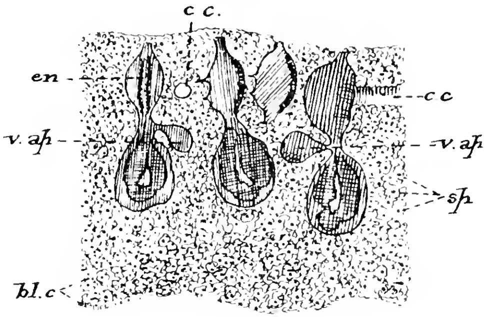

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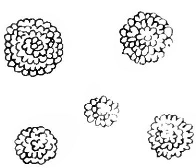
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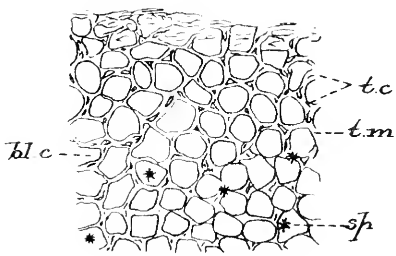

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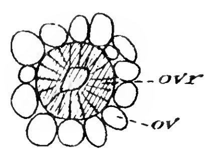

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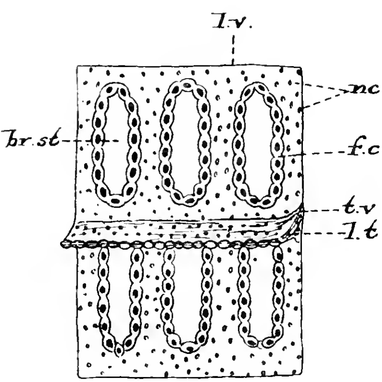

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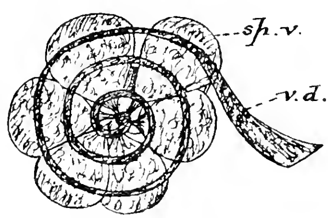

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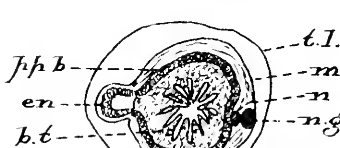


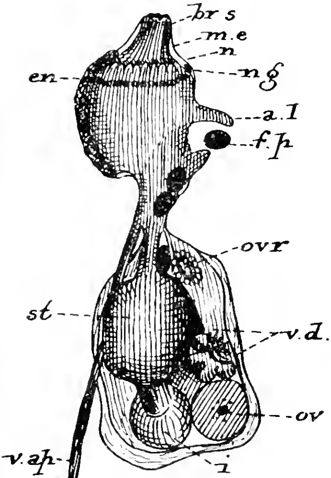
Fig. 8.

J.T.N. del.

N.Z. COMPOSITE ASCIDIANS.

Original Scale reduced 1/3.

C.H.P. lith.



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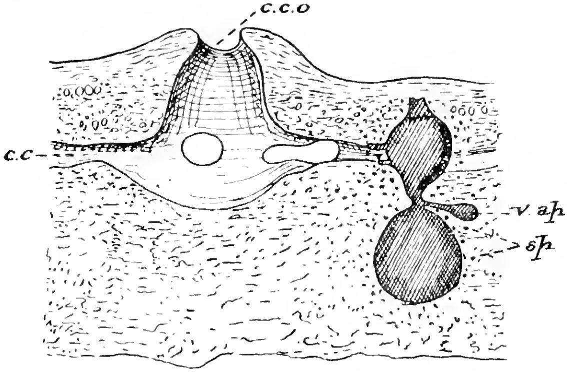

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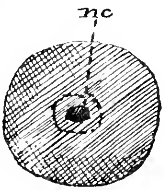

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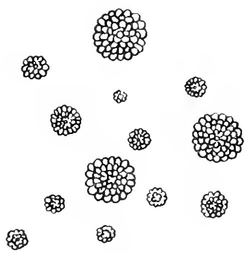

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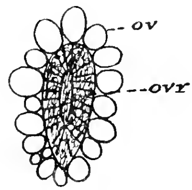

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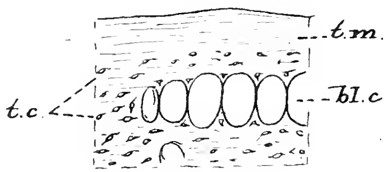

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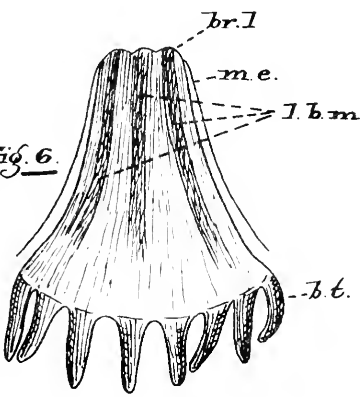

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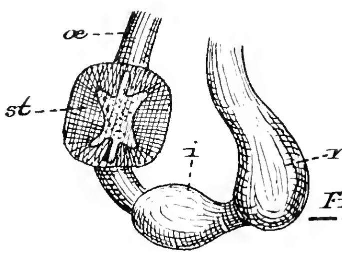

Fig. 8.

J. T. N. del.

N. Z. COMPOSITE ASCIDIANS.

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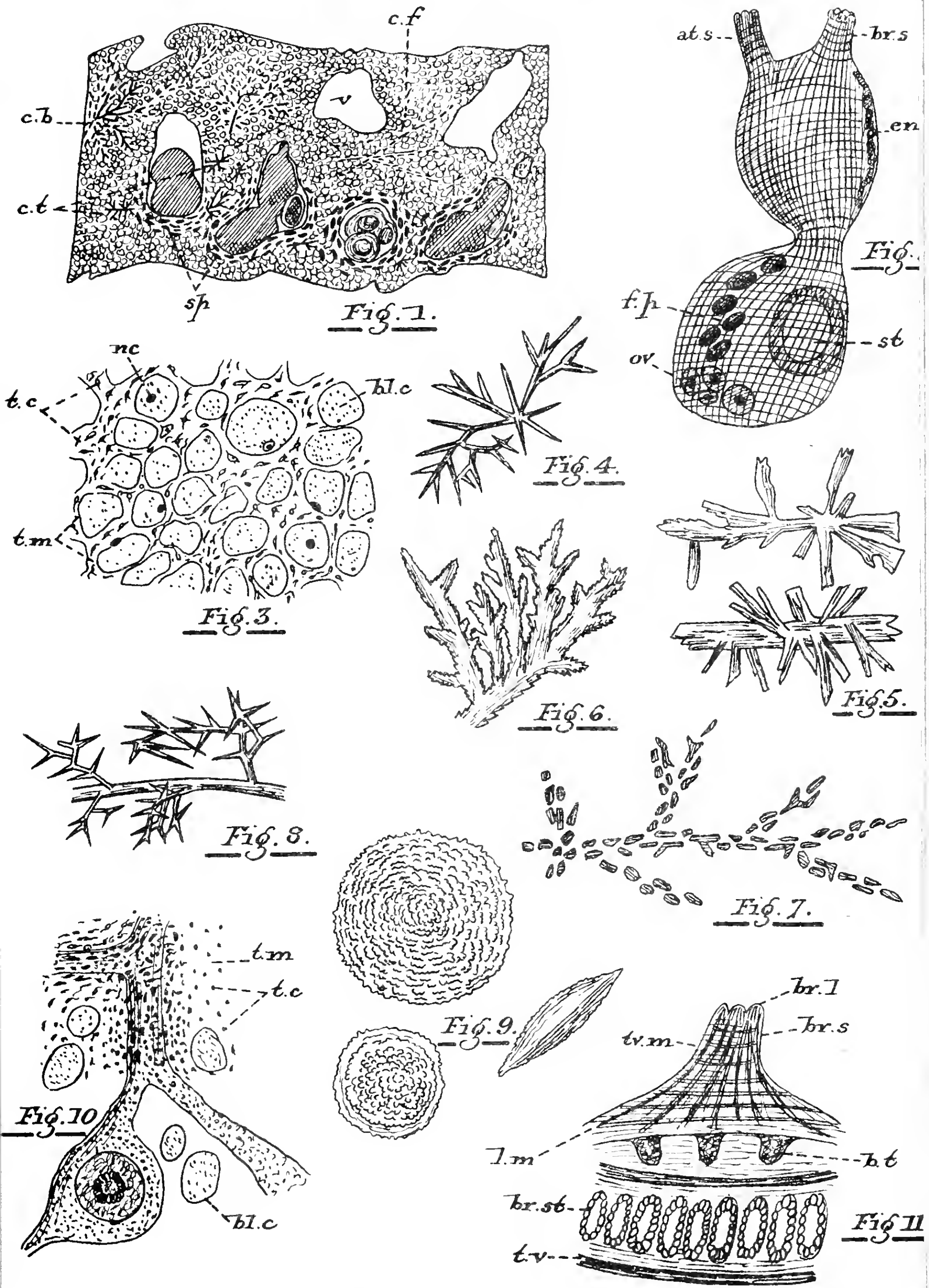
C. H. P. lith.



N. Z. COMPOSITE ASCIDIANS.
Original Scale reduced 1/3.

J. T. N. del. C. H. P. lith.

the upper test-layers. In any case, many ova probably escape through the cloacal cavities simply as fertilised ova if they pass into the peribranchial cavity prior to fertilisation. Those which thus escape may found new colonies. But many do not escape, burying themselves in the common test, where they undergo their development and metamorphosis.

Up to the present time only one species of New Zealand Composite Ascidian has to my knowledge been classified. This is *Botryllus racemosus*, from the mouth of the Thames River, catalogued by Hutton in his "Manual of the New Zealand Mollusca" (1879), along with two species of the genus *Pyrosoma*. These fragmentary observations of mine, deficient as they may possibly prove, are yet of interest in demonstrating the probable richness of our colonial waters in representatives of a section of the world's fauna so interesting as the Tunicata, and, though feeling conscious of much that is lacking in my account, I have no hesitation in offering it as the first fruits of what must ever be to me a deeply-absorbing life-work—the contributing somewhat to a fuller knowledge of Nature's marvellous handiwork.

KEY TO PLATES XXIV.-XXX.

a.p. Adhering papilla.
at.l. Atrial languet.
at.p. „ pore.
at.s. „ siphon.
b.d. Buccal dilatation.
b.t. „ tentacle.
bl.c. Bladder-cell.
br.l. Lobe of branchial siphon.
br.p. Branchial pore.
br.s. „ siphon.
br.st. „ stigmata.
c.b. Calcareous bodies.
c.f. „ fibres.
c.t. „ trees.
c.c. Cloacal canal.
c.c.o. Common cloacal opening.
d.l. Dorsal languet.
en. Endostyle.
f.c. Fringing cell.
f.p. Fæcal pellet.
i. Intestine.
l. Larva.
l.b.m. Longitud. buccal muscles.
l.m. Longitudinal muscle.
l.t. Lamina transversalis.
l.v. Longitudinal vessel.
m. Mantle.
m.e. Mantle ectoderm (lining test).
n. Nerve ganglion.
nc. Nucleus.
n.g. Neural gland.
œ. Œsophagus.
œ.c. Œsophageal constriction.
o.l. Oral lobe (branchial lobe of Herdman).
ov. Ovum.
ovr. Ovary.
p.b. Pyloric bulb.
ph.t. Pharyngeal tubercle in test.
pp.b. Peripharyngeal band.
r. Rectum.
s.o. Sense-organ.
sp. Spicule.
sph. Branchial sphincter.
sp.m. Spicule membrane.
sp.v. Spermatic vesicle.
st. Stomach.
t. Testis.
t.c. Test-cell.
t.l. Test limit.
t.m. Test-matrix.
t.v. Transverse vessel.
tr.m. Transverse muscle.
v. Vacuole in test.
v.ap. Vascular appendage (test-vessel or ectodermal prolongation of mantle).
v.d. Vas deferens.

EXPLANATION OF PLATES XXIV.-XXX.

Plate XXIV.

Leptoclinum niveum.

Fig. 1. Part of a section of colony, showing the arrangement of spicules, &c. Enlarged about 26 diameters.
Fig. 2. Part of a section decalcified in hydrochloric acid, showing cloacal canals communicating with large ventral cavity. Enlarged 26 diameters.
Fig. 4. Buccal tentacles seen from beneath in cross-section. Zeiss obj. C, camera.
Fig. 5. Branchial aperture from above. Z. C, camera.
Fig. 6. Test-cells from decalcified section. Z. E, camera.
Fig. 7. Curvature of alimentary canal, seen in cross-section from above. Z. A, camera. Slightly enlarged.
Fig. 8. Group of calcareous spicules. Z. E, camera.
Fig. 9. Detail of branchial sac and dorsal languets. Z. E, camera.
Fig. 10. Zooid, showing arrangement of parts and method of gemmation, with reproductive bodies. Z. A, camera.

Plate XXV.

Leptoclinum densum.

Fig. 1. Portion of a decalcified section, showing common cloacal opening. Enlarged 26 diameters.
Fig. 2. Portion of a section in the natural state, showing the distribution of spicules. Enlarged 26 diameters.
Fig. 3. Test decalcified and strongly magnified, showing details of structure. Zeiss E, camera.
Fig. 4. Branchial aperture from above. Z. C, camera.
Fig. 5. Branchial siphon, with buccal tentacles. Z. C, camera.
Fig. 6. Spicules from test. Z. E, camera.
Fig. 7. Zooid, with testis and ovum and vascular appendage (test-vessel) *in situ*. Z. A, camera.
Fig. 8. Reproductive bodies. Z. C, camera.
Fig. 9. Portion of test (decalcified), with ovum and developing embryo. Z. A, camera.
Fig. 10. Tailed larva (abnormal), with 4 adhering papillæ. Z. A, camera.
Fig. 11. Normal larva (3 papillæ) Z. A, camera.

Plate XXVI.

Leptoclinum tuberatum.

Fig. 1. Part section of colony showing arrangement of spicules and passages in the test. Enlarged 26 diameters.
Fig. 2. Part section of colony decalcified, showing vascular appendages, &c. Enlarged 26 diameters.
Fig. 3. Surface layer of test, showing branchial apertures, position of zooids, spicules, &c. Zeiss A, camera.
Fig. 4. Group of spicules. Z. E, camera.
Fig. 5. Side view of branchial siphon, showing descending lobes of the test, tentacles, etc. Z. C, camera.
Fig. 6. Detail illustrating branchial sac and dorsal languets. Z. E, camera.
Fig. 7. Complete view of a single zooid showing the arrangement of parts and method of gemmation. Z. A, camera.
Fig. 8. Tailed larva, with sense-organs and adhering papillæ. Z. A, camera.

PLATE XXVII.

Leptoclinum maculatum.

Fig. 1. Complete view of single zooid, illustrating the peculiar elongated form of body and arrangement of internal organs. Zeiss A, camera.
Fig. 2. Portion of a section of the test, showing unusual form of cloacal canals, spicules, and vacuoles. Enlarged about 26 diameters.
Fig. 3. Spicules in a group. Z. E, camera.
Fig. 4. Branchial aperture showing arrangement of spicules around it. Z. C, camera.
Fig. 5. Detail of test highly magnified, with bladder-cells, &c. Z. E, camera.
Fig. 6. Young zooid with branchial stigmata, dorsal languets, &c. Z. A, camera.
Fig. 7. Transverse section through pharynx, viewed from below. Z. C, camera.
Fig. 8. View of branchial siphon from the side, with tentacles, nervous system, &c. Illustrating the peculiar dilatation (buccal mass). Z. C, camera.

PLATE XXVIII.

Polysyncraton paradoxum.

Fig. 1. Complete view of zooid, showing supposed vascular appendage, with internal organs *in situ*. Zeiss A, camera.
Fig. 2. Small portion of section, showing close arrangement of zooids, with cloacal canals, &c. Enlarged about 20 diameters.
Fig. 3. Group of spicules. Z. E, camera.
Fig. 4. Detail of structure in upper layer of the test, showing numerous bladder-cells. Z. C, camera.
Fig. 5. View of supposed ovary. Z. C, camera.
Fig. 6. Detail of branchial basket, showing the transverse lamina. Z. E, camera.
Fig. 7. Enlarged view of testis, showing numerous vesicles and spiral vas deferens with distal enlargement. Altered from a side view to scale of Z. C, camera.
Fig. 8. Transverse section through pharynx, viewed from beneath, with tentacles, nerve system, and endostyle. Z. C, camera.

PLATE XXIX.

Polysyncraton fuscum.

Fig. 1. Complete view of zooid with long filamentous vascular appendage, showing reproductive bodies, &c., *in situ*. Zeiss A, camera.
Fig. 2. Portion of section showing position of zooid with short bulbous vascular appendage, also large cloacal opening and canals. Enlarged about 20 diameters.
Fig. 3. Large ovum. Z. C, camera.
Fig. 4. Group of calcareous spicules, showing extreme variability in size. Z. E, camera.
Fig. 5. Supposed ovary. Z. C, camera.
Fig. 6. Branchial siphon in side view, with tentacles, and longitudinal buccal muscles running up to the buccal lobes. Z. C, camera.
Fig. 7. Detail of upper test-layer, showing the transparent matrix above, and test-cells and bladder-cells below. Z. E, camera.
Fig. 8. Separate view of alimentary canal: the stomach cut through longitudinally. Slightly enlarged from an outline taken with Z. A, camera.

PLATE XXX.

Cystodytes aucklandicus and *C. perspicuus.*

Fig. 1. Portion of test showing spicules, calcareous trees (*c.t.*), fibres (*c.f.*), and calcareous bodies (*c.b.*). Enlarged 7 diameters.
Fig. 2. Zooid of *C. aucklandicus.* Zeiss *a**, enlarged.
Fig. 3. Detail of test in *C. perspicuus.* Z. C, camera.
Fig. 4. Calcareous spicule (tree) of *C. aucklandicus.* Z. A, camera.
Fig. 5. Calcareous crystals of *C. perspicuus.* Z. A, camera.
Fig. 6. Detail of form seen in fig. 4 under high magnifying power (Z. E). Drawn without reference to scale.
Fig. 7. Detail showing calcareous bodies forming radiating branches. Seen in unstained sections.
Fig. 8. Crystalline branching calcareous bodies from the region of the capsule. Z. A, much enlarged. Glycerine.
Fig. 9. Spicules from *C. perspicuus.* Z. A, camera.
Fig. 10. Surface-vessel in the test from *Cystodytes aucklandicus.* Z. C, camera.
Fig. 11. Branchial siphon with part of branchial basket of *C. perspicuus.* The upper part of the basket has been removed in sectioning, leaving the lower surface visible from inside. Z. C, camera.

ART. XXVI.—*On the Structure of* Boltenia pachydermatina.

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From the Biological Laboratory of the University of Otago.

[*Read before the Otago Institute, 11th August, 1891.*]

Plates XXXI.-XXXIV.

THIS species of *Boltenia* is found attached to rocks, piles, shells, &c., or lying loose on the sea-bottom. In the latter case, as a general rule, the specimens have become detached by the breaking of the stalk some distance from the base. Very often they are seen in bunches in masses of seaweed, in which cases, however, they are not directly attached to the seaweed itself, but have become united to it by the entangling among the seaweed of the shell or other base of attachment to which they have united themselves. The members of this species are often seen growing in bunches, when either a number have attached themselves to a shell or some such small base of attachment, the stalks becoming fused at their bases, or a number of younger specimens have fixed themselves to the stalk of a larger.

ANATOMY.

A. *External Characters.*

A.—The body is somewhat ovate in shape, compressed laterally, slightly concave on the dorsal border, convex on the ventral. The posterior end is bluntly pointed, the anterior is narrow, becoming gradually continuous with the stalk. The apertures, which are close together, are conspicuous, but not prominent; the oral aperture is more prominent than the atrial, and is always directed towards the stalk. A characteristic appearance is given to the members of this species by the surface of the thick test being thrown into longitudinal folds, of which there are, as a rule, two or three on each side, with a distinct ventral fold. Very often the number on the sides is unequal, there being probably two on the one side, one on the other, with a ventral fold. Round each of the apertures there are three or four folds. The colour of the body-wall is lodged in a thin external layer of the test, the remainder of its thickness being of a glistening white. The body is sometimes of a creamy-white colour which is sometimes streaked with purple-brown, sometimes of a light-brown colour, or, again, of a purple-brown streaked with white, or there may be a combination of all three colours. In the young state the body is generally creamy-white in colour. In harbour-water, where the water is foul, the colour of the body is dirty-brown, and it is covered with slime, often with a green growth which adheres very closely to the surface of the test, and cannot be removed.

B. *Processes on Test.*—In the young state, on the test there are, as a general rule, spinous processes, which are often of great length compared with the size of the body itself. These, in many cases, are so numerous that the test is fairly bristling with them. They generally disappear during growth, but in a fairly large proportion of specimens which appeared to be almost, or quite, full-grown (varying from 2½in. to 3¼in. in length), I found these spines present on the test. They were, however, not numerous, and not large compared with the size of the body. In many full-grown individuals, in place of these spines there are on the test squarish or oblong processes.

In a number of specimens I collected I observed on the test large protuberances, which in some cases were almost one-third or one-fourth the size of the animal itself. These, when examined, were found to be due to small bivalves (*Crenella discors*, Lamarck; *Modiolacra impacta*, Gray) imbedded in the test. These were, on an average, a little over ½in. in length. In some cases they were not completely covered. The byssus was in all cases more deeply imbedded than the shell, so that it appeared as if the mollusc had become attached to the surface of the body by the byssus, and that the irritation produced had caused the *Boltenia* to secrete fresh layers of test-substance around it. Similar instances to this are given in Sutton's "Evolution and Disease," p. 29. In the cases where the lamellibranchs were not completely covered by the test, they seemed to be still alive. When they were completely imbedded there was, as far as I could make out, no decomposition, so that the secretion must have taken place with great rapidity.

To give an idea of the frequency with which this imbedding may occur, I may instance one collection of full-grown specimens made at haphazard along the shores of Otago Harbour. I collected between twenty and twenty-five specimens, and, of these, five had these shellfish imbedded in the test of the body. In all cases they were completely imbedded. This frequency is above the average, but I have never yet gone collecting in the harbour without getting at least two or three *Bolteniæ* with shellfish imbedded. I may mention that in two or three collections on the open sea-shore among the rocks I was unable to get any instances of it. The processes may occur all over the body except on the dorsal surface between the apertures; their occurrence on the stalk is comparatively rare. In cases of complete imbedding the apex of the process ends in a corkscrew-like arrangement. The colour is generally more or less bleached out on the processes, sometimes of a pure-white. In one instance I found two shells imbedded in the same process. This shellfish belongs to the family Mytilidæ. In Brown's "Mollusca of the Firth of Clyde" a very closely allied species—*Crenella marmorata*—is spoken of as being found in the integument of *Ascidia mentula*: it is there mentioned that over two dozen specimens have been extracted from the test of a single individual.

One of the most characteristic features of this species lies in the very great thickness of the test, which, in ordinary full-grown animals from 3in. to 4in. long, is from $\frac{1}{4}$in. to $\frac{1}{2}$in. The test is always thicker on the folds than on the interspaces, the folds corresponding only in a slight degree to folds on the surface of the body itself.

c. *Stalk.*—The stalk is closely wrinkled transversely, is twisted and creased, and rather tapering distad towards the point of attachment. It may become thicker for short distances of its length than it is at the proximal end. It is of a light-brown colour, and is often overgrown with seaweed, sponges, &c.

The stalk is generally round in section, sometimes compressed, in some cases so much so that it becomes almost ribbon-like in appearance. The thickness, just as the length, varies greatly: in full-grown specimens between 3in. and 4in. long it is between $\frac{1}{4}$in. and $\frac{1}{2}$in.

In one specimen, in which the stalk, which was oblong in section, was for a short distance of its length $1\frac{1}{2}$in. broad by $\frac{7}{8}$in. thick, I found imbedded a small shellfish. In another, in which there was also a shellfish in the stalk, the stalk had grown corkscrew fashion around the shellfish, and then covered it with test-substance. In still another specimen, in which the stalk at the proximal end was greatly thickened, the delicate anterior prolongation of the body, instead of running straight into the stalk, formed for a little distance a very close spiral.

The greatest amount of variation exists with regard to the length of the stalk, which is always greater than that of the body. To illustrate this I will give a few examples:—

	Length of Body. Inches.	Length of Stalk. Inches.
Specimen 1	$3\frac{3}{4}$	$11\frac{1}{2}$
" 2	$4\frac{5}{8}$	7
" 3	$4\frac{1}{4}$	$15\frac{1}{4}$
" 4	$3\frac{1}{8}$	55
" 5	3	40
" 6	4	12
" 7	$3\frac{5}{8}$	$9\frac{1}{2}$
" 8	$2\frac{1}{2}$	11
" 9	3	56
" 10	$2\frac{1}{2}$	24
" 11	$2\frac{5}{8}$	12
" 12	$3\frac{1}{4}$	$16\frac{1}{2}$
" 13	4	36

When the test has been removed the body is seen lying within its delicate anterior prolongation, proceeding for a little way into the stalk. This prolongation narrows away gradually distad till at last it ends in a fine point. The apertures (oral and atrial) are at the end of tubular prolongations of the body, which are surrounded by powerful sphincter muscles. In the fresh state the body is almost transparent, with the exception of the bright-orange digestive gland, the dull-green gonads, and the posterior part of the intestine, which, from the sand, fine mud, &c., it contains, is always of a dark colour.

In fresh specimens the body is kept in close connection with the test by the ectoderm which secretes the latter; but in specimens preserved in spirit the mantle (muscular tunic) shrinks away from the ectoderm and test, the only connection being at the apertures and at the place where the two blood-vessels to the test leave the body.

B. *Muscular Tunic (Mantle).*

The second layer is the muscular and connective-tissue part of the body-wall. It is formed of connective tissue uniting and enclosing the bundles of muscular fibres and blood-vessels, and in the region of the dorsal surface also the nerves.

The muscular fibres are arranged in two layers—an external circular round each of the oral and atrial siphons, and an internal transverse.

The circular layer is external to the transverse, is arranged round the siphons from their apex downwards, and extends for a short distance on to the surface of the body.

The transverse layer arises in two bands, one from the apex of each siphon beneath the circular, and spreads out fan-wise on each side over the surface of the body. The muscles of this layer unite to form networks, especially towards the ventral surface. At the anterior end the muscles are very feebly developed, and are covered by a tissue which spreads from the anterior end of the body, and which in spirit changes colour with the gonads. This tissue may spread in scattered patches over the entire surface of the body. I shall refer to it more particularly in speaking of the gonads.

Into both the oral and atrial siphons are produced delicate lining invaginations of the external coloured surface of the test. In the oral siphon the invagination ends against the circlet of tentacles at the base of the siphon; in the atrial siphon it is produced for a little way into the interior of the body, hanging loosely in the peribranchial cavity, and from the free edge is produced for a little way a delicate transparent membrane. This arrangement seems to assist in effectually closing the atrial aperture when the animal is above tide-mark, &c.

C. *Digestive Organs.*

A. *Tentacles.*—The posterior edge of the invagination of the test lining the oral cone ends against a stout ring-like pad, bearing a circlet of tentacles on its lower surface. The tentacles are numerous and compound. There are sixteen chief tentacles, placed larger and smaller alternating, but external to these is a large number of smaller tentacles, some of which approach closely in size the smaller tentacles mentioned above. Of the eight large tentacles there is generally one, sometimes two, considerably larger than the others. The one generally much larger is that adjacent to the oral end of the endostyle, while the one which often approaches it very closely in size is that opposite—namely, the one adjacent to the dorsal tubercle. In the eight smaller tentacles alternating with the larger, there seems, as in the larger, to be no uniformity in size. In the tentacles external to these I cannot make out any particular arrangement. Each tentacle consists of a main axis greatly compressed, concave on the central, convex along the peripheral border. From the lateral border the branches are given off arranged in a double row. From each of the branches are given off branchlets which consist each of a main stem giving off little processes at right-angles. There are also on the main axis of the tentacle, among the branches, branchlets similar to those on the branches.

Following on the tentacles comes part of the mouth-region, spoken of by Herdman as the præbranchial zone, bounding which on the posterior side are the two peripharyngeal bands. These surround completely the præbranchial zone, surrounding on the one side the dorsal tubercle, on the other adjoining the oral end of the endostyle. Following upon the peripharyngeal bands comes the wall of the branchial sac proper.

B. *Peripharyngeal Bands.*—The two peripharyngeal bands, as before stated, bound the præbranchial zone on the posterior side—*i.e.*, on the side far removed from the tentacles. On the one side these bands immediately surround the dorsal tubercle, then run in a somewhat wavy manner around the circlet of tentacles, and join the endostyle at its oral end. The anterior band forms a complete ring; the posterior is complete only at the sides. At the anterior end its right and left halves become immediately continuous with the marginal ridges of the endostyle; at the posterior, they are continued into the anterior end of the dorsal lamina.

C. *Branchial Sac.*—The peripharyngeal bands bound the commencement of the branchial sac. This organ extends from the anterior to the posterior end of the body. Its ventral edge is formed by the endostyle, which is attached to the mantle along the whole ventral surface. Along the dorsal edge the branchial sac is free between its attachment to the body (immediately posterior to the peripharyngeal bands) and the gullet. On the dorsal surface of the body, at the posterior end, the branchial sac opens into the gullet. The wall of the branchial sac is thrown into large folds, projecting into the interior of the sac, and running from the peripharyngeal bands to the neighbourhood of the œsophageal aperture. These folds are directed towards the dorsal lamina; there are always six of them on each side.

In the walls of the branchial sac are the following sets of vessels: (1) transverse, (2) fine longitudinal, (3) internal longitudinal, (4) large transverse. (1.) The *transverse* vessels run at right-angles to the length of the sac. (2.) The *fine longitudinal* are in the same plane as the transverse, but run longitudinally, and serve as a means of communication between the transverse. (3.) The *internal longitudinal* vessels—larger vessels than the transverse—occupy a plane internal to them, and run at right-angles to them from the anterior to the posterior end of the branchial sac; they are connected with the transverse by short wide connecting-ducts placed at the points of intersection. The rectangular meshes visible to the naked eye are formed by the latter vessels and the transverse. (4.) External to the transverse vessels, and connected with them by the fine longitudinal, are vessels of much stouter calibre. These radiate from the dorsal free edge of the branchial sac to the ventral, and carry the blood to the vessel running along the dorsal edge. On the folds we can see that the meshes are narrower than in the interspaces between the folds. This is due to the fact that the internal longitudinal vessels are always more closely placed on the folds than on the interspaces, becoming more closely approximated the nearer we get to the crest of the fold.

D. *Gullet, Stomach, and Intestine.*—The branchial sac opens into the gullet, which is attached to the dorsal body-wall at the posterior end of the body. The œsophageal aperture is overhung by a large valvular projection of the left inferior wall of the gullet. The gullet passes down the left side of the body, attached to the body-wall, makes a bend forwards when nearer the ventral than the dorsal edge, and at this point passes into the tubular stomach. This, after running forward for rather less than one-third of the length of the body, passes into the intestine, the diameter of which is very little less than that of the stomach itself. This, like gullet and stomach, is firmly attached to the body-wall. It runs straight along the left side to the anterior end of the body, at the anterior end of the body makes a bend dorsalwards, turns backwards, and runs parallel with its former course. When it comes beneath the atrial aperture it turns dorsalwards at right-angles to its course, and, after running for a short distance, opens into the atrial siphon. All along the attached side of the stomach and intestine is a large typhlosole, which is continued right to the anus. The posterior end of the intestine on its attached side projects very little from its attachment to the body-wall; but on its free side the end of the intestine projects for a considerable distance, overhanging the attached side like a great flap.

These general relationships are shown clearly in Plate XXXIV., figs. 1 and 2, where the body-wall of the right side and entire branchial sac are removed.

E. *Digestive Gland.*—Attached along the right side of the stomach are a number of little tree-like structures. Each consists of a stem giving off branches, which branch again and again, the distal ends of the twigs bearing little tufts of cœca. In living specimens the colour of the digestive gland is bright-orange; this colour in spirit changes first to dull-red, then to a yellowish-red, and at last gets bleached out to a yellowish-white. There is no great variation in the number of the stems, there being from 13 to 17 present. The arrangement differs somewhat in different specimens, but there is always a smallish stem towards the ventral edge of the right side at the beginning of the stomach, and another stem (the largest of all) at the end of the stomach towards the dorsal edge. Between these the other stems are arranged in a double row, the one towards the dorsal, the other towards the ventral edge.

F. *Problematical Organs.*—Attached along the dorsal edge of the dorsal limb of the great intestinal loop are structures of which I shall say more in the histological part. There is usually a large number of them, varying in size from blocks resembling in shape and size small gonads down to little structures barely distinguishable, appearing as slight folds of the intestinal wall. They lie, as before stated, along the dorsal edge of the dorsal limb of the intestine, always extending on the posterior side to the ventral end of the last bend of the intestine. On the anterior end they may reach to the middle of the first bend of the intestine, but in this case when they reach this point they are visible only as very slight folds. As a general rule, however, they extend only along the dorsal limb. They are present in all specimens, but the greatest amount of variation exists with regard to their size and arrangement in different specimens. In some they are of fairly even size throughout, tapering away towards the anterior end to slight folds. In others they are largest at the posterior end, becoming smaller towards the anterior, though they may swell out in size towards the middle of their course. In others, again, they are largest about the middle of the dorsal limb, diminishing in size in front and behind.

D. *Vascular System.*

The heart lies on the right side, attached to the inner surface of the mantle, in close relation with and parallel to the endostyle. It is long and tubular. From its anterior end goes off a vessel which we may call the ventral vessel. This runs along the right side, and is, like the heart, connected by transverse vessels (paired) with the branchial sac. When it reaches the place where the endostyle makes its bend dorsalwards it breaks up into three chief vessels—one to the test, one running back along the endostyle, another running forwards. The vessel running forwards gives off branches to the anterior prolongation, and when it reaches the oral end of the endostyle it divides into two vessels running round the circlet of tentacles. The vessel from the posterior end of the heart (dorsal vessel) runs to the posterior end, bends dorsalwards, and when it reaches the point where the gullet passes into the stomach it divides into two vessels, one passing along the ventral surface of the stomach, the other passing round the gullet on to the dorsal surface of the stomach, crossing diagonally to the ventral surface, and giving off in its course branches to the different stems of the digestive gland. This vessel reaches the ventral surface about half-way between the oral and atrial apertures, and, after giving off a large vessel running along the free surface of the intestine, goes to the test. Along the dorsal free edge of the branchial sac runs a large vessel, to which radiate from the ventral edge of the branchial sac the large transverse vessels. The posterior end of this vessel, on reaching the gullet, divides into several vessels, of which one passes along the free edge of the gullet and stomach, and joins (after giving off branches to some of the stems of the digestive gland) the vessel that goes to the test. Another vessel from the dorsal branchial vessel runs along the attached side of the gullet, and joins the dorsal vessel just before its division. The anterior end of the dorsal branchial vessel joins the mantle in close relation to the brain. From the branchial sac to the mantle, the gonads, the intestine, the digestive gland, pass very numerous vessels, which serve also as suspenders to keep the lateral portions of the branchial sac in position.

Of the vessels to the test, that on the right side (which I mentioned as leaving the ventral vessel at the point where the endostyle makes its dorsal bend) runs directly into the stalk. The left vessel (which, as before stated, leaves the body about midway between the anterior and posterior ends from the vessel passing across the stomach) runs forward, turns gradually dorsalwards, enters the stalk along with the vessel from the right side, both vessels running right down the stalk. Both these vessels in their course through the test give off vessels, in their turn giving off smaller vessels, which finally break up into terminal twigs, ending in little dilatations or bulbs. These twigs are more closely aggregated in connection with the external surface. A transverse section of the stalk shows the same arrangement as in the test—the vessels break up into small twigs ending in dilatations or bulbs, two twigs usually opening into one bulb (as in the test).

The anterior prolongation of the body, which is full of blood-vessels, gives off chiefly one large vessel, which after a time unites with one of the vessels from the test.

E. *Reproductive Organs.*

Gonads consist of a double series of somewhat rectangular blocks attached along the body-wall of each side. When I say "somewhat rectangular" I refer to the fact that the larger gonads, at least, are more pyramidal in shape, with the apex attached. The free surface of the larger gonads is also often deeply marked by folds or creases. In young specimens, or those not sexually mature, the gonads are of a light-cream colour, but in sexually mature individuals during most of the year they are of an olive-green colour. Each cut in section shows a central white mass—the spermary—with the green part—the ovary—wrapped completely round it. The green colour of the gonads changes in spirit first to a pink, then slowly to a yellowish colour. The gonads of the right side lie along the body-wall, rather nearer the ventral than the dorsal surface. They extend from the anterior to the posterior end of the body, at the posterior end make a bend dorsalwards, and when adjacent to the dorsal surface send off a duct running forwards, and opening into the atrial cavity opposite to the duct from the left side. The gonads of the left side lie in the intestinal loop, their duct opening into the atrial cavity immediately behind the anus. The blocks of both sides are not uniform in size: they diminish in size from the anterior to the posterior end. This diminution in size is often somewhat abrupt, so that we can distinguish on each side a larger and a smaller series. The gonads of the right side are, as a rule, more developed than those on the left. The total number of blocks on each side is on an average very nearly equal, there being about thirteen or fourteen on each side; but on the right side there are about eight larger blocks, on the left only about five.

In Plate XXXIV., fig. 4, where a view is shown of the body opened from the ventral side, with the branchial sac removed, the gonads of both sides are shown.

Supplementary Notes on Gonads.—In specimens taken in winter the gonads are olive-green in external view. When cut in section, each is seen to consist of the central white portion, with the green part wrapped round it. Later on in the season white specks appear on the green surface of the gonad; and still later, in the beginning of summer, the gonads come to consist mainly of a clear-coloured tissue, with white specks imbedded, and with a small green portion gathered round the base. The green portion is seen to consist of small round green masses imbedded in gelatinous substance. These seasonal changes in the appearance of the gonad I shall try to account for in the histological part.

F. *Nervous System.*

The brain (nerve-ganglion) is oblong in shape, with one or more constrictions about the centre; gives off nerve-trunks anteriorly and posteriorly to the neighbourhood of the oral and atrial apertures. It lies about midway between the two apertures.

From the anterior end a pair of nerve-trunks are given off, which run one round each side of the oral siphon, giving off branches supplying the tentacles, &c. From the posterior end a pair also are given off which go to surround the atrial siphon, sending off nerves to the apex of the siphon. These two nerve-trunks I have traced more than half-way round the atrial siphon. The position of the dorsal tubercle, as I have stated before, is to the right of the brain, and slightly nearer the oral aperture.

The dorsal tubercle is very complicated, "apparently by the development of lateral branches from the original slit" (Herdman).

G. *Atrium.*

The atrium, or space surrounding the branchial sac, and communicating with the exterior by the atrial aperture, presents no essential differences from that in other Ascidians. The atrial aperture, which lies, as before stated, nearer the posterior end of the body, terminates a short tubular process of the mantle, and the atrial siphon is provided with a sphincter muscle, a lining prolongation from the test, and a partial diaphragm at its lower end.

The peribranchial cavity encircles the branchial sac except along its ventral edge, where the two lateral halves of the cavity are separated by the union of the endostyle with the mantle. The cavity is crossed by blood-vessels connecting the branchial sac with the sinuses of the mantle. Besides these, the branchial sac is united to the mantle by the œsophagus along the whole length of the endostyle (except at its posterior end), round the anterior end at the peripharyngeal bands, and along the first portion of the dorsal lamina.

The atrium is in free communication with the interior of the branchial sac through the stigmata, and is traversed by the water in its course to the atrial aperture.

The anus and genital ducts open into the peribranchial cavity in the dorsal median region, often called the cloaca.

Histology.

Histology of Test.

The matrix of the test, which is for the most part homogeneous, is, however, fibrillated in some places. Immediately beneath the external surface are round masses of various sizes. Round them lie, thickly scattered, ordinary cells, rounded in appearance. The rounded masses lie in a single row, either closely packed or having short intervals between them. I have not been able to make out their exact structure, but they appear to be formed of a large number of separate cells.

The small blood-vessels, with their terminal dilatations, which I described, in connection with the vascular system, as ramifying through the test, are lined by a layer of epithelium.

Histology of Endostyle.

The endostyle is in the form of a groove, bounded by parallel lips of considerable height, and projecting into the interior of the branchial sac. The groove is lined by a modification of the epithelium of the interior of the branchial sac. The branchial epithelium is continued on the lips of the groove into more elongated cells, furnished with cilia. Following on these are small flattened cells, closely resembling the branchial epithelium, which run for some little distance down the groove. Then come the cells of the *first glandular mass*, which is much greater in size than the other two glandular masses. These glandular cells are followed by elongated cells with small cilia, after which comes the *second glandular mass*. This, as before stated, is of considerably less extent than the first glandular mass, and is followed by elongated cells with small cilia. Next comes the *third glandular mass;* and, last of all, on the floor of the groove are elongated cells with very long cilia. The glandular cells are of peculiar form—broad at the base, and tapering towards the apex.

The walls of the groove contain very numerous blood-spaces.

Histology of Gonads.

The gonads are covered by a continuation of the epithelium lining the peribranchial cavity. Beneath this wall, and lying right round the gonad, is a distinct blood-space. The gonads are ovotestes; the tubules from each testis open into the vas deferens. The latter runs from the anterior to the posterior end of the body in close connection with and anterior to the oviduct, and at the place where the ducts open into the atrial cavity turns anteriorly for a little way, the two terminations thus forming a fork. In specimens taken in the winter, when the surface of the gonad is of a uniform green, it is found the testis occupies only the lower central portion of the gonad, and a transverse section taken above the centre of the gonad shows merely the riper ova aggregated to one side, and the unripe ova filling the remainder of the cavity.

Later on, at the time when the white specks appear on the green surface, a transverse section of the free surface shows the tubules of the testes scattered here and there, with the unripe ova in between. As we pass downwards we still have the unripe ova among the tubules of the testis, but at some distance down we come upon the ripe ova lying towards the posterior end of the gonad, with the tubules of the testis around them on the three sides.

Consecutive sections, taken at the stage when the green colour of the gonad is aggregated round the base, show that in the upper part of the gonad the tubules completely fill the cavity, the unripe ova being absent, and that at the proximal end the ripe ova are collected. These in the earlier stages have a peculiar, somewhat hexagonal, shape, and exhibit distinct vitelline membrane and germinal vesicle, with clear membrane and germinal spot. When fully ripe the ova are enclosed each in a capsule of low cubical cells.

While speaking of the muscular tunic I referred to a tissue which occupied the proximal end of the anterior prolongation of the body. This, in the specimens collected in winter, presents a greenish colour, resembling that of the gonads; this colour in spirit, like the green of the gonads, changes to pink. The tissue appears to be in connection with the anterior gonads of both sides, especially that of the left, by the body-wall. A section of the anterior prolongation shows that it is full of blood-vessels, the tissue lying at the proximal end. When examined microscopically it is seen that the tissue is made up of small roundish bodies having exactly the structure, size, &c., of unripe ova.

Histology of the Problematical Organs on the Intestine.

These structures are covered with the layer of cœlomic epithelium covering the latter, so that they appear as outpushings of the wall of the intestine into the peribranchial cavity. They are formed of connective tissue full of blood-spaces, their structure, in fact, being simply that of the intestinal wall. Through the blocks themselves, and in the wall of the intestine below, wind very numerous tubules. These branch free, and end in terminal dilatations or ampullæ. Both tubules and ampullæ are lined with a single layer of low cubical cells. They appear to correspond to those described in Ascidia, Perophora, &c., as ramifying over the stomach and part of the intestine, the difference being that the organ in *Boltenia pachydermatina* extends almost to the posterior end of the body.

The histological structure of the brain I have not been able to make out at all satisfactorily. The nerve-cells are small, and the nerve-fibres lie beneath. The neural gland I could not discover at all, unless it corresponded to certain tubules among the brain-tissue. These were small clear-walled tubules, in connection with which appeared to be secondary vessels with small ampullæ. In the walls of some of these vessels were what appeared to be concretions, on which acetic acid (1 per cent.) had a slight effect. The cavities of the dorsal tubercle are lined by a layer of columnar epithelium provided with very long cilia. Under the epithelium is a layer of connective tissue continuous with that of the mantle.

In concluding this paper I might take the opportunity of drawing attention to the close resemblance *Boltenia pachydermatina* bears to *Culeolus* in certain important points of structure. In some of these points, as far as I can gather, it differs from other genera of *Boltenia*, and about other points I am uncertain. The description of *Culeolus* is taken from

Herdman's "Report on Tunicata, 'Challenger' Expedition," vol. vi. First of all, as to the position of the heart, Herdman speaks of *Culeolus* as being singular among the Cynthiidæ in having the heart on the right side of the body, in close relation to the endostyle: as we have seen, in *Boltenia pachydermatina* it occupies this position. Secondly, in the branchial sac *Boltenia pachydermatina* alone of the *Bolteniæ* possesses six folds on each side, the others having more: in *Culeolus* six appears to be the normal number.

Again, *Culeolus* and *Boltenia pachydermatina* agree pretty closely in the structure and position of the gonads, also in the fact that the ripe ova are enclosed in capsules of cells. In both *Boltenia pachydermatina* and *Culeolus* we find sixteen tentacles, placed larger and smaller alternating, and besides these a number of smaller tentacles without definite arrangement.

The chief works which I consulted in writing this paper were,—

Herdman's "Report on the Tunicata collected during the Voyage of the 'Challenger'" ("Report on the Scientific Results of the Exploring Voyage of H.M.S. 'Challenger:' Zoology," vol. vi.).

Hancock "On the Anatomy and Physiology of the Tunicata" (Linnæan Society's *Journal of Zoology*, vol. ix., p. 309).

Papers by Julin and van Beneden in the "Archives de Biologie," tome ii., fascicules 1, 2; tome vi., fascicule 2.

Bronn's "Klassen und Ordnungen des Thierreichs," iii., 1 (Malacozoa).

KEY TO PLATES XXXI.-XXXIV.

a. Anus.
at. Atrial aperture.
at. n. Nerves arising from the atrial end of the ganglion.
br. Branchial (oral) aperture.
br. f. Longitudinal folds in branchial sac.
br. n. Nerves arising from the branchial end of the ganglion.
d.b.v. Vessel running along the dorsal free edge of the branchial sac.
d.g. Digestive gland.
d.t. Dorsal tubercle.
d.v. Vessel arising from the dorsal end of the heart.
en. Endostyle.
f, f. Folds in test.
g, g. Hermaphrodite genital masses.
g.d.l. Left genital duct.
g.d.r. Right genital duct.
h. Heart.
i. Intestine.
i.s. Structures on intestine.
m.b. Muscular bands in mantle.
n.g. Nerve-ganglion.
œ. Œsophagus.
œ.a. Œsophageal aperture.
r.t.v. Vessel to test from right side.
st. Stomach.
st'. Stalk.
t. Test.
t.p. Processes on test, spinous, round, or oblong.
t'. Typhlosole in intestine.
tn. Tentacles.
v.v. Vessel from ventral end of heart.

DESCRIPTION OF PLATES XXXI.–XXXIV.

Plate XXXI.

Fig. 1. Full-grown specimen, stalk cut off.
Fig. 2. Specimen nearly full-grown, having spinous and oblong processes on the test.
Figs. 3 and 4. Young specimens. Fig. 4 is very young, the spines beginning to develope.
Fig. 5. Specimen having a bivalve imbedded in the test.
Fig. 6. The right half of the test is cut away. Notice the muscular bands of the body and the interlacements between them. Notice also the blood-vessel to the test on the right (cut).

Plate XXXII.

Diagrammatic view, with the test and body-wall of the left side removed.

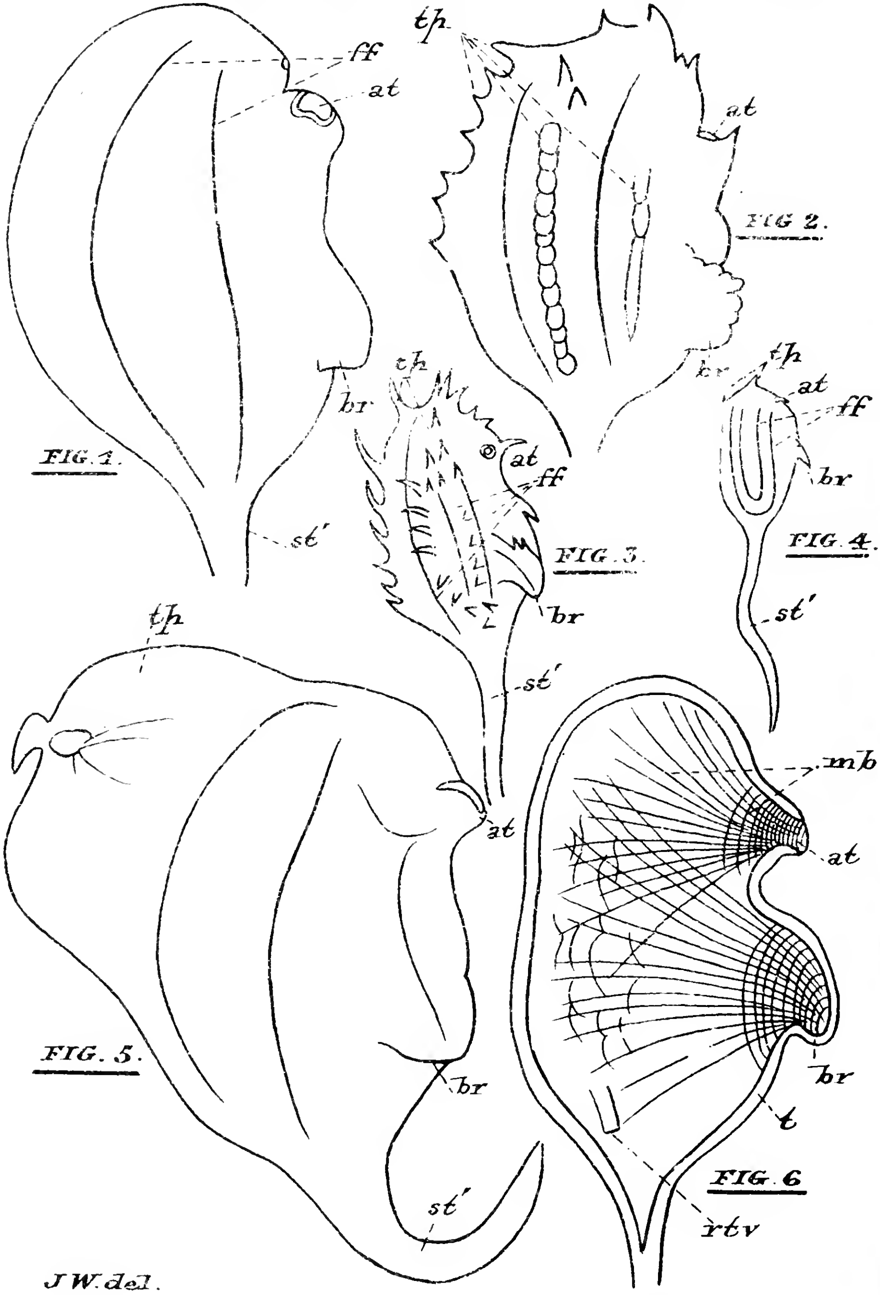
The cut body-wall is represented by the double line between endostyle and test, &c. The branchial sac is shown with part of its left wall cut away to show the ring of tentacles and dorsal tubercle. The folds of the right side are represented as seen. A bristle is passed from the interior of the body out through the branchial aperture.

Plate XXXIII.

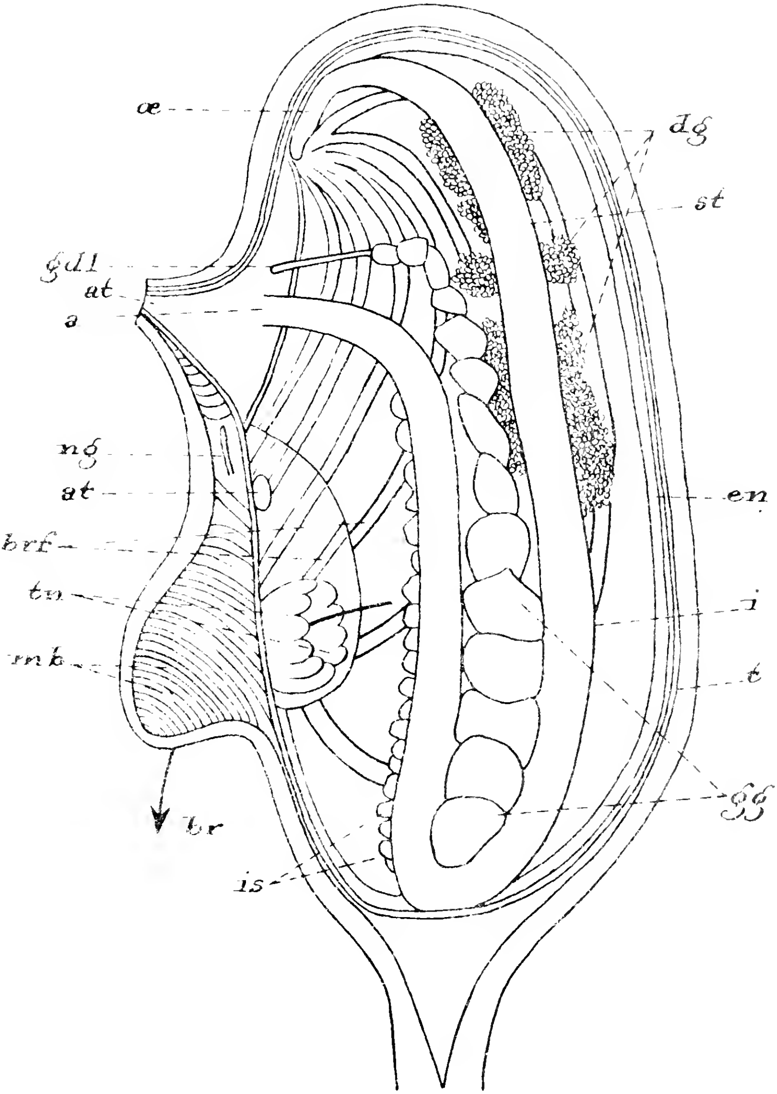
Diagrammatic view of the body from the right side, the body-wall of the right side and the right half of the test being removed. The cut body-wall is represented by a double line, as in Plate XXXII., and the branchial sac is shown cut open as before. A bristle is passed out through the branchial aperture, as in Plate XXXII.

Plate XXXIV.

Fig. 1. The body-wall of the right side is removed. Note, as in figs. 2 and 3, the black line drawn across the body-wall in the neighbourhood of the anus. This represents the point to which the lining invagination of the test is carried from the atrial aperture. The terminal end of the intestine is shown projecting from beneath the branchial sac, to its left.
Fig. 2. The right wall of the branchial sac is cut away. A bristle is passed out through the branchial aperture.
Fig. 3. The branchial sac is removed, also the right half of the ring of tentacles.
Fig. 4. The body is opened along its ventral aspect, the sides thrown back, and the branchial sac removed. In this sketch the muscles of the right half of the body only are shown. The liver is cut away, the stalks being represented on the stomach. The lining invagination of the test in the atrial aperture has been removed.
Fig. 5. Transverse vertical section of the body near the atrial aperture. This sketch shows the relations of the atrium. The atrial invagination is shown shaded dark. The cut is made at the point where the intestine turns at right-angles to its former course, to end in the anus.



BOLTENIA PACHYDERMATINA.



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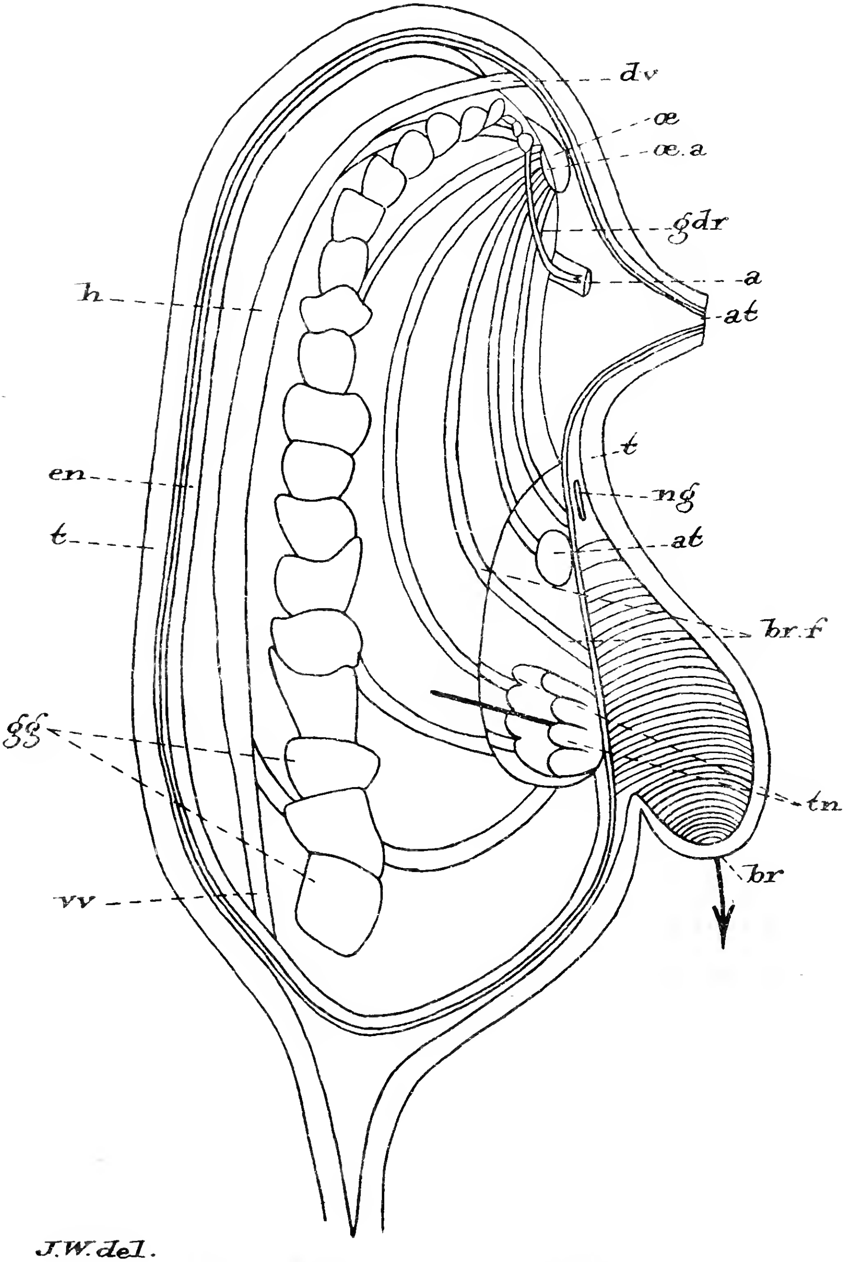
BOLTENIA PACHYDERMATINA.



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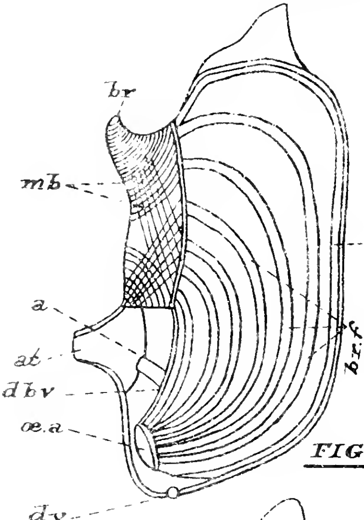

FIG. 1.

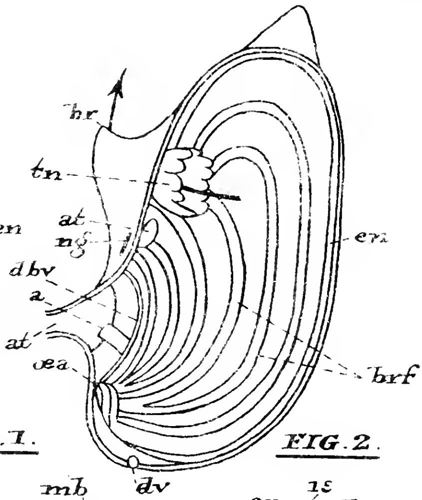

FIG. 2.

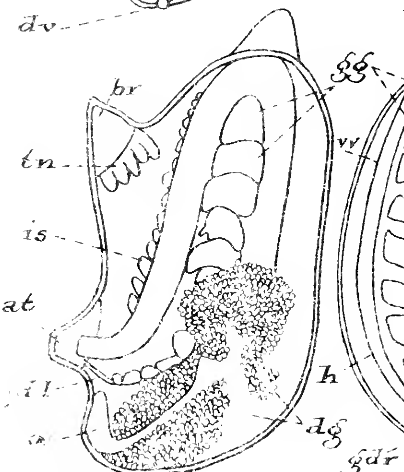

FIG 3.

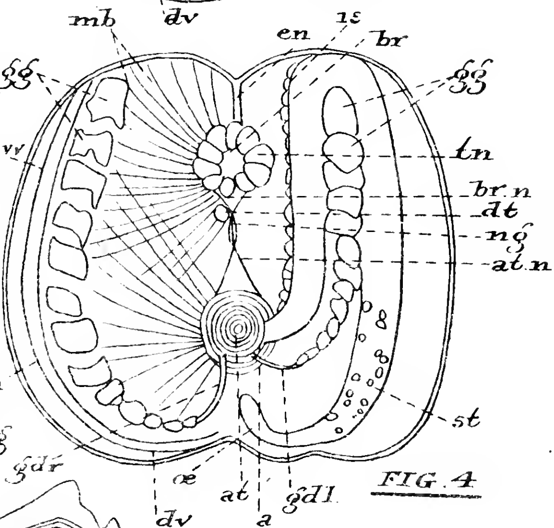

FIG. 4.

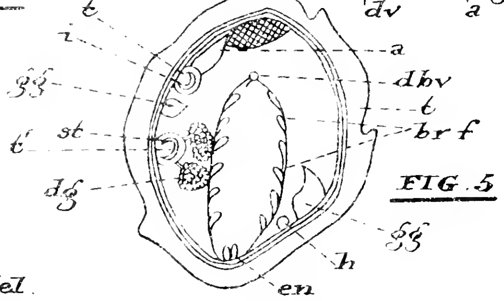

FIG. 5.

J.W. del.

BOLTENIA PACHYDERMATINA.

ART. XXVII.—*Animal Intelligence.*

By WILLIAM W. CARLILE.

[*Read before the Wellington Philosophical Society, 29th July, 1891.*]

IT has come to be recognised only of late years that for the adequate comprehension of the phenomena of mind in man some knowledge with regard to the manifestations of mind in the lower animals is in the highest degree necessary; and the attention of late paid to comparative psychology has already revolutionised much of human psychology, with its cognate and derivative sciences. Take the one fact of its having drawn attention to the great principle of heredity, more especially to the heredity of acquired faculty. The importation of this conception alone into philosophy goes far to render all the older philosophies obsolete, or, at any rate, to reduce their interest for mankind to an historical interest only. It is not by any means in the region of metaphysics and psychology alone that it thus operates. Dr. Kuno Fischer, in his work on "Francis Bacon of Verulam," traces the course of the Anglo-Gallic empiricism from Bacon through Hobbes, Locke, Berkeley, Hume, Voltaire, Rousseau, Condillac, and the Encyclopædists down to such English writers as Macaulay and J. S. Mill; and points out truly that in all of them, with the single exception of Hume, the mode of thought was anti-historical. As an instance of this anti-historical mode of thought it is sufficient to point to Hobbes's theory of government as resting on a fancied contract between king and people. This, as Dr. Fischer says, became "a revolutionary theory in the mind of Rousseau. The anti-historical mode of thought became an anti-historical mode of action. The French Revolution came to an incurable rupture with history. The theoretical Rousseau was followed by the practical Robespierre, in whom the anti-historical mode of action became not only barbarous but grotesque." Dr. Fischer, with justifiable complacency, compares this mode of thought with that which, in Germany, took its rise in Leibnitz, and flowed down to our times through Lessing, Kant, Goethe, Hegel, and the other idealists. Whatever its failings were, it was, at any rate in the main, free from the failing of being anti-historical. If Dr. Fischer had traced the course of English empiricism down a little further, however, than he did, he would have found that it had learnt to think historically; that, indeed, in the philosophy based on the theory of evolution, it had come to converge with the stream of German thought that flowed in upon us through the channel of Thomas Carlyle's writings. When Hegel tells us that "the grades that Spirit seems to have left behind it, it still possesses in the depths of its present," or when Carlyle affirms of the old Norse religion, the "sternly impressive consecration of valour," that, "unconsciously and combined with higher things, it is in us yet," the modern evolutionist —say, Mr. Bagehot, for instance, in his "Physics and Politics" —steps in to point out that such a view is not metaphor or poetry, but is scientific truth. "In 1789," he remarks, "when the great men of the Constituent Assembly looked on the long past, they hardly saw anything in it that could be praised, or admired, or imitated; all seemed a blunder—a complex error, to be got rid of as soon as might be. But that error had made themselves. On their very physical organization the hereditary mark of old time was fixed; their brains were hardened and their nerves were steadied by the transmitted results of tedious usages. The ages of monotony had had their use, for they had trained men for ages when they need not be monotonous." The old governments of the strong hand, as he says elsewhere, "made the human nature that aftertimes employ." That human nature is made and makeable. How vast a revolution in psychological, ethical, and political speculation does the importation into science of this one thought imply!

It is not, of course, to be asserted that the modern doctrine of heredity would not have dawned on the world even apart from the study of animal intelligence. The only wonder is that the world for so long lost sight of it. But animal intelligence was for it, in Bacon's language, the "Prerogative Instance" in regard to which it could not be overlooked. M. Ribot, in his work on heredity, draws attention to the case of a little dog that, at the scent of a piece of wolf's skin, went into convulsions of terror. The similar case of apes born in captivity being convulsed at the sight or the sound of a snake is familiar. From what depths are these terrifying associations drawn? Not from the depths of the animals' individual consciousness, but from that of ancestors far back in the buried past. We are becoming familiar with the notion of hereditary memory. Science will perhaps some day have to try and grasp the notion of hereditary identity, and will have to recognise that perhaps there is a sense in which, after all, Plato was right in affirming the pre-existence of the soul.

I have not attempted in this paper to give even a *résumé* of any theory of either the nature or genesis of animal intelligence, but have merely introduced the above in illustration of the importance of the study. As to its fascination, little need be said. It is the one description of study, if one can call it so, that has fascinated us all as children, and that, in spite of ourselves, seldom fails to fascinate us yet. We have to say "in spite of ourselves" because, with Dryasdust perversity, we have absolutely, on account of its fascinating character, come to regard it as trivial and contemptible. It is only of quite late years that we have seen an attempt made by a man of science to collect as much authoritative information as he can, in regard to any instances of the display of instinct or of incipient reason in animals, which seem to be worthy of remark. Such an attempt is embodied in Professor Romanes's book entitled "Animal Intelligence," in the International Science Series, and it is a book which can be read with delight from beginning to end even by those who care nothing for the subject from the scientific point of view.

Any of us who live in the country and keep our eyes open will occasionally have instances analogous to those cited by Professor Romanes brought under our notice. A few have come under my own, and I hereby "lay them on the table," as they call it in an adjacent building. Probably they may be capped by many equally interesting, or more so, drawn from the recollection of other gentlemen present.

What Professor Romanes has to say in regard to marsupials is very brief. He considers the kangaroo very low in the scale of intellect, and knows of no fact connected with the psychology of the group worth quoting, except an instance cited from Jesse of a female kangaroo which, when hard-pressed by the dogs, took her young from her pouch and threw them as far as she could on each side of her. To any one who has done any kangaroo-hunting, another and more common incident of the chase will occur. The kangaroo, especially if he is an "old man," invariably makes straight for water. That I have noticed myself; and why? Because there he is master of the situation. When the dogs attack him in a waterhole he can hold them under till they are drowned. I cannot say that I saw a dog drowned, but I had only a few weeks of kangaroo-hunting. The friends with whom I stayed spoke of it as a thing that happened frequently, and were alive to the necessity of being on their guard to prevent it. The increased danger in case of the hunted kangaroo being an "old man" is worthy of note. It would be due, perhaps, in part to his strength, but also, perhaps, in part to his experience; and, if we credit him with the capacity for learning by experience, we must promote him a step or two in the scale of intellect.

When staying a few years ago at the house of a Hawke's Bay sheepfarmer—Mr. Fleming, of Wanstead—I heard of a circumstance that seems worth recording in connection with the reasoning-powers of the horse. Mr. Fleming breeds horses extensively. In some of the valleys on his property the cabbage-tree is to be found in considerable numbers. It was a common occurrence, he told me, during the protracted drought, which had then just broken up, to see a couple of horses gnawing at each side of the stem of the tree at about a foot from the ground. The tree, it is necessary to remark, is of the palm family, and has all its leaves at the top. The rest of the horses might be seen at the same time grouped in all directions along the side of the hill, watching, but not interfering with, the operations. At last, when the stem was gnawed through, down would come the tree, and there would be a general rush and scramble for the leaves. This over, the tree-fellers would move on to the next Cordyline, and set to work, with, after a little, a similar result. Mr. Fleming told me that he had frequently brought visitors to witness the operation.

The above would, perhaps, form an instance of a chance discovery, utilised as soon as found, of which there are innumerable others in the history of the development of instinct. The horses, no doubt, in the first instance chewed the bark of the tree simply to appease their hunger. By chance one was brought down, and this result was followed by a rich find of succulent food. After a few such chances—perhaps after one —they no doubt went about the gnawing with the set purpose of bringing the tree down, and soon improved on that by arranging with one another that one should gnaw, say, the western side of the tree, while the other gnawed the eastern, at about the same height from the ground. The concert and co-operation implied in this exhibit no inconsiderable approach to human intelligence. We can see, too, in such a case some of the factors necessary for the origination of a new instinct. Supposing the drought protracted for generations, and the supply of cabbage-trees unexhausted, we should soon have a breed of horses that were born tree-fellers, and whose jaws and teeth would, no doubt, in time become endowed with the increased strength and sharpness necessary for the rapid and efficient performance of the operation.

I was informed by another of my Hawke's Bay neighbours of a circumstance in connection with the habits of the wild —that is, the feral—dog, which I believe is familiarly enough known to those to whom the habits of this animal are a matter of concern. When a slut has a litter of pups to feed, she will gorge herself with the flesh of her quarry, then go home and vomit it out for their benefit. I have heard since that the habit is not peculiar to the wild dog. Mr. Sims, who was manager for Mr. Cotter, of Ashurst, and was afterwards with me for a short time in a similar capacity, informed me that an imported slut belonging to Mr. Cotter was in the habit of doing precisely the same thing. What is, perhaps, most remarkable in connection with this case is the control acquired by the animals over the muscles of the abdomen and diaphragm, enabling them to expel the contents of the stomach at will. In the imported slut it was exceptional, but in the wild variety the constant demand for the exercise of the capacity had apparently converted it into a characteristic of the breed.

The skill of dogs in slipping their collars is noticed by Professor Romanes. In one of my own dogs I had occasion to notice his *modus operandi*. He stretched his chain out to its full length, then turned on his back and rolled as a horse rolls, dragging at the collar all the time. Presently his ears slipped through, and he was free. Probably this he learnt by accident when rolling to scratch the parts made itchy by flea-bites, but he was not slow to make use of the lesson once learnt, and by the time I noticed him he took the steps necessary to liberate himself in the most purposelike manner.

Professor Bain has an interesting speculation, in his work "On the Emotions and the Will," on what he calls the link of feeling and action, or the instinctive germ of volition. His theory is that in the very young animal or child the feeling of pain, as from too great proximity to a fire, has no automatic tendency to make the animal or child withdraw from the fire. "It knows nothing of the causes, and as little of the remedy." What happens is this: The tendencies to spontaneous movement with which the nervous system is charged, prompting now to one part now to another, make it at last spring to its legs and commence a forward locomotion. Should the locomotion chance to be away from the fire, the uneasiness sensibly subsides. After several trials only will there come to be formed an association between such a motion and such relief. Or, "to take another example. An infant lying in bed has the painful sensation of chilliness. . . . Spontaneous movement will arise, whether from healthy natural powers or from irritated nerves. In the course of these spontaneous movements there occurs an action bringing the child into contact with the nurse lying beside it; instantly warmth is felt, there is a throb of pleasure, and a concurrent stimulus to the physical system. The successful movement is sustained, made more energetic, and the contact is kept up. Such would be the natural operation of the law that connects pleasurable relief with increased energy. The child twelve months old can perform this act by a true selective volition. The child of three days can do it only at random, and by the help of the principle we have been explaining." The primary essential for learning the right movement in any direction is thus the abundance of spontaneous activity, prompting to innumerable movements in all directions. Have we not here, in the dawn of reason in the individual, an analogy to the operation of reason in the living universe? To the theory of natural selection it has been objected that it means firing innumerable shots to kill one bird. Nature, indeed, it truly seems, tries innumerable variations before the one useful variation is hit on and survives. We ourselves have all done the same. We may thus catch, behind the apparently fortuitous processes of nature, a glimpse of the operations of a mind analogous to our own.

Art. XXVIII.—*Instances of Instinct in Insects.*

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

[*Read before the Wellington Philosophical Society, 9th September, 1891.*]

The following remarks are offered as a supplement to Mr. Carlile's extremely interesting paper on "Animal Intelligence," which I had the pleasure of hearing at one of our recent meetings. Two of the observations on instinctive habits are taken from recent numbers of the *Entomologist's Monthly Magazine*, while the other two are original.

In September, 1886, Mr. C. G. Barrett, F.E.S., recorded the following observation on the habits of a little black moth called *Phycis carbonariella* :—

"One of the most singular preferences known among small moths is that of *Phycis carbonariella* for burnt places on heaths. A fire, lighted by accident or for mischief, or sometimes to allow of the growth of young herbage, sweeps across a heath, destroying everything (plants and insects) for hundreds of yards, and leaves a dreary waste of burnt *débris* and charred sticks; and when the next autumn arrives *Phycis carbonariella* deserts the living heather, on which it surely must have fed, and resorts in numbers to this burnt ground. I have certainly seen a hundred specimens on such a piece of ground in less than an hour, when the whole number disturbed from among living heather in an afternoon would not exceed four or five, and this on occasions when they flew quite freely, towering in the wildest manner. The resemblance of the moth to the charred sticks is wonderfully close, and its sagacity in choosing such a resting-place would be equally surprising if it could only be satisfied to sit still, and not hurry away at the smallest alarm.

"The only satisfactory explanation appears to be that the creature has an acute sense of the fitness of things, and, feeling that its black coat harmonizes but ill with anything that is living or growing, it congregates where the fire has reduced everything to the same carboniferous condition. This seems to be an unexpected application (by the moth) of the theory of natural selection, but, as the *normal* condition of heaths can hardly be that of periodic burning, or can hardly have been so long enough to produce so important a modification in a moth, and as there are very few birds on these heaths, and none equal to inflicting serious damage on so active an insect, I can only suppose that a theory of individual *preference* is applicable in this case.—CHAS. G. BARRETT, King's Lynn, Norfolk, England. September, 1886."

In connection with this most interesting observation, I cannot help thinking that, even allowing for the scarcity of the birds, the habit of perching on burnt ground has probably been the result of natural selection. Prior to the burning of heaths no doubt the black coloration was useful to the insect for another purpose—possibly to absorb heat; but since the alteration in its environment has taken place the colouring has become serviceable for protective purposes. Hence it is probable that if adequate records had been kept we should find that the species had become much more numerous in recent times.

On the 5th October, 1890, while searching for insects on tree-trunks in the forest near Wellington, I heard an unusually loud buzzing sound in the neighbourhood. On endeavouring to ascertain the cause, I discovered a small hunting-spider of the grey species (family Salticidæ), which frequent sunny tree-trunks, struggling with a large flesh-fly fully four times its own size. The spider had seized its victim by the sternum, but the fly continued violently moving its legs and wings for more than eight minutes. During this time the little spider had considerable difficulty in detaining such a large insect.

In this case I think the action of the spider in biting its victim in the sternum, which is the seat of the great thoracic nerve-centre, and consequently the most vital part as regards locomotion, was undoubtedly instinctive. I do not imagine any one would contend that the spider had a knowledge of the internal anatomy of its victim, or that it acted through individual experience. The obvious explanation is inherited instinct, or the experience of the race accumulated during countless generations by natural selection, preserving those individual spiders which were most successful in killing their prey.

On the 1st February of the present year I was collecting and observing insects in the same locality. Whilst approaching a mass of dead branches which was situated near the track I observed what appeared to be a leaf fall from one of the upper twigs, stop for a second on another twig, and finally come to rest on the ground amongst a lot of litter. I felt perfectly sure it was a leaf, but was impelled for some reason to stoop down and look at it. On close examination I found it was a specimen of *Drepanodes muriferata*, a somewhat rare moth. The insect was resting with outspread wings, slightly turned upwards, and appeared exactly like a crumpled leaf on the ground. All the varieties of this species resemble dead leaves in their varied tints; but the insect's habit of *falling* like a leaf when disturbed is, of course, an instinctive action. I think in this case we have an example of structure and instinct developed simultaneously. It is evident that the instinct is just as independent of the will of the animal as its protective colouring, both having been essential to the species in avoiding destruction by insectivorous birds. It is also interesting to reflect on the immense number of abortive variations which must have occurred before the moth acquired its present habits and colouring.

The following notes on *Osmia bicolor*, Schk., are contributed by Mr. V. R. Perkins, F.E.S. (*Entomologist's Monthly Magazine*, July, 1891):—

"In vol. xxi., pp. 38 and 67, of this magazine I drew attention to what I considered was a very curious habit of *Osmia bicolor*, Schk., a habit, I believe, quite peculiar to this one bee—that of picking up dry bents of grass or stick and flying away with them in its mandibles. It is only the female that does this, and I concluded at the time I first noticed it that it must have something to do with nidification, but in what way I was at a loss to know. This bee is known to make use of the old shells of *Helix nemoralis* for its nidus. These it fills with its cells, and I have seen the bee right inside the whorl of this shell busily at work, and so captured it; but I have never seen any symptom of stick or bent connected with it; so it was a puzzle what the bees did with them. This present season, notwithstanding the very severe winter and continued cold spring, these bees were out and about quite as early and as numerously as usual, and by the middle of April they had become plentiful. I was too much engaged with other matters at that time to go and look after them, and it was on the 6th of this present month that I was able to get away to one of the spots where these bees can be watched attentively, and where I was not likely to be disturbed. I found the females in abundance, and they were at their old game; so now was my opportunity. I saw them alight on the ground, search about and select a bent, and then fly off with it. I was determined to solve the mystery if possible, so I crept about on my hands and knees, watching intently the bees flitting along the dry sunny bank, working in and out among the short herbage, and soon I saw one start up under my very nose, and I saw also a little pile of bents collected into a heap, just such as the bees select. It struck me as a very peculiar-looking mound, and I took up the lot in my hand, when what should I see under it but a *Helix* shell full of cells of the *Osmia!* Here, then, was the explanation of the mystery plain enough. These bees, when they have filled a shell full of cells, set to work to cover it over—to hide it both from the sun's rays and from any birds, mice, insects, or other enemies that might chance to come across it. Having so far succeeded, I made up my mind to return the next morning, and prosecute my studies further in the same direction. I soon found another of these peculiar little constructions; so I sat myself down by it, and watched to see what would occur. I was close enough to take it up if I wanted to; but the bee came with her load, perfectly indifferent to my presence, and deposited it in her own peculiar way and to her own satisfaction, and then went away for another. She worked hard, and brought them rapidly one after another. With each one she would alight on the top of the mound, then look round, walk over it, and with her jaws push one of the ends into the heap where she wanted it to remain, and so fix it. As soon as she was satisfied with its position off she went for another, brought it in, and did exactly the same. Every bent was put in its proper place, and she never laid one simply down on the top while I watched her.

"These nests very much resemble those of *Formica rufa* in miniature; they are from 4in. to 6in. round the bottom, and are from 2in. to 3in. high, so that they are very easily detected when you once know what they are; and the labour spent upon them must be very great, for there are hundreds of bents in each, and each one is brought and added separately. I found some dozen or more, all within a short distance, and three so close together that I could watch the proceedings of them all at the same time. This furnishes a complete history of the habits of this wonderful little *Osmia*. —Wotton-under-Edge, England, 13th May, 1891."

In this extremely interesting case, much as we might desire to attribute individual intelligence to the insect, I do not think it is possible to do so. The habits of the female bees, first in selecting the empty snail-shells as receptacles for their nests, and secondly in covering them over with sticks, have probably been gradually produced by an immense number of variations in instinct, those variations most favourable to the welfare of the young under the given conditions having been finally preserved. In the discussion which followed the reading of Mr. Carlile's paper, Mr. Harding contrasted instinct and reason, and showed how, in many respects, the former attribute was superior to the latter. If it is admitted that instinct is the inherited experience of the race, whilst reason is that of the individual only, then the explanation of the superiority of instinct is obvious. Instinct is the result of continued selections from the experiences of countless generations, whilst reason is only the experience acquired during the brief lifetime of a single individual. It is not surprising, then, that instinct so vastly transcends the intellectual power of the animal that exhibits it. I think that we may look for the development of human instinct when most of our individual experience or knowledge has become hereditary. At present only the capacity for acquiring knowledge is inherited by human beings, but, judging from the facts above considered, knowledge itself must in time be inherited also. So far from supposing, then, that we have lost our instincts through civilisation, I do not think that they have yet been evolved. Now nearly all our results have to be attained by long training and laborious mental calculations, but in the future we may hope to arrive at far greater results by almost unconscious instinctive processes.

II—.GEOLOGY.

Art. XXIX.—*On the Foliated Rocks of Otago.*

By Professor F. W. Hutton, F.G.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

The foliated rocks of Otago are found in two districts, separated from each other by a band of sandstones and slates, about eight miles broad at its narrowest, which belongs to the Maitai or Carboniferous system.

1. Northern Otago.

The first of these districts is in north-eastern and central Otago, the rocks found in it being the "foliated schists" of Sir James Hector,* and the "Wanaka and Kakanui formations" of my "Report on the Geology of Otago" (Dunedin, 1875), p. 26. These rocks extend in a band—some one hundred and thirty miles long and eighty miles broad—across the north-eastern part of Otago, where they form a single broad anticlinal curve, the axis of which runs from near Dunedin, west of Cromwell, to Lake Wanaka. The rocks lie remarkably flat (for foliated schists) over the whole area, dips of more than 45° being rare, and almost exclusively confined to the flanks of the curve. The average dip is between 25° and 30°. The rocks are not contorted or plicated in the usual meaning of the terms, but in the lower part of the Wanaka series they often have a waved or corrugated structure. All the rocks of the Wanaka series are foliated, and nearly all are true mica-schists, varying from coarsely foliated, with lenticular plates of pure quartz, to finely foliated, with nearly parallel foliæ. The Kakanui series is composed at the base of fine-grained mica-schists and silky phyllites, passing upwards into beds of quartzite and clay-slate, which is cleaved only in the plane of stratification. There is, however, no distinct separation of the Wanaka from the Kakanui series, but one passes insensibly

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* Quar. Jour. Geol. Soc. of London, 1865, vol. xxi., p. 128.

into the other. Graphite-schists, sometimes 13ft. thick, occur in the lower part of the Wanaka series, at the Carrick Ranges; and chlorite-schists, also belonging to the Wanaka series, are found near Queenstown.

The *Mica-schists* of the *Shotover River* (Wanaka series), near Queenstown, are distinctly foliated with quartz and mica, and break readily along the plane of foliation. The foliæ often have parallel sides and extend far, but occasionally they are lenticular. The broader quartz foliæ are always lenticular in shape. The quartz is white and milky, being filled with innumerable gas-pores, arranged in bands, which are oblique to the plane of foliation. There are no liquid cavities in the quartz, but many of the gas-pores are irregular in shape, and look as if they had at one time been filled with liquid. In these cases the long axis of the cavity lies in the direction of the band. The quartz elements are dovetailed grains, from 0·004in. to 0·014in. in diameter, and occasionally they show undulose extinction. In some specimens there are patches of amorphous, isotropic quartz. The micaceous layers are dark-grey and glittering to the naked eye. The microscope shows small flakes of muscovite, from 0·014in. to 0·022in. in length, oriented to the plane of foliation. Part of the muscovite is altered to a green mica with undulose extinction and no axial interference figure. A colourless mineral, apparently zoisite, is very abundant in grains and in jointed columns; and a fine dust of secondary magnetite is sometimes present, scattered in clouds drawn out in the plane of foliation.

At *Clyde* the mica-schists differ from those of the Shotover in the absence of the bands of gas-pores from the quartz, much of which is amorphous.

The *Phyllites* of *Kingston* (Kakanui series) are composed of elements uneven in size, but mostly smaller than those of the mica-schists. They also occasionally contain patches of a fine aggregate, which is probably part of the original rock, as well as broken grains of feldspar. The mica is brownish-yellow, not dichroic, and with low polarisation colours. It is probably muscovite, but the scales are too small to examine with convergent polarised light. Zoisite is present as in the mica-schists, which latter differ from the phyllites chiefly in having undergone more vertical segregation as well as more alteration.

The *Chlorite-schists* of *Queenstown* are formed of much larger elements than the mica-schists, and they also contain small quantities of feldspar. The quartz has large gas-cavities, but no bands of gas-pores. The chlorite is in bluish-green flakes, which are either isotropic or else have dull polarisation colours. It is associated with abundant grains of yellow epidote, or pistacite, and crystals of secondary magnetite are not uncommon. These schists are probably altered eruptive rocks.

Age of the Rocks.

Up to the present it has been the general opinion of New Zealand geologists that these foliated rocks are the metamorphosed equivalents of the Ordovician and Silurian rocks of Nelson, and by the officers of the Geological Survey some of the schists are considered as probably still younger. My reason for holding this opinion was that the publications of the Geological Survey showed these schists passing northwards continuously through the Victoria, Brunner, and Lyell Mountains to Mount Arthur in Nelson. But in 1887 I examined the rocks of the Buller River, and found that the schistose rocks of the south were not stratigraphically connected with those of the north, as I had previously supposed,* and this led me to reconsider the whole question. The absence of plication, and of cleavage oblique to the stratification, throughout the district are sufficient proofs that the foliation is not due to crushing, or dynamic metamorphism, while it cannot be considered as a region of contact metamorphism, for the only eruptive rocks are those near Queenstown, and they have been foliated along with the rest. The metamorphic action would therefore appear to be due to the internal heat of the earth at a very early period of its history, when the temperature-gradient was much steeper than now. In other words, they are, in all probability, of Archæan age, and may have been deposited almost in their present condition.

The Pre-cambrian, or Archæan, rocks have been separated into two divisions. The upper of these is, in part, detrital, and has been called the Huronian, or the Proterozoic, or the Algonkian. The lower is altogether crystalline, and is known as the Laurentian, or the Azoic, or the Archæan in a limited sense. In the Northern Hemisphere there is usually, but not always, a break between these two divisions, while in all cases there is a great discordance between the upper division and the overlying Cambrian or Ordovician rocks. Our Wanaka series can be received as the equivalent of the lower division without much hesitation; and, as there is no break between it and the Kakanui series, it is more probable that the latter belongs to the Archæan than to the Palæozoic era.

Equivalents elsewhere.

The Otago schists sweep round to the north-west, and have been traced by Sir Julius von Haast and Mr. S. H. Cox as far north as the Teremakau River. Beyond this point

* "On the Geology of the Country about Lyell," Trans. N.Z. Inst., vol. xxii., p. 387.

they have not been followed; but in Cannibal Gorge mica-schists and phyllites occur, which probably belong to the Kakanui series, and are probably continuous with the schists of the Teremakau. According to Mr. S. H. Cox these mica-schists are underlain by slates and limestones;* but this is very improbable; and most likely these carbon-slates, calcareous slates, and white limestone belong to the Reefton series—perhaps more or less altered by contact with the granite of the Victoria Mountains—and lie unconformably on the mica-schists.

North of Cannibal Gorge the schists are overstepped by sandstones and slates belonging to the Maitai system, and it is uncertain whether the schists of western Marlborough and eastern Nelson should be considered as belonging to them.

In the Collingwood district mica-schists and phyllites are found near the mouths of the Aorere and Parapara Rivers, which pass under grey and dark-blue slates of the Aorere series containing diprionidian graptolites† undoubtedly of Ordovician age. It seems probable that these schistose rocks are the equivalents of the Kakanui series, and underlie the Aorere series unconformably; but this last point has not yet been made out distinctly.

2. Western Otago.

The foliated rocks of the West Coast sounds, from Milford to Dusky—forming the gneiss-granite formation or crystalline schists of Sir James Hector, and the Manapouri formation of myself—have been generally regarded as consisting principally of typical gneisses of Archæan age, and as passing below the mica-schists of northern Otago.‡ Last summer, during the excursion of the Australasian Association to the Sounds, I collected a number of these rocks from Wet Jacket Arm, from George Sound, and from Milford Sound, which I have examined microscopically, and found to consist chiefly of plagioclase and hornblende or biotite, quartz being almost completely absent. The rocks, therefore, are not gneiss-granites, but schistose diorites and gabbros, and their microscopical texture shows that all of them are plutonic eruptive rocks which have undergone strong dynamic metamorphism. In the following short descriptions I have con-

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* "Reports of Geological Explorations," 1883–84, p. 4, Nos. 2 to 4 of the section.

† *Phyllograptus folium*, His. I have also recognised *Didymograptus quadribrachiatus*, Hall, and *D. octobrachiatus*, Hall. All three are found in the Lower Silurian slates of Victoria. Both genera are Lower Silurian only.

‡ Haast, "Geology of Canterbury and Westland," Christchurch, 1879, p. 225.

sidered them as hornblende diorites; but, as the hornblende is in all cases allotriomorphic, it is probable that they were originally augite diorites.

Schistose Mica Diorite.

George Sound.—A black-and-white coarsely-speckled rock, indistinctly foliated, but not breaking easily along the plane of foliation. Composed of feldspar—chiefly, if not entirely, plagioclase—and biotite, with a little hornblende, the ferro-magnesian minerals occupying less than half the rock. The feldspars range up to 0·1in. in length, but usually they do not exceed 0·04in., while the biotites go up to 0·03in. A slight pressure-granulation is visible.

This is the rock of the Gertrude Waterfall, at the head of the sound.

Hornblende Diorite.

Milford Sound.—A black-and-white coarsely-speckled rock; not foliated. Composed of plagioclase and hornblende, the latter occupying less than half the rock. The plagioclase crystals go up to 0·08in. in length, the hornblendes to 0·04in. The feldspar shows pressure-granulation, and the hornblendes are much broken up and granulated.

From the boat-landing below Lake Ada, Arthur River.

Schistose Hornblende Diorite.

Milford Sound.—Coarsely-grained black-and-white-speckled rocks with the foliation distinct, sometimes so pronounced as to make the rock split readily along the plane of foliation. Often containing pink garnets, sometimes large sometimes small, in which case they are often clustered in bands, averaging about ½in. broad, lying in the plane of foliation. The rocks are composed essentially of plagioclase and hornblende, with a little quartz and, occasionally, some muscovite. The hornblende occupies from half to less than half the rock. Sphene is often abundant. The feldspars go up to 0·04in. in length, and the hornblendes to 0·06in. There is no appearance of pressure-granulation, but the feldspars are often full of inclusions.

From Harrison's Cove, and from Metal Point, below Mitre Peak. These rocks, which are very common in Milford Sound, pass into gabbros.

Dusky Sound.—A black-and-white fine-grained rock, distinctly foliated, and breaking readily along the plane of foliation. Composed of plagioclase and hornblende, the latter occupying rather less than half the rock. A small quantity of quartz is also present. Sphene is abundant. The feldspars go up to 0·04in. in length, and the hornblendes to 0·05in. No pressure-granulation.

Enstatite Diorite.

Dusky Sound.—A rather pale-grey, finely-grained rock, not showing foliation. Under a lens it is finely speckled with black and white. Composed of plagioclase and hypersthene, the latter occupying about one-quarter of the rock. The feldspars go up to 0·1in. in length, but show pressure-granulation. The hypersthene is mostly in uncleaved small grains enclosed in feldspar, but occasionally it is in allotriomorphic crystals up to 0·04in. in length. It is strongly pleochroic, and not schillerised.

From the head of Wet Jacket Arm.

Enstatite Gabbro.

Milford Sound.—A dark, almost black, rock, composed of hornblende and feldspar, the latter occupying less than half the rock. The feldspars are chiefly plagioclase, but some seem to be microcline. In addition to the hornblende there is a little enstatite, which is nearly colourless, and slightly pleochroic. There is also a little muscovite. No pressure-granulation.

From Harrison's Cove. A similar rock is found in many places in Milford Sound, and has been called hornblende-schist.

Age of the Rocks.

The large size of the elements of these rocks shows that they are of plutonic eruptive origin, while the pressure-granulation observable in many of them shows that the foliated structure is of secondary origin. It will be noticed that the size of the elements is approximately the same all through, and the coarseness or fineness of the grain depends upon the amount of segregation the minerals have undergone.

They have been considered as Archæan on account of lithological structure, and not from any stratigraphical evidence. Consequently, this opinion cannot now be sustained. On the contrary, the absence of contortion, and the almost universal westerly dip of the foliation planes, is strong evidence that they are not Archæan. What their age may be it is impossible to say at present. Sir James Hector says that "wrapping round these crystalline strata, and sometimes rising to an altitude of 5,000ft. on its surface, is a series of hornblende-schists, soft micaceous and amphibolic gneiss, clay-slate and quartzite, associated with feldstone dykes, serpentine, and granular limestone;" and he believes these "to be metamorphic rocks of not very ancient date—probably of Devonian age."* Some of these are no doubt sedimentary rocks, altered by contact with the eruptive diorites, and the diorites

* "Outlines of the Geology of New Zealand," Wellington, 1886, p. 51; and Quart. Jour. Geol. Soc. of Lond., vol. xxi. (1865), p. 124.

are therefore probably younger than Devonian. When the boundaries between the eruptive and the surrounding sedimentary rocks have been carefully examined, and when the relation of the limestones in Caswell Sound and other places with the diorites has been clearly made out, it will then perhaps be possible to assign them to their proper place with some degree of certainty. And it may be found that the eruptive diorites of Milford Sound are connected with the greenstone-tuffs of the Route Burn and Greenstone River, west of Lake Wakatipu, which form the type of the Te Anau series of Sir James Hector.

ART. XXX.—*Note on the Boulders in the Port Hills, Nelson.*

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

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

A GOOD many years ago I pointed out that the Arrow rock, at the entrance of Nelson Harbour, was composed of a conglomerate of large boulders, and that boulders of the same nature were also found in the sandstones forming the northern part of the Port Hills.* These boulders are rounded, go up to 3ft. or more in diameter, and are composed of a granitoid rock which I took to be syenite. Last July, when in Nelson, I collected a fragment of one of these boulders for microscopical examination, and find that it is a biotite diorite. There is a small quantity of quartz, but it is quite subordinate to the feldspars, which are chiefly plagioclase, which has suffered but little decomposition. The ferro-magnesian constituents are biotite and brown hornblende, the former being the more abundant. There is also a little magnetite.

From this description it will be seen that these boulders differ materially from the syenite of the boulder-bank, in which the orthoclase is more abundant than the plagioclase, and the hornblende much more abundant that the biotite.† I do not know any rock in the district from which these boulders could have come, but probably it will be found near Motueka or Separation Point.

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* "Reports of Geological Explorations," 1873-74, p. 49.
† Proc. Royal Soc. of N.S. Wales, 1889, p. 124.

ART. XXXI.—*The Auckland Volcanoes.*

By HUGH SHREWSBURY, M.A.

[*Read before the Auckland Institute, 2nd November, 1891.*]

Plate XXXV.

THE isthmus which separates the Waitemata and Manukau Harbours, and upon which stands the City of Auckland, has an average breadth of six miles; but at its narrowest part, between the eastern shore of the Manukau and the Tamaki River, it is not more than a mile and a half in width; and, again, between the Whau River and the Manukau its breadth is only about two miles. Small as this tract of land is, however, it is thickly studded with extinct volcanoes, there being no less than sixty-three separate points of eruption within a radius of ten miles, in many places so close together as to merge into one another. The greater number of these volcanic cones are in a very perfect state of preservation. It is true that many of them have been deeply terraced by the Maoris for purposes of fortification; many also have been cut into to obtain supplies of road-metal; but from weathering and denudation these hills have suffered little, and are remarkably well preserved. They present the form of cones of low altitude, Rangitoto, the highest of them, being only about 920ft. in height, and the slope of their sides being about 30° or 40°. The majority of them are dome- or mound-shaped rather than conical. Classifying them according to their mode of formation, we may divide them into three classes: (1) tuff cones and craters, (2) scoria cones and craters, (3) lava cones.

1. *Tuff Cones and Craters.*—Instances of these are Lake Takapunä and the Orakei and Panmure basins. They are readily distinguished from the scoria-cones by their shape, being wider and flatter, with much larger craters. The material composing them is not, as in the case of the scoria-cones, entirely scoria and lava, but consists of a mixture of sand and grit of non-volcanic origin, derived from the Waitemata beds, with volcanic blocks, scoriæ, lapilli, and ash, in some cases the former, in others the latter, class of material predominating. Some of the tuff-craters have been partly filled up by scoria-cones thrown up by subsequent eruptions—for example, Mount Wellington and the North Head—and it is probable that many of the scoria-cones stand upon older tuff-craters, which, however, are hidden from view by the great quantities of lava and scoria ejected by the later eruption.

The tuff-cones were evidently formed prior to the scoria-cones, and, as stated by Hochstetter, appear to have been formed under water, for, where cut across by roads or opened up by gravel-pits, their materials are distinctly stratified. A very good instance of this bedded structure can be seen at Lake Takapuna, where a scoria-pit in the northern wall of the crater shows a thick bed of black scoria, succeeded by a bed of sand and scoriæ mixed. This sandy bed is stratified and banded, and has every appearance of having been laid down in water. When the volcanic action commenced, therefore, the isthmus, or parts of it, must have been under the sea. We will return later on to a discussion of the condition of the land at the time of the first eruptions.

What is the reason of the essential difference between the tuff-cones and the scoria-cones? Why is it that the former are so much wider and flatter, and contain so much more non-volcanic material, than the latter? The reason, I think, is twofold. In the first place, the earliest eruptions, by which the tuff-cones were produced, would naturally be more violent than those succeeding—clearing away obstructions, rending and reducing the superincumbent rocks to fragments, and opening up a way by which the subsequent eruption of volcanic material would be comparatively easy. Such violent paroxysmal outbursts, as stated by Judd, produce flat cones, of low elevation, with wide craters, such as these tuff-craters; while the steeper and smaller scoria-cones are the result of more moderate but long-continued volcanic action. In the second place—and in this probably lies the chief reason of the difference—the presence of water in abundance would largely increase the violence and suddenness of the first eruptions, for we know that the chief factor in volcanic explosions is steam, and we can readily imagine that the sea-water would not only enter the fissures formed at the commencement of volcanic action, but would also percolate through and fill the pores of the sandstones, &c., of the Waitemata beds. The conversion of this water into steam, when the tension became so great as to overcome the weight of the overlying rocks and water, would not only add to the sudden force and intensity of the eruption, but would also cause the comminution of the sandstones, and thus account for the large amount of non-volcanic material in these earliest-formed craters.

Some of the tuff-craters are situated in close proximity to the sea-shore, and in such cases we generally find that the side of the crater nearest the sea has given way, and the crater has become filled with mud and sediment carried in by the sea. This is seen at the Orakei and Panmure basins, which at low water are mere mud-flats and mangrove swamps, connected with the sea outside by narrow channels cut through the mud by the ebb and flow of the tide. There are two of these crater-basins near Northcote, which are remarkable from the fact that they contain, in the material of their walls, certain olivine nodules which are extremely interesting as affording a parallel to the nodules of that mineral found in some Tertiary basalts of Europe. They are small—the largest I have found measure only about 1½in. by 1in. They fracture with an uneven, crystalline-granular surface, and are sometimes so loosely coherent as to be easily crumbled down to a coarse powder; most, however, are harder and more compact, requiring a pair of pincers or a hammer and chisel to break them. The olivine is of a pale yellowish-green colour, and remarkably fresh. In some of the nodules a few of the grains are coloured a dark-grey, almost black, by vast numbers of grains and fine thread-like or needle-shaped inclusions of magnetite and dark-coloured glass. Most of these inclusions are so minute as to appear as short, fine, hair-like bodies when examined with a magnifying-power of 300 diameters, and are arranged in parallel lines or rows closely crowded together. More interesting, however, is the appearance of fluid inclusions in this olivine. Their presence points to the deep-seated origin of the nodules, and so exactly illustrates the words of Teall in his "British Petrography" that these words may be quoted here: "If we consider the distribution of fluid inclusions in the different classes of rocks, we are struck by the fact that they are especially characteristic of the plutonic rocks, such as gabbro, diorite, and granite, and the crystalline schists. They are rare or absent in rocks of the volcanic group. . . We do occasionally find glass and stone inclusions in the minerals of certain granites, and fluid inclusions in those of volcanic rocks, as, for instance, in the olivine and leucite of certain lava-streams; but it must be remembered that in these exceptional cases the minerals in question have probably been developed before the actual eruption of the lava." This is just what appears to have occurred here. The olivine nodules must have crystallized out or segregated from the magma some time before it was erupted—while it was still deep below the surface—and were afterwards ejected along with the scoriæ and ash formed by the comminution of the surrounding magma. That they are segregations from the basalt itself, and not inclusions of foreign matter, is, I think, almost certain; they do not contain penetrating veins of basalt, nor possess a thin easily-removed coating or shell of basalt, as exhibited by the foreign inclusions occurring in the scoria which will be presently described. Moreover, the olivine is exactly similar to that occurring so abundantly in smaller crystals in all the Auckland basalts. Their origin, therefore, is to be explained by the "segregation hypothesis" put forward by Roth, Rosenbusch, and others in explanation of the olivine nodules occurring in the Tertiary basalts of Europe already referred to, rather than by the "inclusion hypothesis" held by Bischof and Daubree with respect to the same.

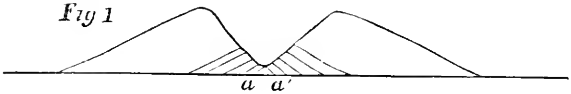
2. *Scoria Cones and Craters.*—Passing on to the second class of these volcanoes—the scoria-cones—we find they are more numerous than the visible tuff-cones. They are steeper than the tuff-cones, but only moderately steep, the angle of their sides varying from 30° to 40°. Now, in many of the hills which have been cut into for the supplies of rough metal for the roads, the back or sides of the cuttings have been sloped down in the course of removal of the material, so that the scoriæ are resting at their natural angle of repose. This angle is found to be about 36°. In other words, the slope of the hills as we see them is approximately the same as the slope of loose scoriæ which have assumed a position of rest. This proves that the hills have not been disturbed to any great extent by either elevation or subsidence since the materials composing them first settled down after eruption.

The walls of several of the cuttings show a rude semblance of bedding in their materials, which is rendered more apparent where layers of different degrees of coarseness alternate with one another. This stratification or bedded structure affords a further illustration of the words of Judd (*vide* "Volcanoes," chapter v.): indeed, these cones form a very perfect parallel in nature to the artificial cone described by him. The layers or beds of volcanic material slope at an angle which gradually increases from the bottom to the top of the hill. Of course, a single cutting is usually too small a section of the beds to show this clearly; but this we do find: that in cuttings near the bottom of any of the hills the beds dip at lower angles than in cuttings at a relatively higher position—for example, near the foot of Purchas Hill the dip of the beds is about 20°, whereas about half-way up Mount Wellington the dip is over 30°. The reason of this is that the volcanic cone is formed by repeated and successive additions of ashes and lava to its surface, the material ejected falling thicker and faster towards the centre of eruption. As the cone grows, therefore, the ashes and lava are laid down upon progressively-steeper slopes. This structure accords with the remarks of Professor Geikie and other geologists on the growth of volcanoes; but there is this discrepancy: In sections illustrating this formation (for example, Geikie's diagram section of a normal volcano*) the material is usually represented as in fig. 1 below—that is, in beds sloping at a *constant* angle. Such a structure as this would imply that the eruptive force

* "Textbook of Geology," 2nd ed., p. 225, fig. 47.

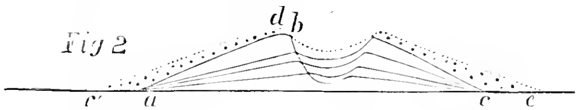
was extremely weak at first, scattering the material to such a short distance from the centre of eruption that a very minute cone (as *a a′*) was formed, and that the force gradually and

Fig 1



uniformly increased as the eruption progressed, reaching its maximum intensity as the eruption began to die out. Such a state of things is not suggested, and would be difficult to imagine as actually occurring. Indeed, if anything, the first eruption would probably be of greater intensity and violence than those succeeding it, clearing away obstructions and forming a vent by which subsequent ejection of material would be more easy, and attended by less violent explosions. Of course, after the slope of the sides reached about 35° the material would no longer remain in a state of repose where it was laid down, but would slide and roll downwards, so that the angle of slope would then become constant, or slightly decreasing. A section of a normal volcano would therefore present something of the form shown in fig. 2.

Fig 2



a, b, c. The cone when its sides have attained an angle of 35°, and before the materials have begun to roll to any extent. *c′, d, e.* The cone after this angle is passed. The lines show the cone at progressive stages in its growth, and represent the beds sloping at a constantly-increasing angle.

3. *Lava-cones.*—Rangitoto is an example of this class. Only its upper part consists of scoriæ and ash, the whole of the lower slopes being formed of lava-streams. It rises at a low angle (from 5° to 10°) to the foot of the peaks or scoria-cones forming its summit. These dip at the usual angle of 30° to 35°.

Having described the three classes into which these volcanoes may be divided, we may now pass on to consider the material of which they are composed. This is in every case a basalt very rich in olivine, and showing great similarity at all the points of eruption. The scoriæ are of all sizes, from dust and small cinder-like fragments to large masses weighing several tons. The smaller fragments are generally highly vesicular, so much so in some cases that, though a heavy basic rock, the enclosed air enables it to float on water. Bombs and curiously twisted and contorted fragments of lava are of frequent occurrence. Inclusions of olivine (nodules) do not occur in the scoria-cones, but inclusions of clay, sandstone, &c., and of silica are not infrequently met with. The former are fragments of the Waitemata beds which have been caught up by the lava in its expulsion as scoriæ, and altered by the heat to which they have been subjected. This alteration has been carried to very varying degrees: in some cases the fragments have been greatly hardened, have assumed various shades of grey, red, and black, and have acquired a porcelain-like appearance, whence they are known as porcellanites; in others very little change has been produced, and the inclusion consists of soft sandstone, just like the unaltered rock of the Waitemata beds. They are generally somewhat rounded, and the exterior is either partly or wholly covered with adhering scoria, sometimes in thick lumps, sometimes as a thin semi-vitreous coating which can usually be readily cracked off. As a rule the lava has not penetrated to any extent; some of the porcellanites, however, show minute veins of penetrating lava. A microscope section which I have prepared from the outer part of such a porcellanite shows in an interesting manner the gradation from ordinary basalt on the exterior to an almost perfect glass at the furthest limit of the vein. Occasionally these porcellanites display a very interesting columnar or prismatic structure, due to contraction on cooling. Since they are more or less spherical in form, and contraction-jointing took place at right-angles to the surface of cooling, the columns or prisms radiate from the centre. They can be more or less readily separated from one another, giving rise to a number of curved and tapering fragments.

The inclusions of silica are smaller and less common than those of the preceding class. They are fragments, generally somewhat rounded, but sometimes angular, of nearly pure quartz, in the form of a crystalline-granular aggregate, crumbling almost with a touch. Except when stained with ferric oxide, they are colourless or white. They generally, like the porcellanites, show a loosely-adhering coating of basalt; many also contain small beads and threads of glassy basalt, which has penetrated them from the lava as it surrounded them. It is difficult to account for the origin of these quartz-inclusions. It is improbable that they are derived from the slates and greywackes which underlie the Waitemata beds, for these do not, where exposed near Auckland, contain free quartz, except in minute quantities; and, moreover, no fragments of the slates themselves are found in conjunction with the quartz, as we should certainly expect to find if this was the origin of these fragments. The Waitemata beds themselves contain no free quartz or quartz-veins. Whence, then, is this quartz derived? To this question I am unable to give any satisfactory answer, but may perhaps venture to put forward two theories, at the same time acknowledging that, in the absence of actual proofs in their support, they afford but a possible explanation. One is that these inclusions are fragments of silicified wood which have been caught up by the lava in its ascent, fused, and ejected with the scoriæ. This idea suggested itself to me on finding a specimen in which the penetrating veins of vitreous or semi-vitreous lava had taken the form of thin parallel plates and threads bearing some resemblance to fibres, as if the lava had been intruded into cracks or fissures formed in the direction of the *grain* of the original wood. The other theory is that this silica represents fragments of diatom earth, deposits of which occur near Auckland—as, for instance, at Mount Albert. Whatever their origin, the occurrence of fragments of free quartz in so basic a rock as the Auckland basalt is very remarkable.

The lava appears to have flowed rapidly—to have been, in fact, fairly liquid, certainly not very viscid—for the streams present, for the most part, a rough, clinkery surface, strewn with loose blocks and fragments, and not, except in a few places, the smooth, "ropy" surface exhibited by slowly-moving lava. The surface of Rangitoto Island, for instance, is exceedingly rough and uneven, being broken up by deep clefts into blocks, some of them of enormous size, which are covered with jagged, cindery projections. Another proof of the liquidity of the lava, and therefore of the large amount of steam given off from its surface while cooling, is afforded by the presence on Rangitoto of small cones—miniature volcanoes—of lava, thrown up on the streams, just as was the case with the extremely liquid lava erupted by Vesuvius in 1872. The small thickness of the streams in proportion to their length and breadth, also, I think, points in the same direction. And, indeed, we can well understand this lava to have been thoroughly liquid, owing to its very basic composition.

As regards its physical character, the lava from all the points of eruption is very similar in general appearance, in structure, and in composition; and, though varieties of microscopic structure are to be found in it, yet no variety characterizes the lava from any particular hill; on the contrary, the different kinds of structure can be seen in different parts of one and the same lava-stream, and are, in fact, merely the results of different conditions and circumstances of cooling. The texture, of course, varies according to the depth at which the rock solidified, being vesicular and porphyritic near the surface of the streams, becoming more granular and microscopically holocrystalline the further it is from the surface of cooling.

The olivine occurs as small crystals in the groundmass of the rock, but far more abundantly as porphyritic crystals or aggregates; sometimes, as in the lava-streams of Lake Takapuna and in the blocks of basalt in the tuff at Northcote, reaching ½in. or more in diameter. These crystals are somewhat granular and irregular in shape, having no doubt been rounded since their formation by the solvent action of the magma before the lava actually flowed at the surface. We must here, however, distinguish between the macro-porphyritic and the micro-porphyritic olivine, for the latter often shows very perfect and regular crystalline form. Except at the surface, where it has been exposed to weathering, the olivine is perfectly fresh and unaltered, unless the rock is very porous; very often, indeed, the olivine crystals stand out almost unchanged by the corrosive influences of the atmosphere on the very surface of the lava-streams.

The augite is also porphyritic in the Lake Takapuna and Northcote basalt, but not, so far as I am aware, elsewhere; nor have I observed either of the other constituents occurring porphyritically.

In describing the microscopic structure of this basalt it will be convenient, I think, to divide it into three classes, according to the depth at which it solidified and the relative arrangement of its constituents. The classification being one of degree rather than of kind, there is no hard-and-fast line between the three classes—they shade imperceptibly into one another—but it will serve to define the three main varieties in the microscopic structure of the rock, from which the numerous intermediate forms and gradations are derived Since a description of a large number of sections would entail repetition, and become tedious, I will merely describe the three sections of which I have appended sketches, and which illustrate respectively the three classes into which this basalt is divided. These classes are,—

1. Basalt which has cooled comparatively rapidly at or near the surface.—The rocks of this class are more or less glassy, usually dark-coloured, and finely porous or scoriaceous to a varying degree. The abundance of magnetite, especially in the darker varieties, renders the micro-sections very opaque till they are brought down very thin, when it is seen to be matted together, as it were, with the feldspar microliths, minute augite grains, and glassy matter. Rock-section 70 (Pl. XXXV.) is typical of this class: the olivine is both macro- and microporphyritic, surrounded by a base composed of small feldspar microliths, minute augite grains (colourless and almost indistinguishable except with polarised light), a large quantity of magnetite as grains and fine dust, and glassy matter. It is very pale yellowish-green, almost colourless, and is exceedingly fresh-looking, being unaltered even at the margin and along the cracks. It contains numerous inclusions of magnetite and glassy base, showing that some of the magnetite began to

crystallize before the olivine. A few small grains of olivine also occur in the groundmass.

The augite is not abundant; it is mostly in the form of small irregular grains in the groundmass, but a few large crystals occur (2, rock-section 70, Pl. XXXV.). In this particular section these crystals are not well developed, but in some sections of the basalt belonging to this class an occasional very regular augite crystal occurs.

The feldspar is in the form of small crystals, giving the usual lath-shaped sections. They are all minute and approximately equal. There are no microporphyritic crystals of this mineral present.

A half-developed flow-structure is observable in this section. The greater number of the olivine crystals and the feldspars are arranged with their long axes pointing in one direction (the direction of flow), and the groundmass separates into two currents at the porphyritic crystals, flows past them, and unites beyond. This structure is of somewhat frequent occurrence in the basalt of this class; also, though to a less marked degree, in the basalt of class 2; but not in that of class 3, where the lava had ceased to flow at all rapidly before the rock began to solidify.

2. Basalt which has cooled less rapidly than that of class 1, but yet in most cases while the lava was still in motion.—This class includes all those varieties in which, as in the preceding class, there is a well-defined base between the larger crystals, but it is more crystalline and less glassy than in rocks included in that class. These basalts, being intermediate between, show greater variety than, the basalts of the other two classes, but rock-section 17 (Pl. XXXV.) is fairly representative of class 2. It illustrates the large amount of augite frequently occurring in the groundmass of rocks belonging to this division. A glance at the illustration will suffice to show the smaller proportion of magnetite and glassy groundmass in this as compared with the preceding section.

The olivine is similar to that just described. The augite in this section is of a pale yellowish-purple tint, slightly dichroic, and is mostly in the form of rounded grains or plates of irregular shape. Some of the feldspar laths reach a fair size, and in some of the rocks of this class (*e.g.*, sections of basalt from One-tree Hill and the Three Kings Hills) are very regular and perfect in outline.

3. Basalt which has cooled comparatively slowly—that is, which has crystallized near the centre or bottom of the stream.—The olivine occurs mainly micro-porphyritically, its crystals being relatively smaller than in the preceding classes. The ingredients are more equal in size, and there is but little glassy or semi-vitreous groundmass; the structure is, in fact,

almost holocrystalline, owing to the pressure under which the rock crystallized, and the comparatively long time it took to cool. The olivine in this case (rock-section 72, Pl. XXXV), is seen to be, for the most part, unaltered, but in places has yielded ferruginous products.

Besides the well-defined crystals (of which there are two in this figure), there are small irregular patches of this mineral (as at *a*) which with ordinary light can hardly be distinguished from the augite. The latter occurs in fair-sized plates and irregular crystals.

With regard to the feldspar, there is a marked difference in its mode of occurrence in typical sections of the two extreme classes. In the first, or semi-vitreous, it is wholly in the form of minute laths and bars mingled with the magnetite dust and glassy matter (as in rock-section 70, Pl. XXXV.); in the last the crystals are larger and broader, and there is, in addition, a development of *plates* of this mineral, intercrystallized with the other constituents more after the structure of the diorites and plutonic rocks generally. The magnetite also occurs not as fine dust, but as large crystals or plates.

Between the types of rock of which these sections are taken as illustrations a complete gradation can be traced, and the transition followed from a semi-vitreous rock on the one hand to the more holocrystalline state of the same or a similar rock on the other. In other words, all these basalts, though their appearance varies under the microscope, merely represent differently-cooled portions of one and the same molten mass. The constituents are everywhere the same, the olivine, magnetite, and glassy matter decreasing, and the feldspar increasing, as we recede from the surface of cooling; and no particularly-glassy or particularly-crystalline variety characterizes the lava from either of the hills.

In speaking of the constituents, I have throughout referred to the pyroxenic constituent under the general name of "augite;" and this appears to be the only form of pyroxene present. I have examined the optical characters of this mineral in a number of sections of the basalt under consideration, and have been unable to detect any rhombic pyroxene: in other words, the pyroxene apparently occurs only in the monoclinic form. It remains to decide to which of the monoclinic pyroxenes the mineral in question belongs. Unfortunately the crystals are nearly all very irregular and imperfectly developed, with no definite outlines or cleavages. They are, in fact, rather grains or granules. Where, however, individuals are sufficiently well developed they can be identified as augite, showing the short prismatic forms characteristic of that mineral. Long columnar forms, on the other hand, such as are almost invariably assumed by diopside and acmite, are rare or absent. Moreover, as already mentioned, the pyroxene in these rocks is frequently of a pale violet or wine colour, in which case it exhibits distinct dichroism, changing from pale yellowish-brown or yellow-violet to brownish-violet. This character is not, I think, met with in any of the pyroxenes except augite, none of the others showing any approach to a violet or purple colour. On the whole, therefore, the evidence, though not conclusive, seems to show that augite is the only kind of pyroxene present.

The feldspar of these basalts is in too minute a form to be isolated and its nature determined by Szabo's method. I have therefore employed the method of determination by measurement of the angle of extinction referred to the length of the microliths; and, where the feldspars are twinned, by measurement of the angle between the directions of extinction in two adjacent lamellæ. These angles in nearly every case are high—sometimes very high—the average observed in the case of the twin crystals* being 33°; and in the slides examined by me the crystals in which this angle was lower than 20° were in the proportion of only 2 in 45. Further, in many of the slides the angles given by laths from all parts of the section are very close, indicating a uniformity in the composition of the feldspar throughout. This mineral, therefore, must belong to the labradorite-anorthite group. In most cases it probably consists entirely of anorthite.

Before leaving the microscopic structure of this basalt we may notice a slight variation which occurs in the blocks containing the large porphyritic groups of olivine at Northcote. The groundmass is seen under the microscope to contain a large quantity of augite and a little olivine, in the form of almost circular grains distinctly separated from one another by the rest of the groundmass, and not, as is usually the case, intercrystallized irregularly with it. I have noticed above the similarity between the mode of occurrence of the olivine in this rock and in some of the lava at Lake Takapuna; and, on examination with the microscope, a further resem-

* The following are some of these angles:—

Rangitoto Scoria-cone.	Mount Hobson.	Mount Eden.	One-tree Hill.	Mount Smart.	Tamaki.	Three Kings.	Takapuna.
24°	32°	37°	43°	25°	25°	40°	37°
22°	41°	41°	25°	26°	32° 30′	35°	27° 30′
27°	33°	36° 30′	39°	28°	30°	30°	29°
26° 30′	22°	30°	40°	38°	23°	30°	16°
26°	21°	20° 30′	34°	40°	..	34°	42°
25°	38°	28°	29°	44°	..	23°	41° 30′
30°	37°	28° 30′	32°	25°	..	24°	38°

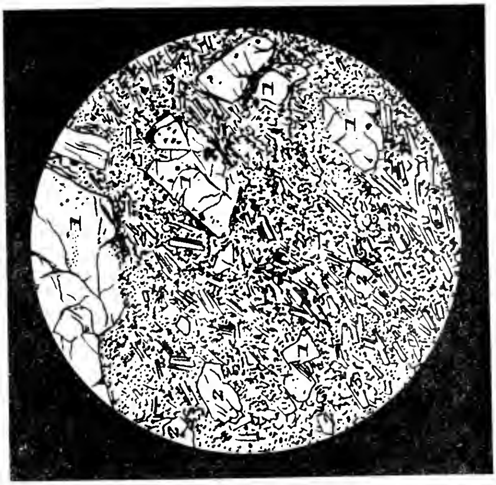
Section 17.

—Basalt_ Mt. Eden. Auckland.—

Section 72.

—Basalt_ Rangitoto. Auckland.—

Section 70.



—Basalt_ Mt. Eden. Auckland.—

Reference.

1. Olivine. 3. Felspar. 5. Ferric oxide.
2. Augite. 4. Magnetite.

H. S. del. C. H. P. lith.

blance is seen, the latter rock showing the same peculiarity in the arrangement of circular augite crystals in the base. The groundmass, indeed, in these two rocks is almost identical. It is very probable, therefore, that the Northcote tuff-craters and Lake Takapuna are closely connected, and drew their supplies of lava from the same point.

A more interesting peculiarity occurs in a small basalt-dyke which has been exposed in one of the scoria-pits at Mount Eden. This rock shows to the naked eye numerous small crystals which have the shape and general appearance of olivine, but are black. The microscope shows that they are in reality olivine crystals almost entirely filled with magnetite grains and dust. This magnetite is partly scattered irregularly through the crystals, partly arranged in parallel rows, and in lines crossing one another at right-angles. It may have been produced in either of two ways. It may be the result of weathering: the first stage of decomposition would then be marked by the production of ferric oxide, which on further weathering would be converted into magnetite. Examples of this are frequently met with in volcanic rocks, the olivine being altered round the margin and along the cracks, and even for some distance on either side of them, into red ferric oxide, which sometimes shows a fibrous arrangement similar to that assumed by the magnetite in the present instance. A further change takes place in the centre of the cracks and at places most exposed to decomposing influences, and the red ferric oxide becomes at these places converted into the black oxide or magnetite. A crystal of olivine under these circumstances shows the fresh unaltered mineral in its central parts, changing to red oxide of iron towards the edges and fissures, which in its turn changes to black oxide in the cracks themselves and round the margin of the crystal. It is more probable, however, that the magnetite in this case was formed at the time of the cooling and incipient crystallization of the lava, and is not the result of weathering, for the olivine in question does not contain any of the red oxide, but, on the contrary, the crystal substance between the grains of magnetite, as well as the spaces clear of them, are fresh and quite unaltered. It seems, therefore, that this magnetite is not a secondary product, but began to crystallize out before the olivine, and was subsequently caught up and included by that mineral in the course of growth of its crystals. This view is strengthened by the fact that, although the octahedra are so imperfectly developed that the magnetite is for the most part in the form of mere irregular grains, yet the lines in which the grains are arranged are in many cases those assumed by skeleton crystals of magnetite, such as are frequently met with in basaltic rocks.

These, however, are mere local variations in form or structure. The constituents which build up the lava, from whatever point erupted, are invariably the same—felspar, pyroxene, olivine, and magnetite; and, moreover, it appears that the felspar may in every case be referred to the labradorite-anorthite group, while the pyroxene probably occurs throughout in the form of augite only. No other mineral enters into the composition of these basalts at any point: on the contrary, the accessory ingredients found in some basalts are not met with in this rock. The internal structure of the lava is similar at all points at which it has cooled and consolidated under similar conditions, and what differences there are lie not in the constituents themselves, but in their form and mode of development. Moreover, with regard to such differences, we have seen that no variety characterizes the lava from any focus of eruption, but that the differences in texture, relative arrangement, and proportions of the component crystals, are observable in different parts of the lava from one and the same volcano, and pass by insensible gradations into one another. We have seen also that the basalt which occurs in the form of scoriæ and fragmentary material is the same rock as that which flowed as streams of lava; in short, that in composition, colour, and general outward appearance, as well as in microscopic structure, the materials ejected from all the points of eruption so closely resemble one another that the lava in all cases may be considered identical in origin. We have seen that the lava is basic—so much so, in some cases, that the olivine has separated out, or crystallized, to an unusual extent before the actual eruption of the lava, and in at least one instance was ejected in the form of nodules. The conclusions to be drawn from these facts are that the eruptions are not distinct, but closely connected with one another, and belong to one period—that, in fact, they originated from a common point or focus of activity; and, further, that this focus was not situated near the surface, but at some depth—possibly beneath the oldest rocks in the neighbourhood. All the volcanoes were probably connected with one and the same reservoir of molten rock, which, instead of escaping at a single point with one great explosion, was expelled through a great number of minor vents.

All the points of eruption may be included in an elliptical area, the long axis of which has a general north-east and south-west direction. Moreover, a line joining the principal volcanoes—Rangitoto, Mount Eden, One-tree Hill, Mount Elliot (Mangare), and the three volcanoes situated in a line with one another, and known as Moerangi and Maungataketake—also trends to the north-east. This line, if produced in a north-easterly direction, joins the "line of volcanic activity" which passes through the New Hebrides and New Guinea, and then forks, one branch being continued northwards through the Philippine, Japan, and Kurile Islands to Kamtchatka, the other westward, through Java and Sumatra. New Zealand therefore represents a continuation in a south-westerly direction of this volcanic belt, and the elevation of the North Island was probably due to volcanic activity. It is now well known that in the majority of cases volcanic eruptions commence with the formation of a fissure or fissures in the earth's crust. It is probable, therefore, that previous to the outburst of volcanic activity* in what is now the isthmus of Auckland disturbances took place in the direction of the line above stated, and a deep fissure was formed running in that direction, from which numerous minor fissures branched off at right-angles.

As regards the conditions attending the earliest eruptions and the surface-features at the time, we have seen above that most of the tuff-craters were formed under the sea. On this point Hochstetter says, "The first outbursts, as a closer examination shows, were probably submarine; they took place at the bottom of a shallow muddy bay, little exposed to waves and wind." He fails to notice, however, that, though the earliest eruptions were submarine, dry land had previously existed—that, in fact, the land was submerged only just previously to the commencement of volcanic activity. That this is so is shown by the presence at the Panmure basin of a bed of vegetable matter (in composition intermediate between peat and lignite) immediately underlying the volcanic tuff. Logs, stumps, flax, &c., have also been found under the tuff at other points on the isthmus. The bed at Panmure is several feet in thickness, and contains stems and branches of trees, some of them of considerable size. This points to a luxuriant vegetation covering the ground at the time the first eruptions took place, and proves that dry land must have been in existence for a long period before the submergence took place and volcanic action began. The sequence of events therefore seems to have been this: After their original upheaval the Waitemata beds suffered the usual weathering and denudation, and became covered—at least in places—with vegetation; subsequently, just previous to and probably as a result of the same earth-movements as produced the eruptions, a depression took place, until parts of the isthmus were submerged beneath the sea. A fissure was then formed, and volcanoes burst out under the sea in various places, forming the tuff-craters. Then, as stated by

* This period of volcanic activity must not be confused with the antecedent period of activity during which the Manukau and Cape Colville breccias were formed, and the distribution and contour of the land were very different from the features now existing.

Hochstetter, "With the beginning of volcanic action, by which the tuff-cones were formed, a slow and gradual upheaving of the whole isthmus seems to have taken place, so that the latter eruptions"—by which the scoria-cones were formed—"were supramarine."

There remains one question of interest which I should like to notice—the question of the age of these volcanoes. On this point we may be certain that, although the last of them was probably extinct before the advent of the Maori, still they are of comparatively modern date. They distinctly overlie all other formations in the neighbourhood, being the latest or surface-deposits, and containing, mingled with their materials, fragments of the Waitemata beds upon which they rest. The fresh and recent appearance of the scoria and lava, the unaltered angle of slope of the sides of the hills, the fact that the lava-streams have everywhere followed valleys and depressions in the surface of the land which exist at the present day, all show that these volcanoes are of geologically recent date, and that since the cessation of volcanic activity the general contour and surface-features of the land have remained unaltered. We conclude, therefore, that this activity dates from Pleistocene, if not later or recent times.

Art. XXXII.—*On the Prospects of finding Workable Coal on the Shores of the Waitemata.*

By James Park, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 22nd June, 1891.*]

The recent reported discovery of a thin, irregular seam of coal in the cliffs near Northcote has again directed attention to the probable existence of workable coal in the vicinity of the City of Auckland. The great economic importance of this question has long engaged the attention of the Director of the New Zealand Geological Survey; and during the past ten years a number of surveys have been undertaken by the officers of his department with the view of collecting sufficient data to definitely determine the relation existing between the Waitemata beds and the New Zealand coal-bearing series.

In the years 1879, 1880, and 1881 Mr. Cox, late New Zealand Assistant Geologist, examined the country extending northwards from the Auckland isthmus to Whangarei on the east coast and the Upper Kaipara on the west. He arrived at the conclusion that the Waitematas, as typically developed at Orakei Bay and Fort Britomart, were unconformable to, and had no connection with, the brown-coal measures of Drury and the Lower Waikato basin. In 1885 and 1886 I re-examined the same country, and also made a close and detailed survey of the shores of the Hauraki Gulf from Auckland to the Maraetai Range. The result of my observations tended to show that no unconformity existed from the top of the Waitematas to the base of the Papakura series; and subsequent surveys by Mr. McKay, F.G.S., the present Assistant Geologist, have shown that the Papakura beds rest quite conformably on the brown-coal measures of the Waikato and Drury areas. The fact has therefore been established, by actual survey and observation, that the Waitemata beds are conformable to and belong to the New Zealand coal-series—an opinion which has always been maintained by Sir James Hector.

It may be as well, before pursuing this subject further, to shortly inquire into the physical conditions considered necessary for the formation of coal. By the geologists of the early part of this century it was believed that workable true coal could only be found among a certain class of shales and sandstones of the Palæozoic or Primary period, to which the age-name Carboniferous had been affixed; and it may be as well to note here that this conclusion was fully sustained by their experience of the coal-measures of Great Britain, continental Europe, and North America, all of which were found to belong to this period. But the many brilliant discoveries of the past forty years have led to a remarkable evolution of thought and theory in every branch of knowledge, and in none is this seen more conspicuously than in the science of geology. True coals of superior quality have been found in the Jurassic and Triassic rocks of India and New South Wales, and in New Zealand in rocks that belong to the base of the Tertiary period, but which possess in some places a Secondary *facies*, and hence have been called Cretaceo-tertiary in age.

Thus it is seen that there is interposed between the Carboniferous coals of Britain and the Cretaceo-tertiary coals of New Zealand the whole of the Secondary and a part of the Primary periods, representing an immensity of time of such infinite duration as to defy the comprehension of our finite minds. This wide lapse of time renders it easy to explain the great geological differences that exist between our own and the Old-World coals. Perhaps the most marked distinction lies in the character of the vegetation of which each is composed, for, while the European coals are mainly composed of the remains of a flora belonging to the cryptogamic kingdom, truly characteristic of the Palæozoic period, the New Zealand coals are composed of the remains of a varied forest vegetation which everywhere marks the advent of the Tertiary period and the luxuriant flora of the present time. In the forests of our coal period there flourished two species of the kauri, which at that time grew all over New Zealand; three species of the beech, so commonly and erroneously known throughout the colony by the settlers' name of "birch;" also the oak, laurel, myrtle, heaths, palms, ferns, grasses, &c.

It is now recognised by geologists that coal could form at any period of the earth's history if the necessary conditions existed, and it is probable that these conditions have continued the same through all geological time. They were—(1) a humid, temperate climate, favouring the growth of a dense vegetation; (2) flat or gently-sloping low-lying areas, favourable for the accumulation of thick deposits of vegetable humus and peaty matter; and (3) a stationary, or nearly stationary, state of the land, to permit a long-continued and uninterrupted growth of vegetation.

In New Zealand our coal-areas are mostly littoral, of small extent, and patchy, characteristics resulting principally from the insular and mountainous nature of the country in older Tertiary times. Where the sides of the valleys were steep and the hills met the sea it was impossible for the remains of vegetation to accumulate to any extent; and this explains the somewhat anomalous fact that the coal-measures do not always contain coal. The steepness of the land during the coal period is also accountable for the noticeable fact that our coals often thin out towards the dip, and, when lying near the old rocky floor, are usually found to conform with the contours of its surface.

But whether the forests which formed the coal grew in soils lying directly on the old basement rock, as we find is the case with those of the Auckland Provincial District, or on the upper surface of areas reclaimed from the sea, as is the case of the forests which formed the Shag Point and West Coast coals of the South Island, it happened that after a long period of rest, permitting the accumulation of thick deposits of vegetation, the land began to sink slowly, and in course of time the vegetation became covered by fluviatile clays and sands, generally containing fragments of leaves and other plant-remains derived from the vegetation which continued to flourish on the higher portion of the dry land which had not become submerged.

As the land continued to sink the fluviatile or estuarine beds became covered by blue clays and greenish-coloured sands, containing the imbedded remains of the numerous Mollusca, crustaceans, corals, whales, sharks, and other life which teemed in the seas of those times. In a few instances in the north of Auckland coalfields true marine beds containing a varied molluscous life appear close to the roof or upper surface of the coal. It is difficult to look back into these old Eocene times and judge the conditions which prevailed in every isolated nook during the formation of the coal; but examining the geological records—the fossil life preserved in the rocks—we arrive at the conclusion that in these exceptional cases the matter which afterwards formed the coal accumulated in narrow, sheltered valleys adjacent to the sea, in places where after its gradual submersion it was not subject to the action of streams or rivers laden with sand or mud or other detritus.

Again, pursuing the order of events which followed the deposition of the coal, we find that the blue clays and greensands were followed by shelly and coralline sands which now form the well-known Whangarei, Waipa, Raglan, Mokau, and Oamaru limestones. These are simply local names for the same limestone which is perhaps one of the most marked, constant, and characteristic geological horizons in New Zealand, and seems to form the natural close of the coal-formation. Now, this limestone is followed throughout New Zealand, quite conformably, by a great series or succession of sands and clays, which, in the classification of the New Zealand Geological Survey, possesses the generic name "Grey Marls," or "Waitemata series." These sands and clays are typically developed on the shores of the Waitemata, which has given its name to the rocks of this period throughout New Zealand. The Waitematas, as seen at Fort Britomart or the Calliope Dock, consist of rapidly-alternating layers of clays and soft sandstones. The presence in these of numerous plant-remains, and sometimes thin irregular streaks of coaly matter, together with the almost entire absence of true marine beds, clearly point to the prevalence of fluviatile conditions during their deposition.

The sequence of events which we have traced in order to show the relation of the coal-measures and the Waitemata beds may be more graphically shown as follows:—

Cretaceo-tertiary formation.

1. Waitemata sands and clays.
2. Whangarei or Oamaru limestone.
3. Marly clays and greensands of marine origin.
4. Fireclays and coal with grits and conglomerates.
5. Basement rock.

The Waitemata beds occur at the top of the Cretaceo-tertiary formation, while the coal occurs at the base, the two being separated by two great geological horizons. This in itself might be taken as strong evidence that no coal of a workable nature would be found in the Waitematas; but we have seen that coal could form at any geological period if the necessary conditions existed. We, however, receive little encouragement from this source, as the rapidly-altering character of the Waitemata deposits would tend to show that dynamic forces were at work during this period, causing frequent oscillations of the land, thus preventing the accumulation of sufficient vegetable matter at any period to form workable coal-seams.

Workable seams of coal exist on the flanks of the Hunua Range, and dip in the direction of the Waitemata, but it is doubtful if they reach as far as Auckland, and, if they do, they would certainly be found at a great depth—probably not much under 800ft. or 1,000ft., judging from the thickness of strata which is known to exist between the Waitematas and the coal at other places.

Auckland stands in the centre of a great synclinal or trough, and the depth to be penetrated there would be greater than at any other point. Towards Howick on the one side and Riverhead on the other the depth of strata to be passed through gradually decreases until, on the flanks of the Hunua and Maraetai Ranges, the coal crops out on the surface. In the case of the upper reaches of the Waitemata, wherever the old floor or basement rock is found at or near the surface, and whether it is composed of hydraulic limestone or slaty shales, a careful search should be made for indications of coal, for it was on such old floors that the coal vegetation grew and flourished in the older Tertiary times.

If, therefore, there is a probability of coal on the shores of the Waitemata, it will be found in the upper reaches, in the direction of Riverhead, where the edges of the lower members of Cretaceo-tertiary formation are upturned against the basement rock.

Art. XXXIII.—*On the Occurrence of Native Zinc at Hape Creek, Thames.*

By James Park, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 24th August, 1891.*]

Last month Mr. George Manton, a settler on the right bank of Hape Creek, discovered in his garden a heavy metallic substance, which he handed to me for identification. This substance proved on examination to be metallic zinc, of great purity, and coarsely crystalline structure.

In reply to my inquiries Mr. Manton informed me that when removing a quantity of gravel and boulders which he had excavated from the well in his garden he was attracted by the unusual weight of a soft flat-shaped stone about 6in. long and 2in. wide. The stone on being broken exhibited a thin slab of a dull heavy metallic substance, with an irregular surface, and tapering at the edges. It was easily detached from its matrix.

This thin slab of zinc weighed about 4oz. On freshly-broken surfaces it showed a brilliant metallic lustre, and a white, slightly greyish, colour and streak. It was coarsely crystalline in structure, with a perfect cleavage, apparently parallel to the chief rhombohedron R. Chemically it seemed to be pure zinc. In external appearance, but not in colour, it resembles the thin flakes of native copper found in serpentine rocks of the Dun Mountain mineral belt, Nelson.

The formation in which the metallic zinc was found is composed of stratified clays, sands, and gravels, intermingled irregularly with large boulders of solid andesite and quartz. It is of Pleistocene age, and extends from Waiokaraka Gully, across Irishtown and Block 27, to Hape Creek. The material composing it has been derived from the adjacent country, and there is abundant evidence to prove that it was formed by the Hape and Karaka Streams during a period immediately preceding the last general upheaval of this area.

The point where the metallic zinc was found lies in a direct line with the old course of Hape Creek, which drains the southern slopes of Una Hill, which is itself composed of rudely-stratified tuffs and breccias of pyroclastic origin, with intercalated sheets or flows of hornblende-andesite. The gold-bearng quartz veins intersecting these tuffs and breccias are often highly impregnated with blende as well as pyrites and antimonite.

Metallic zinc is a substance so readily acted on by dilute acids, or even acidulous waters, that it is hardly known in a native state. Dana, in his "System of Mineralogy," mentions only two instances of the supposed occurrence of native zinc. One is reported by Professor Ulrich, who describes the zinc as having been found in a geode in basalt, near Melbourne, the piece weighing 4½oz.; the other is reported in the gold sands of the Mittamitta River, north of Melbourne, associated with topaz, corundum, &c.

In the present instance the zinc was found in an ancient drift, and its great purity and crystalline structure strongly point to its native origin. It has been deposited in the Auckland Museum.

Art. XXXIV.—*On the Occurrence of Native Silver at the Thames Goldfield.*

By James Park, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 2nd November, 1891.*]

The great extension of mining operations in the up-country goldfields of the Hauraki Peninsula during the last few years has led to the discovery of many mineral substances which were not previously known to exist in New Zealand. This is particularly the case with respect to silver and its combinations, of which many rare and valuable forms have been found.

To these must now be added native silver, which has recently been found by Mr. George Peel in the Nordenfeldt Mine, situated on the watershed between Shellback Creek and Tinkers' Gully, which falls into Tararu Creek.

The silver occurs in an ordinary greyish-blue crystalline quartz, in a 12in. vein known as the South British leader, which drops into the hanging-wall of Dixon's Reef. It is found in very narrow irregular shoots running parallel with the walls of the leader, in the form of thin shining scales, resembling fine scales of mica, dispersed in a soft black powdery substance which looks like precipitated silver, and assumes a bright metallic lustre when rubbed or pressed with the blade of a knife.

Last year I drew attention to the occurrence of petzite in the Nordenfeldt Mine; and since that date pyrargyrite, the antimonial sulphide of silver, has been found there in considerable quantities, closely associated with the native silver, the form of which would tend to show that it was a product of the decomposition of one of these ores. A ton of quartz from this leader was treated at the School of Mines experimental plant, but the silver was found not to exist in payable quantities.

In the jurors' reports of the New Zealand Exhibition held at Dunedin in 1865, page 403, Sir James Hector states that silver in a native state was exhibited in small rolled fragments from Wakatipu Lake Diggings. This is the only reference I can find to the occurrence of native silver in New Zealand. The present discovery of native silver in the Nordenfeldt Mine is of great interest as being the first authenticated discovery of silver in a native state *in sitû* in New Zealand.

The specimen of quartz containing native silver has been deposited in the Auckland Museum.

III.—BOTANY.

Art. XXXV.—*A Description of some Newly-discovered Indigenous Plants, being a Further Contribution towards the making known the Botany of New Zealand.*

By W. Colenso, F.R.S., F.L.S., &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1891.*]

Class I. DICOTYLEDONS.

Order XXVIII. Myrtaceæ.

Genus 2.* Metrosideros, Br.

1. *M. tenuifolium*, sp. nov.

Plant diffusely creeping, very slender in all its parts, much branched, wholly glabrous; branches very long, flexuous, filiform, tetragonal, their angles slightly winged; bark bright-red, shining; rooting scattered, rootlets long wiry. Leaves distant, opposite, roundish and broadly elliptic, membranous, sub ¼in. long, margins entire, flat, patent, pale-green above, greenish-white below, penninerved without an intramarginal line, glandular red-dotted on both surfaces; petioles very short. Flowers and fruit not seen.

Hab. Steep cliffy sides of streamlets and dry gullies, forests south of Dannevirke, County of Waipawa; 1889–91: *W. C.*

Obs. I. This plant grows very thickly in its peculiar habitats; adhering closely yet loosely to the dry soil, or rocks, which it overruns as well as itself, so that frequently no other plant is found growing among it; and when a specimen is sought to be gathered a large portion of the plant generally comes away with it. It looks strikingly pretty, from its numerous small and regular leaves and their clean and healthy appearance. I have frequently met with it during the last three years in those localities, and at various

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* The numbers attached to the orders and genera in this and the following paper (Three New Ferns) are those of them in the "Handbook of the New Zealand Flora."

seasons too; but never found it bearing either flower or fruit, in spite of all my researches.

II. This species is allied (though not very closely, judging from its leaves and branches) to *M. scandens*, Banks and Sol.; but that species has larger thick recurved sessile dark-green leaves, pubescent when young, glandular only on their lower surface, and tomentose branches.

Order XXXVIII. Rubiaceæ.

Genus 1. **Coprosma**, Forst.

1. *C. alba*, sp. nov.

A much-branched thick bushy glabrous shrub, 10ft.–12ft. high; bark pale-brown, dull, roughish; branches largely spreading subhorizontal; branchlets numerous, close, opposite, flattish. Leaves small rather distant, sometimes two together, narrow linear-oblong very obtuse, sub ½in. long and 1 line wide, slightly curved, dark-green, margins coloured purple-red, much but obscurely net-veined; petioles short; stipules small, acute, glabrous, black-tipped. Flowers: *male*, axillary (often opposite on branches), and terminal on tips of short lateral branchlets, fascicled in threes; peduncle short, stout, curved, with a broad hemispherical scale at base of flowers. Calyx small, lobes deltoid-acute, dark-coloured. Corolla glabrous, whitish, purple-striped and purple-dotted on both surfaces, membranous, subpellucid, 4–5–6-lobed, cleft two-thirds down, much expanding, revolute; lobes subovate, tips suddenly contracted apiculate, minutely pulverulent within. Stamens 4–5, largely exserted, reddish; anthers large, oblong, obtuse, nodding, at first yellow afterwards of a greenish hue, their valve-margins delicately serrulate, the connective large thick minutely pitted with the tip slightly crested: *female*, solitary, scattered, at tips of very short lateral branchlets, mostly between two leaves. Calyx very small, 4-lobed; lobes acute, appressed, irregular 2 linear and 2 subovate. Corolla small, tubular, broadest at top; lobes 3–4, cleft half-way down, obtuse, conniving. Styles 2 (sometimes 3), 3 lines long, obtuse, pubescent, pinkish, diverging. Fruit globose, 2 lines long, crowned with persistent calyx-limb, white with minute purple dots, shining. Seeds 2, large, white, 2 lines long, broadly elliptic, slightly convex flattish, finely and closely laterally corrugated on the flat side.

Hab. On the eastern banks of the River Manawatu, near the new bridge, road from Dannevirke to Wainui, County of Waipawa, forming thickets; 1891: *W. C.*

Obs. This is a very distinct species: the male plant has a neat and even elegant appearance when in flower from their profusion; and so also the female when in ripe white fruit, from their striking contrast to the dark-green of its foliage. It flowers in September, and bears ripe fruit in April and May.

2. *C. turbinata*, sp. nov.

A much-branched erect shrub, 8ft. – 9ft. high; bark smooth, shining, red-brown; branches suberect and spreading; branchlets opposite, numerous, slender, divergent at right-angles, their tips puberulent when young. Leaves small, 2–3 lines long, numerous yet rather distant in pairs, spreading, obovate, very obtuse, subcoriaceous; veins reticulate, obscure; stipules small, blunt, glabrous. Flowers: *male*, plentiful, 1–2–3 together, each single, subfascicled. Calyx (and corolla) glabrous, shining, small, 4-parted; lobes irregular, 2 long and 2 short, subdeltoid, obtuse. Corolla 4-cleft; lobes subovate, acute, recurved. Anthers large for flower, 4, exserted, nodding, linear-oblong, subapiculate, base sagittate: *female*, not seen. Fruit small, lateral, solitary, often opposite on branch, turbinate, 1–1½ lines long, yellow when ripe; peduncle short, stoutish. Seeds rather large for fruit, round, white, flattish, 1 line diameter.

Hab. Sides of streamlets, edges of woods, south of Dannevirke, County of Waipawa; 1890–91: *W. C.*

Obs. This shrub has a general resemblance to the preceding species, *C. alba* (although it is a much smaller plant, with smaller and differently-shaped leaves), also to *C. aurantiaca*, Col. (Trans. N.Z. Inst., vol. xxii., p. 464), but differs in several characters from both, especially in its fruit. Female plants, that were loaded with fruit last autumn, had not a single flower on them this spring, although the male plants close by were flowering in rich profusion. I went thither (a long tramp!) purposely to obtain flowering specimens of both sexes, and was much disappointed in not detecting those of the female plant.

Order XLII. Ericeæ.

Genus 1. **Gaultheria**, Linn.

1. *G. multibracteolata*, sp. nov.

Plant (apparently) a stoutish shrub, my specimens of forked branches being 5in.–6in. long; bark pale, glabrous, shining. Leaves opposite, petiolate, ovate, 1in.–1½in. long, slightly cordate (those on lower stem broader and more cordate), pale-green, coriaceous, glabrous, tip subacute, thickened, margins crenate-serrate with sharp black teeth, veins much reticulate; petioles short, stoutish; young leaves membranaceous and bright-red, with a few long coarse flexuous reddish hairs scattered on veins below. Flowers in small few-branched compact terminal panicles 1½in. long; branches short, few-flowered, with many bracteoles between the flowers; the bracts at bases of branches of panicle large, broadly deltoid, pale, conspicuous, with coarse and close erect black bristle-teeth at margins; pedicels stout, curved, sub 2 lines long, with several (3 or more) small bracteoles within the large and pale bract at their bases. Calyx (sometimes 6-lobed), lobes deltoid, glabrous, subacute. Corolla pale-red, 2 lines long, lobes blunt, tips recurved, each lobe with 1 strong middle vein and 3 parallel veinlets on each side roundly united below base of anther and branched above. Stamens sub-lanceolate, slender, broadest near base, thickly muricated; anthers short gibbous, with each forked awn springing from a single narrow stem arising from tip of anther. Style slightly capitate, penicillate. Capsules small, dry, on long spreading pedicels.

Hab. Interior hilly country near Taupo; 1889: *Mr. H. Hill.*

Obs. This species has close affinity with *G. oppositifolia*, Hook., but its differential characters appear to me to be strong. Its leaves are much smaller, and of a different shape, more sharply serrate with hard black prickly points, hairy below, petiolate, and *not* stem-clasping—which is so prominent a feature in that species; its panicle of flowers is also smaller and much more compact, with different bracts bearing bristly margins, and a larger number of bracteoles; its flowers, too, are larger and coloured reddish; and its anthers have very differently-shaped awns.

Order L. Boragineæ.

Genus 1. **Myosotis**, Linn.

1. *M. subvernicosa*, sp. nov.

Plant perennial, ascending, 6in.–18in. high, strigosely hairy; hairs white, closely adpressed, very thick on upper part of raceme; lower stem woody, subprostrate, much branched above; branches compound, slender, flexuous, erect, each usually bearing long terminal virgate racemes. Stem-leaves thin, sub-linear-ovate, very obtuse, $1\frac{1}{2}$in. long, 3–5 lines wide, sessile, amplexicaul, midrib thick at base, margins coloured and ciliolate; hairs on upper surface stout, subulate, acute, the leaf at their bases of a different colour submuricated and shining as if varnished. Racemes axillary, slender, 4in.–8in. long. Flowers 12–24, distant 4–6 lines apart, alternate; pedicels sub-secund, 3 lines long, patent. Calyx large, 5-lobed; lobes cut nearly to middle, ovate, subacute, 1-nerved, 2 lines long in fruit, much expanding; hairy within; with shining dots at bases of hairs on outside as in leaves; the base of calyx dark-coloured. Corolla small, $\frac{1}{12}$in. diameter, pale-blue on the upper surface with a yellow eye, and pink on the outside; lobes spreading, elliptic-orbicular, tips retuse; tube nearly as long as limb; anthers included small; processes at mouth of tube very small and crenulate. Seeds 4, large, cordate-orbicular, flattish, shining, pale-brown (dark mature), margins thin produced dark-brown.

Hab. Sides of streamlets, low grassy plains, south of Dannevirke, County of Waipawa; 1891: *W. C.*

Obs. A species having affinity with some of our British species, but differing from them in several characters. It was late in the season when I detected this plant, and so failed to obtain radical leaves.

Order LIII. SCROPHULARINEÆ.

Genus 7. **Veronica,** Linn.

1. *V. macrocalyx*, sp. nov.

Plant herbaceous, densely gregarious, perennial (or biennial), glabrous, small, 3in.–4in. high, usually simple, erect, sometimes branched and ascending, and when so the slender decumbent branches are rooting below; stem and peduncles puberulent. Leaves scattered, lowermost broadly elliptic (or broadly oblong-ovate), $3\frac{1}{2}$–$4\frac{1}{2}$ lines long, 3-nerved, margins slightly and sparsely crenate-notched, petioles short, slender; upper stem-leaves smaller and narrower, margins entire, subsessile. Flowers at top, axillary, single, alternate, rather distant; peduncle 2 lines long, erect. Calyx large, leaf-like, 4-cleft nearly to base, much larger than corolla, spreading; lobes oblong, obtuse, 1-nerved, margins entire. Corolla patent, 2 lines diameter, oblate-orbicular, white (bluish before expanding), the 3 larger lobes sub-orbicular-ovate with blue-purple longitudinal lines (the upper lobe having 6–8 and the lateral lobes 2 lines on each), the lower lobes much smaller oblong-spathulate, white; tube very short, the faux yellowish, hairy, hairs patent. Anthers large, cordate, exserted, blue; stamens stout, white; stigma capitate, penicillate. Capsule pale-fawn, large, compressed, obcordate-orbicular, 2 lines wide, deeply notched, glabrous, margins subacute glandular-hairy. Seeds numerous, broadly elliptic, compressed, pale.

Hab. Open grounds, in grassy spots, forming large patches, banks of River Manawatu, near Te Hautotara (Maori) village, four miles south of Dannevirke, County of Waipawa; late autumn, 1891: *W. C.*

2. *V. rugulosella*, sp. nov.

Plant small, herbaceous, annual, simple, erect, 6in.–8in. high, slender, sometimes rooting at lower leaf-nodes, stem and peduncles pubescent; hairs numerous, short, close, sub-strigosely appressed. Leaves few, glabrous, distant, lower 4–5 pairs opposite, connate, 1in. apart; broadly elliptic, ½in. long, tip rounded, 5-nerved, veinlets largely anastomosing, margins slightly crenate-toothed, petiolate, petioles short sub 1 line long; upper leaves alternate oblong, tips rounded, decreasing gradually in size to apex of stem. Flowers 12–30, axillary, one in each axil of upper leaves; peduncle erect, 2 lines long. Calyx-lobes cut nearly to base, elliptic, 3-nerved, erect, a little longer than capsule, glabrous (but when young sparsely and finely ciliolate), subrugulose. Corolla pale, small, 2½ lines wide, lobes rounded, the uppermost 7-nerved nerves forked at top; lateral lobes 5-nerved, nerves simple. Stamens linear-lanceolate, widest near top, slightly exserted; anthers orbicular-cordate. Style length of capsule, erect; stigma capitate, penicillate. Capsule reniform, 2 lines broad, glabrous, shining, pale-brown, rather deeply notched, a few short erect glandular hairs ciliolate at margin; each cell subinflated. Seeds numerous, very minute, 38 in one cell, broadly-oblong, shortly stipitate, white.

Hab. Among grasses and other low herbage, open lands south of Dannevirke, County of Waipawa; 1889: *W. C.*

3. *V. areolata*, sp. nov.

Plant herbaceous, prostrate, weak, annual (?), simple, slender, 12in.–15in. long, sometimes branched from base. Leaves few, thin, hairy, hairs rather long and weak, shrivelled, white and jointed, petiolate, patent, distant, the lower ones 2in. the upper 1in. apart, alternate (the lowest pair opposite), sub-orbicular and broadly oblong, 5–7 lines long, tip obtuse, base truncate, 5-nerved (the upper ones only 3-nerved), much veined; veinlets anastomosing; margins cut crenate-serrate, largely ciliate, ciliæ stout, acute. Flowers axillary throughout from near base, single, peduncles erect, spreading, filiform, 1in.–1½in. long. Calyx large, spreading, ½in. diameter, lobes 3 lines long, ovate-acuminate, 3-nerved, ciliate, cleft to base; veinlets anastomosing. Corolla membranous, 2 lines diameter, pale-bluish, lobes broadly rounded, much veined, margins entire. Anthers included, large suborbicular, peltate, blue, margined; stamens stout, broadly lanceolate; style rather long; stigma capitate, penicillate. Capsule large, reniform, 3 lines broad with a deep notch, hairy, margins ciliate, much veined; veins prominent, anastomosing. Seeds obovate, sub-cup-shaped, stipitate, regularly laterally ribbed on one side; pale, 6–8 in a cell.

Hab. Open land, edges of forest, south of Dannevirke, County of Waipawa; 1890: *W. C.* Only a few plants noticed.

4. *V. hirsuta*, sp. nov.

Plant annual, small, herbaceous, weak, pale-green, very hairy; rootlets numerous, exceedingly slender, long, hair-like; stem simple, erect, 2in.–3in. (rarely 4in.–5in.) high, sometimes branched from near base; branches ascending, slender, reddish-brown; hairs white, jointed, irregularly long and patent on stems, their bases broad and shining on leaves. Leaves petiolate, few, very thin, broadly ovate, 3–4 lines long, margins cut-serrate, tip subacute, base subtruncate, 5-nerved; petioles short. Flowers 10–12, axillary in upper part of stem and branches, pretty close together; peduncles short about 1 line long, erect. Calyx 4-lobed; lobes irregular, 2 large and 2 small, broadly lanceolate, cut nearly to base, much ciliate, the 2 smaller ones length of capsule, the larger pair much longer. Corolla pale, small, $\frac{1}{10}$in. long, 6-veined, tube very short; stamens short; anthers included, reniform, bluish. Style short, not reaching to outer margin of capsule; stigma small. Capsule obcordate, $\frac{1}{10}$in. broad, deeply notched, glabrous, pale-fawn, ciliolate. Seeds very minute, sub-obovate-oblong, slightly convex, pale-yellowish, 9–10 in a cell.

Hab. On open plains, among grasses and small herbage, south of Dannevirke, County of Waipawa; 1889: *W. C.*

Obs. I have diligently compared these four small species of *Veronica* with the similar British species of this genus (as described and drawn by Hooker, Sowerby, and Bentham); and, although in some few and minor particulars they correspond with those northern species, they differ largely in the more important and grave characters. I regret that I did not obtain any specimens of them in their early flowering state, though had I only done so I should have missed their ripe fruit.

Order LVIII. Plantagineæ.

Genus 1. **Plantago**, Linn.

1. *P. dasyphylla*, sp. nov.

Plant perennial, small, tufted, gregarious; rootstock thick, hairy; hairs dense, rather long, fine, pale-reddish-brown; rootlets very long, descending. Leaves suberect, 10–14, of various lengths, narrow-oblong-lanceolate, 1in.–1$\frac{3}{4}$in. long, 3–4 lines wide, tip subacute, thickened, gradually tapering into petiole, thin, green (sometimes reddish), margins red, entire (sometimes with 2 small blunt sinuate teeth on each side), very hairy on both surfaces and at margins, but most so on the under-surface; hairs scattered, tortuous, thickish, articulated; petioles $\frac{3}{4}$in.–1$\frac{1}{4}$in. long, slender, flattish, slightly hairy (hairs as those of leaves), bases much dilated and having long reddish-brown hairs. Scapes 1–4 (usually 3) to a plant, erect, much longer than leaves, 3in.–5in. long, very slender almost filiform, densely hairy especially at top; hairs short, white, strigose pointing upwards. Spike small, broadly-oblong, 3–4 lines long, subcylindrical, 7–12-flowered; flowers sessile, close. Bracts broadly ovate, subapiculate, glabrous, purple (brown in age), with broad black thick keel. Calyx sepals similar but smaller, extending beyond circumciss of capsule. Corolla small, very membranous, narrow-triangular-ovate, white, erect, sometimes adpressed to capsule. Anthers slightly exserted, cordate-orbicular, strongly apiculate, red-brown. Style largely exserted, flexuous, shaggy. Capsule large, ovoid, shining, beak stout. Seeds 5, oblong, obtuse, white, shining, minutely and closely pitted.

Hab. Among grasses and other small herbage on banks of a small stream, open plain, Tahoraiti, south of Dannevirke, County of Waipawa, where it forms pretty large patches; 1890–91: *W. C.*

Obs. A species having near affinity with *P. picta*, mihi (Trans. N.Z. Inst., vol. xxii., p. 481), but differing in several characters.

Art. XXXVI.—*Description of Three Species of Newly-discovered New Zealand Ferns.*

By W. Colenso, F.R.S., F.L.S., &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1891.*]

Hemitelia, Br.

1. *H.* (*Amphicosmia*) *falciloba*, sp. nov.

Caudex erect, stoutish, woody, 6ft. high. Fronds spreading, bipinnate, submembranous, brownish-green above, pale (sometimes nearly white) below with minute shining specks widely dispersed, glabrous, with a few scattered weak hairs on costa and veins, and mostly on upper surface; basal scales, subulate, 2in. long, $\frac{1}{12}$in. wide at base with a small circular hole, very acuminate, tips filiform acute, margins plain, dark-brown finely and much striate, crinkled, very glossy. Rhachis unarmed, rather narrow, deeply sulcate on upper side, filiform at tip (and also subrhachises), densely clothed with weak reddish woolly down, intermixed with scattered long flat narrow crumpled red scales, $\frac{1}{2}$in.–$\frac{3}{4}$in. long, nearly 1 line wide at base (some narrow throughout), very acuminate, tips setigerous black, centre thickish dark-brown, sides semi-pellucid, margins distantly and roughly setigerous-serrate, teeth black. Pinnæ remote 3in. (or more) apart, subopposite (alternate towards apex), subpetiolate, 15in. long, 6in. broad, oblong, tip acuminate; rhachis slender, flattish, reddish, deeply sulcated above; pinnules extending close to rhachis, 2–3 at base a little shortened. Pinnules 3in. long, ¾in. broad, linear, tips very acuminate acute, shortly stipitate, pinnatifid, cut almost to costa, subpectinate, rather distant ½in. apart, free, alternate, spreading, horizontal; lobes alternate, remote, free falcate, semisubulate, tips acuminate, acute, margins recurved, plain, slightly serrulate towards apex. Veins pinnate, distant, very clear; veinlets forked and triple, when triple the lower one is invariably single, the upper forked. Sori small globular, regular near costa on forks of veinlets, usually 2 on a lobe one on each side of vein, and 4–5 (rarely 6) on lowest basal lobes. Involucre a very small concave greyish scale on the posterior side, margin entire; veins much coarsely reticulated, black (under lens).

Hab. On the side of a precipitous gully overhanging a small streamlet, in a forest south of Dannevirke, County of Waipawa; January, 1889: *W. C.*

Obs. This species is very distinct from those New Zealand species already described,* apparent at first sight. Unfortunately I have not obtained complete specimens, or, rather, what I have are partial and young, though perfect in themselves. This fern has a little history: I was returning one evening rather late and tired from my usual botanizing excursion during a hot day at midsummer, when on nearing the edge of a deep gully I noticed two tree-ferns overhanging it. From their appearance I thought them different from others, and I exerted myself to secure portions of their fronds for examination. Being higher than myself, with fallen trees and broken branches around, I could scarcely get at them; moreover, on the side towards me their fronds had been broken off short, as if by a falling tree; so I only brought away tips of fronds (8in.–10in.), and perfect full-size barren pinnæ from about the middle of a frond, and young pinnæ from newly-developed immature fronds bearing fruit; and when I next visited that spot (purposely, I may say) I found it had been ravaged by fire (a too common thing in those woods), and those two tree-ferns were consumed. I have since assiduously sought another specimen in my frequent visits to those forests, but without success.

Genus 5. **Hymenophyllum**, Smith.

1. *H. polychilum*, sp. nov.

Plant terrestrial; rhizome subterranean, shortly creeping, naked, its rootlets very hairy; hairs dark-red, patent, often

* *H. smithii*, Hook. (described as *Cyathea smithii*, Flora N. Zealand), and *H. (Amphicosmia) stellulata*, Col., Trans. N.Z. Inst., vol. xviii., p. 222.

terminating in a minute round glandular-like ball. Frond membranous, 8in.–11in. high (stipe included), 3½in.–4in. broad at base, deltoid-acuminate, 3-pinnatifid, leafy, dark-green, suberect, slightly decurved; stipe (4in.–5in.) terete, glabrous, shining, rigid, more or less flexuous, dark-brown. Rhachis and subrhachises winged throughout, pinnæ close overlapping, their tips often elongated, simple and forked at apices, the lower ones decurved; sometimes the second pair from base are the longest, the lowest pair opposite with their large basal segments meeting over rhachis, presenting a semi-crisp appearance; segments broad, laciniate; lobes narrow-linear, entire, obtuse. Involucres on all pinnæ, but mostly very numerous on upper two-thirds of frond, marginal on all sides and tips of segments and lobes, very large, wider than lobe, oblate, hemispherical and oblong, 2–4-fid to base, open, spreading, sometimes 2–3 together; lips entire, truncate, broad, sometimes once-notched; here and there two clusters of sori are together within one involucre. Sori prominent, much exposed; capsules large, striking, each with a bright-red shining elastic ring.

Hab. Dry shaded woods south of Dannevirke, County of Waipawa; 1890–91: *W. C.*

Obs. This is another handsome fern; it forms small loose tufts or mats, on the ground among the trees. It is allied to *H. demissum*, from which species, however (and from all others known to me), it differs—in its large and peculiar involucres, also in its rhachis and subrhachises being winged throughout, in its darker-green colour, close and overlapping pinnæ and segments, and in not creeping diffusely nor climbing trees like that species. It is also closely allied to *H. erecto-alatum*, Col. (Trans. N.Z. Inst., vol. xi., p. 431), but that species is much smaller, and of a light-green colour, with the wings of its rhachis and subrhachises largely and vertically crisped, its stipe is also winged above, and its involucre though large is very different.

Genus 22. **Polypodium**, Linn.

1. *P. amplum*, sp. nov.

Plant terrestrial, forming large close beds or patches many yards in extent; stipites single, distant, suberect, fronds drooping. Rhizome creeping, slender, subterraneous, somewhat brittle (as also stipites). Stipe 2ft. 8in. long (some shorter), as thick as a common-size lead pencil, obscurely triquetrous the back broadly rounded and the sides flattened, glabrous, shining, pale-brown, with minute sparsely-scattered darker-coloured points scarcely submuricate, deeply sulcated on upper side throughout the whole length, the lower part semi-scaberulous to the touch, the extreme base (also elongating tips or shoots of rhizome) densely clothed with very short shining reddish-brown terete jointed appressed hairs, their tips obtuse. Frond ample, subdeltoid, 3ft. 6in. long (some smaller), 3ft. 2in.–3ft. 6in. broad at base, tripinnate (or subquadripinnate), green, very membranous, glabrous, with small weak shrivelled whitish strangulated scaly hairs scattered singly on veins and veinlets both surfaces; pinnæ large, distant, loose, horizontal; rhachis and subrhachises pale, stramineous, smooth and glossy on the under-side, with minute greyish scaly hairs on the upper. Pinnæ, primaries distant on main rhachis, lowest pair 6in. from the next, which is 5in. from the next above, sub-ovate- (or deltoid-) acuminate, 20in.–21in. long, 10in.–11in. wide at base, the lowest pair always opposite (and the next two pairs nearly so), their petioles 1in. long; secondaries petiolate, alternate (the lowermost pair subopposite), free, 2in. apart, 5in.–6in. long, 2in. wide, sub-ovate-acuminate, tips caudate acute their lobes very small confluent; rhachis remarkably slender, almost filiform. Pinnules alternate (the three lower pairs opposite), free, distant, spreading, 1¼in. long, 4 lines wide, narrow oblong broadest at base, flat, deeply pinnatifid, subsessile (or much contracted subpetiolate), narrowly decurrent, the superior base also runs up (*sursum currens*), so that both sides join on to the next pinnule, tips rounded and bluntly 4–6-toothed, midrib undulate. Lobes opposite, usually six pairs (decreasing in number towards tips), distant, broadly oblong, subfalcate, narrowly margined, margins pale and shining, entire (sometimes a single large crenate tooth on anterior margin), irregularly undulate, sinuses rounded, tips rounded very obtuse, 2–3-toothed, teeth obtuse. Veins pinnate, 3-jugate; costa forked at apex; veinlets simple and forked, free, distant, extending to margin. Sori round, distant, regularly disposed opposite in pairs, one on a lobe on the lowest inner veinlet, and 2 opposite on the basal lobes, about 4–5 pairs on a large pinnule (confined to the lower lobes), submarginal and near to sinus, pale- and light-brown.

Hab. Edge of wood, south of Dannevirke, County of Waipawa; May, 1891: *W. C.*

Obs. I. This fern, which I call a remarkable one, has both pleased and puzzled me. Fortunately I found it growing in abundance, forming large tangled brakes, much like *Pteris esculenta* in growth and habit, and like that also in it being difficult to get through—in which respect it is almost worse than the *Pteris*, from it being so brittle and entangled, the long tender fronds breaking and impeding. From the extreme tenderness of its fronds it is also difficult to obtain a perfect specimen, even in a young state the tips of its long flaccid pinnæ being generally broken and imperfect.

II. I again visited its place of growth in September, and was surprised to find not a single frond living. All had died quite down to their roots, and were prostrated and soft; but fine stout green leafy young fronds 8in.–10in. high were everywhere vigorously shooting.

III. It is pretty nearly related (*primâ facie*) to *P. punctatum*, Thunb. (*P. rugulosum*, and *P. rugosulum*, of authors), but differs from that fern in many characters, and particularly from the drawings of it, with dissections and descriptions, as given in Labill., Flora Nov. Holl., and in Beddome's Ferns of S. India. Our N.Z. *P. punctatum* is a much smaller plant, its pinnæ and pinnules close and compact, with differently-shaped pinnules and lobes, that are thicker and very viscid (adhering to drying-papers), with its numerous crowded sori situate on middle of veinlet, and has dark-red rough muricated stipes and rhachises with numerous coarse red and patent hairs. A good and peculiar differential character is to be found in this fern (*P. amplum*), in its broad and flat pinnules, which are semi- (or constricted-) adnate, with their extreme bases narrowly extending both upwards and downwards on their subrhachises (requiring, however, when dried, a good lens to detect), and also in the very acuminate and narrow tips to its pinnæ.

Art. XXXVII.—*A List of New Species of* Hepaticæ novæ-zelandiæ, *named by* F. Stephani, *Leipzig.*

By W. Colenso, F.R.S., F.L.S., &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1891.*]

Last year (1890) I completed the somewhat arduous task I had imposed on myself—viz., the putting-up for Kew the numerous specimens of the smaller Cryptogams (*Hepaticæ* and *Fungi*) I had discovered during the last few years in our inland forests. They arrived safely at Kew, and the Director, Mr. Thiselton-Dyer, sent the *Hepaticæ* to Leipzig, to the celebrated cryptogamist, Mr. F. Stephani, for examination and determination. And in February last I received from Mr. Thiselton-Dyer the following list of *species novæ* that had been determined and named* by Mr. Stephani, and of others already known to science, but now detected here:—

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* Many of these *Fungi* were determined and named last year by Dr. Cooke, and are already published in Trans. N.Z. Inst., vol. xxiii., p. 391.

I. Species novæ, now named by Mr. Stephani.

Symphyogyna monoica.
Chiloscyphus erectifolius.
C. trilobatus.
Lophocolea filicicola.
L. triangulifolia.
Radula grandis.
R. papulosa.
Lejeunea colensoi (Lopholejeunea).
L. glauca (Pycnolejeunea).
L. colensoi (Harpalejeunea).
Aneura colensoi.
A. striolata.
A. oppositiflora.
A. æquitexta.
A. dentata.
• Tylimanthus (Gymnanthe) spinosus.
Anthoceros pallens.
A. laminiferus.

II. Species already known to Science, but not hitherto included in the Flora of New Zealand.

Plagiochila fenzlii, *Reichardt.*
P. banksiana, *G.*, MS.
P. hookeriana, *Ldbg.*
Lepidozia centipes, *Tayl.*
L. ulothrix, *Ldbg.*
Mastigobryum mittenii, *Steph.*
Radula mittenii, *Steph.*
Monoclea forsteri, *Hook.*
Lejeunea serpyllifolia, (?) *Lib.* (Eulejeunea).
L. sinclairii, *Spruce* (Eulejeunea).
Metzgeria nitida, *Mitt.*
M. australis, *Steph.*
Acrobolbus concinnus, *Mitt.*
Polyotus menziesii, *G.*
Marchantia cephaloscypha, *Steph.*
Cephaloziella exiliflora, *Tayl.*

III. Species not before detected in New Zealand.

There were also some others which had not before been detected in New Zealand, though described in the Handbook Flora of N.Z., from being found in the Auckland and Campbell Islands: these I do not here repeat.

And, as Mr. Stephani has also kindly examined and determined several *species novæ* named and described by me in some of the late volumes of the Transactions N.Z. Inst.

(specimens of them being among those sent to him, and included in his list), I also give them here—viz.,—

Gottschea guttata.
G. marginata.
G. heterodonta.
G. squarrosa.
G. ramulosa.
Plagiochila subfasciculata.
Lepidozia concinna.
Symphyogyna connivens.
S. brevicaulis.
S. flavovirens.
Mastigobryum nitens.
M. elegans.
Chiloscyphus vulcanicus.
C. lingulatus.
C. ammophilus.
Madotheca amœna.
Aneura marginata.
A. polymorpha.
A. perpusilla.
Isotachis montana.
Anthoceros pellucidus.

There were also very many others, specimens of *Hepaticæ* already known to science, and described by Sir J. D. Hooker in his "Flora Novæ-Zealandiæ" and "Handbook of New Zealand Flora;" most of them (and, indeed, *all* in the list) being often repeated and numerous, having been collected in several years and at different seasons, and from various habitats: besides others (probably *species novæ*) that were sterile or imperfect. The number of separate packets of *Hepaticæ* received by Mr. Stephani amounted to 1,027.

Art. XXXVIII.—*Plain and Practical Thoughts and Notes on New Zealand Botany.*

By W. Colenso, F.R.S., F.L.S., &c.

[*Read before the Hawke's Bay Philosophical Institute, 15th June, 1891.*]

Class III. CRYPTOGAMIA.

Order VI. Hepaticæ.

On this occasion, having been unexpectedly called on by our Honorary Secretary (on my recent return from sojourning in the bush district) to furnish a paper for this evening's meeting, I come before you very much in the character of an "emergency man." And, in thinking over what I should bring before you, I have determined to say something concerning what I have frequently seen with delight while away among our dense forests in the interior.

Of course you know of the two great living kingdoms of nature—namely, (1) the animal and (2) the vegetable.

This latter, the vegetable or botanical kingdom, is very properly divided into two great groups—the phænogamous or flowering, and the cryptogamous or non-flowering. (And here I will say, for the benefit of the younger portion of my audience, that I will endeavour to explain all hard scientific and technical words and names as I go on.)

The phænogamous or flowering group contains two great natural classes—the monocotyledons and the dicotyledons. To the monocotyledon (or one-seed-blade) class belong all plants of the grass, corn, lily, palm, onion, and very many others, including the large orchideous order; these all take their one distinctive name from the *single* cotyledon or shoot (sprout or tiny blade) which emerges from the seed or grain in germinating: while to the dicotyledon class belong all plants whose seed possess *two* cotyledons, leaves, or seed-lobules, as are so clearly shown in germinating in the pea, bean, radish, mustard, clover, &c.

The cryptogamous or non-flowering class is so called from not possessing perfect flowers, as are found in the flowering group; or, at all events, from their not being so apparent. In this great third class there are nine orders, which I shall briefly mention, and in so doing give you familiar instances of them all.

1. FERNS—for which, as you know, our colony bears a great botanical name from the rarity and beauty of many of them; and not only so, but some of them were to the ancient Maoris verily "the staff of life" (as bread-corn has been called with us)—the common fern, the *aruhe* of the Maoris, *Pteris esculenta* = edible *Pteris*, as it was rightly named by Forster, the able botanist who accompanied Captain Cook on his second voyage to New Zealand and the South Seas, and who often witnessed the general use made by the Maoris of its roots. This fern was of very great value as an article of food to the old Maoris, and was dug up and harvested and stored by them with much care for future use. And here I should inform you that, although this species of fern is so very common throughout all New Zealand, yet the best and prized edible root was not so common, and only found scattered in suitable soils and places: hence the common error respecting it by the settlers, who, in ploughing up the ordinary

fern-lands, marvel at any human being deriving nourishment from the fern-roots. Wishing to show good specimens of it at one of our Institute meetings some years ago, I got some through our resident Maori chiefs, obtained from inland beyond Te Wairoa, seventy miles distant. And I recollect being shown a small isolated volcanic hill, far away in the interior in the Taupo district (when I was travelling in those parts nearly fifty years ago), that was famed for producing first-quality fern-root; and for the possession of that hill battles had been fought and much blood shed. The officers of Cook's expedition ate of it when prepared by the Maoris, and praised it, remarking that it resembled London gingerbread. Then, there were also other ferns used as food by the ancient Maoris, particularly the inner stem, or large succulent semi-gelatinous pith, of the large "black fern-tree," the *mamaku* of the Maoris = *Cyathea medullaris* = marrow-stalked *Cyathea* (also justly so named by Forster, who, in his writings, compared the soft edible pith, of which he had eaten, to sago). But I must pass on from the useful and pleasing fern order.

2. Lycopodiums—of which order we have several species, though of little known use. Perhaps *L. volubile* (or twining *Lycopodium*) is among the prettiest. This plant was formerly used by the young New Zealand females to make neat and simple wreaths for their heads; and certainly, from its graceful slender form and light-green colour, it was well adapted for their raven locks. One other species, *L. densum*, I may also briefly mention, from its being considered very nearly allied to the large fossil *Lepidodendron* of our British coal-shales.

3. Marsiliaceæ.—Of this small and curious order we have only one species in New Zealand, *Azolla rubra*, a peculiar-looking water-plant, which may be commonly seen in large quantities, red, and floating on the lakes and pools near Te Aute and in the bush district, and in other small still waters. It was on the small fruits or capsules of nardoo (*Marsilea gigantea*), an allied plant of low humble growth, that the explorer Burke and his party, when they were in great distress from want of food, subsisted for some time in the interior of Australia, where it grows abundantly on the extensive plains of that country.

4. Mosses.—Of these elegant productions of nature New Zealand has a good share, some of them being really superb, and prominent among the largest and handsomest of the order.

5. Hepaticæ.—This order is also well represented here; but, as I intend to make it the main subject of this paper, I pass on.

6. CHARACEÆ.—A small order of peculiar water-plants containing only two or three genera, of which we have two, *Nitella* and *Chara*, and, somewhat curiously, seeing their species are few, three species of each.

7. LICHENS.—Of these strange aberrant vegetable productions we have several genera, and very many species of almost all conceivable shapes and sizes, many of them being also very rich in striking and bright colours, especially while living and after rains. It is really a grand, a superb sight to see an old tree, living or dead, in the still forests, closely covered with lichens—literally bedizened—and looking magnificent in its diversified multiform and many-coloured living decorations.

8. FUNGI, or the great Mushroom Order—whose manifold shapes and forms are still more strange and bizarre than those of the preceding order of lichens; and, while some are very small, among the minutest of all vegetable productions, others are exceedingly large and heavy, even as much as, or more than, a man can well lift. Many of them (like the common mushroom) are of quick sudden growth, soft, and short-lived; while others are of very slow growth, exceedingly hard and tough, and of long continuance. A few of our New Zealand Fungi were articles of food with the ancient Maoris; but the principal edible one, *Hirneola polytricha* (commonly known by the appellative of the order, "fungus"), has long been a commercial article of considerable export, so much as 339 tons, valued officially at £15,581, having been collected in the forests in one year for the Chinese market, for the purpose of making into soups. When dried (and it is only purchased in that state) it is exceedingly light tough and horny, and will keep well for many years.

9. ALGÆ, or marine and fresh-water weeds—of which our seas and rivers have their full share. A few of the shore seaweeds were also used as articles of food by the ancient Maoris residing near the sea—not, however, commonly, but as dainties; and not only so, but, when dried, sent as presents to friendly tribes residing in the interior, who made the return in fat forest-birds—pigeons and parson-birds—potted in their own oil.

Of those nine courts or natural divisions in the grand temple of cryptogamic vegetable nature, I choose No. 5, *Hepaticæ*, for my subject to-night; and the main cause of my so doing is my having lately received a letter from the Director of the Royal Botanic Gardens at Kew, containing a very long list of *Hepaticæ* from the celebrated cryptogamic expert, F. Stephani, of Leipzig, lately determined by him, numbering 1,027 specimens (or, rather, separate packets), being portion of a very large lot I had collected in our forests during several years and sent to Kew last year. This list I now lay before you; and the *species novæ* contained in the same,* now named by him, will form the subject of a future paper. Moreover, as an adjunct or minor cause is the fact of my recent return from those dear old sequestered haunts in the dense and lonely forests where I had again been admiring those lovely productions of nature.

In 1864, Sir J. D. Hooker, in his "Handbook of the Flora of New Zealand," writing on this order, says, "Of the *Hepaticæ* (about 212) here enumerated, the greater majority were discovered by Mr. Colenso and myself, and were new to science on the return of the Antarctic Expedition to England" (*loc. cit.*, p. 498). Since then, owing to many subsequent discoveries, I suppose the present number known of our New Zealand *Hepaticæ* to amount to about five hundred. Many of them are endemic; some are also found in Tasmania and in Australia, in the far-off antarctic islets, and at Cape Horn and Fuegia; while others are strictly identical with species denizens of the British mountains and of the South American Andes. Here, then, there is food for thought—whether such productions, now found so very far apart in the two hemispheres of the globe, were originally specially created, or whether developed; and, if the former, whether together at one time at both ends of the globe, or, if singly, which first.

And here I may mention a letter I have lately received from a skilful naturalist in the South Island. I had sent him some living molluscs (univalve land-shells) I had lately detected on a living tree in the forest, which seemed to me peculiar. In his reply he mentioned having lately found a species of land mollusc which is identical with a species hitherto only found in Java, and which he considered as proof of these two countries, that and this, now so far apart, having been at some distant period geologically connected. I cannot, however, agree with him in his conclusion; and I merely mention this as bearing in a slight degree on the finding of the same species of *Hepaticæ* occupying the extremes of both the Northern and Southern Hemispheres.

Numerous as our endemic species are, some of them are both very rare and local, while others are very common and plentiful. Some are generally epiphytical—that is, growing on other species, and on mosses and on some of the smaller ferns, particularly on *Trichomanes elongata* and *Hymenophyllum demissum*, one species in particular not unfrequently completely and closely covering the upper surface of the frond in the former plant with its pale delicate fringes, which are the more conspicuous from the very contrary colour of that dark-green fern; the branches of many living trees, even the topmost of

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* See above, Art. XXXVII., p. 398.

the tallest, including branchlets that are dead, are often clothed with them; the steep sides of streams and mouths of caves abound in species; and even isolated stones and boulders, and dry hardened logs denuded of their bark and exposed to the hot rays of the burning meridian sun, possess them, exhibiting most astonishing proofs of their endurance and long vitality; even dry black and charred logs, extra heated in the sun, are often thickly clothed with a small red species, bearing fruit too, presenting an uncommon appearance after rains. Many of them are very beautiful, being most exquisitely and symmetrically formed and adorned; each species, however minute, possessing the greatest regularity in shape and size of leaves, in their delicate fringes and their mathematically-formed cells, &c., and this in its most delicate and microscopical distinctions.

I am not aware of any of them being of service or use to man, only that a few of the larger species of the genera *Lophocolea* and *Chiloscyphus* that are odoriferous were formerly prized and eagerly sought after in the woods by the ancient Maori females to impart a fragrant scent to their anointing-oils, as well as to wear in little sachels around their necks.* To such an extent was this perfume valued that it was also both used as a proverb and sung in a loving nursery song.

> Oh! there are curious things of which men know
> As yet but little—secrets lying hid
> Within all natural objects.
> He who findeth out
> Those secret things hath a fair right to gladness;
> For he hath well performed, and doth awake
> Another note of praise on Nature's harp
> To hymn her great Creator.

Some of our principal genera I will briefly mention, as I purpose showing you mounted specimens of some of their species, and plates of others faithfully drawn and coloured, with their dissections highly magnified, in illustration. I trust that, at least, the ladies of my audience will not be discouraged on hearing their proper generic names, supposing them to be sadly uncouth and unmeaning, and totally unfitted for such delicate and elegant forms; for such is really not the case, as I hope to be able to prove to them.

Generic names of plants are usually chosen with two objects—1, to indicate and perpetuate the proper name of the botanical discoverer, or of some distinguished patron or friend of the science; 2, to show some striking specialty of the plant itself, the type of the genus—for this purpose a suitable Greek

* These were also worn by the men (chiefs). Parkinson says, "The principals among them had their hair tied up on the crown of their heads and some feathers, with a little bundle of perfume hung about their necks" (Journal of Voyage, p. 93).

name Latinised (simple or compound) is used. Thus, among those of our New Zealand *Hepaticæ* we have—of the former class, (1) *Jungermannia*, in honour of L. Jungermann, a botanical author; this genus is a very large one—formerly (and until the last forty-five years) nearly all our present genera were included in this one: (2) *Frullania* (another large genus), named after Signor L. Frullani, an eminent Italian statesman and great patron of botany: (3) *Lejeunia* (a very large and cosmopolitan genus, stated by Hooker in 1864 to contain 236 species, which have been largely increased since), named in honour of Dr. A. L. S. Lejeune, a botanical author: (4) *Gottschea*, "a noble genus, almost confined to the Southern Hemisphere, and abundant in New Zealand" (Hook., *l.c.*, p. 512), named after the celebrated cryptogamic botanist and author Dr. C. M. Gottsche: and of the latter class—(1) *Trichocolea* = hairy sac or bag (such being the state of its calyx); (2) *Polyotus* = many ears (from the very peculiar appearance of its neat little concave and lobulated leaves); (3) *Isotachis* = equal-rowed spike or ear—as cf wheat, &c. (the leaves of this elegant species forming two close and very regular rows, while a third and similar row is formed of its large stipules); (4) *Plagiochila* = oblique lip, or mouth—of its calyx; (5) *Madotheca* = bald, smooth, largely-rounded capsule, issuing from its calyx bag or case; (6) *Mastigobrýum* = whiplash-like moss (from its very long and slender scaly aërial rootlets, resembling the scaly stem of a minute *Lycopodium*, a peculiar and striking feature); (7) *Lepidozia* = scaly bud (gemma), from its general appearance; (8) *Chiloscyphus* = cup-shaped lips, from the form of its calyx; (9) *Psiloclada* = slenderly branched, sparingly leaved; (10) *Zoopsis* = rigid, silvery, scaly, animal-like; (11) *Aneura* = without nerve.

Now, these and suchlike generic names (and there are many such among our New Zealand plants) convey a true and useful *primâ facie* meaning to those who know the Greek and Latin languages, and such natural names aid in properly placing newly-discovered species under their respective genera. And, strange as it may seem to English ears, such names are far more scientific and serviceable than many of those common and plain ones of our English plants, as alder, ash, apple, cherry, oak, larch, plum, &c.

Here, I think, I may properly relate a striking observation of Bishop Selwyn's on this very subject of (the so-called) "hard botanical names." The Bishop had been looking over my manuscript scientific catalogue of New Zealand plants (which I had collected from various sources for my own use, there being then no published work on New Zealand botany) for their names for his "Church Almanac;" and, he having casually remarked on "the reproach of the science" (its often hard and uncouth names), and coming to *Urtica ferox* = fierce stinging-nettle; *Phormium tenax* = tenacious basket-weaving plant; *Pteris esculenta* = edible fern; *Arundo conspicua* = conspicuous prominent reed (and suchlike), the Bishop said, "Now, this is what I like. In these names is contained intelligent and useful information, even to a stranger or novice in botany."

The fascinating wonders of Nature are indeed greatly displayed here in this order to the inquiring mind and eye. Here is to be seen the perfection of elegance and beauty in her humblest productions. Permit me to more particularly call your attention to the specialities of some of our genera of this order—*e.g.*, in form, so intricately and finely compound, almost bewildering, yet regular—*Trichocolea*; and, on the other hand, so very simple—*Symphyogyna*: in size, *Plagiochila*, some of which are large dendroid and tree-like, branched and nearly 1ft. high, resembling small shrubs; while others of this same genus are very minute: in extreme fineness and delicacy of structure—*Zoopsis* and *Psiloclada*: in remarkable close regularity, shape and position of their imbricated leaves—*Isotachis, Madotheca, Mastigobryum*: in their charming rich and varied colours (on the one plant), golden, orange, purple, emerald-green, &c.—*Polyotus*: in elegance and richness of superb cutting and fringing—*Gottschea, Chiloscyphus*: and, generally, in their minute cells, their structure, shape, regularity, and mathematical correctness; in their endurance, retaining life though daily heated and scorched, crisped and dried up by the summer's sun; in the excessive minuteness and regular form of their microscopical spores (seeds), &c.; in the highly curious manner of the distribution of their seeds when ripe, which is done by coiled and double-spiral elaters, or springs.

Not unfrequently, when alone in the low, secluded, damp dells and gullies of the umbrageous forests, far away from man, surrounded by these beautiful *gems*, and contemplating them in their luxuriant perennial growth, their pleasing elegant profusion, and almost endless variety of forms, have I been led to exclaim,—

> Who can this field of miracles survey,
> And not, with Galen, filled with rapture, say,
> "Behold a God! adore Him, and obey"!

And here I may briefly remark in passing (and so, possibly, anticipate a question) that it is all one to me, at such times, whether those many and varied, yet regular and symmetrical, forms were produced by creation or by evolution. Rather, however, would I set the consideration of that deep and difficult question aside that I might the more fully drink in and enjoy the exquisite living scene before me.

I will now lay before you a few dried and mounted specimens illustrating some of the principal genera I have mentioned; but in so doing I must premise that, just as the planets and distant large objects are the more clearly revealed by the aid of the telescope, so also these minute ones are by the aid of the microscope. Indeed, without it their beauties and wonderful formation and structure are wholly unknown, being invisible to the unassisted eye.

Here, also, in several large botanical volumes on the table are faithful coloured and magnified drawings of many species, with their microscopical dissections. These well-executed plates will best show these lowly yet lovely plants, and will no doubt interest you more than the dried specimens.

In some of the later volumes of the Transactions of the New Zealand Institute I have described several new species of *Hepaticæ*. Both in detecting and in collecting, and also in working at them under the microscope, I have enjoyed many a pleasant hour; such sometimes even serving to powerfully neutralise chronic rheumatic pains.

I am happy in knowing that the study of this order of plants has become increasingly popular of late years—that is, abroad, all over the world; for I regret to say such is not yet followed here in New Zealand. I have received several letters from cryptogamic botanists in both Europe and America, who were desirous of studying our New Zealand *Hepaticæ;* but I am unwillingly obliged to decline, at my advanced age, the taking-up with any new scientific correspondents, involving the collecting and transmitting of specimens, though a few years ago I should have rejoiced in doing so. It grieves me not a little when I reflect on the utter carelessness of our colonists generally (both old and young) toward all scientific pursuits. Superior education, though so largely praised and attended to by our rising generation, seems to have effected very little in this respect. The study of botany, especially of the cryptogamic class, and more particularly of this order *Hepaticæ*, is a highly-pleasing one. It is of a calming nature, beneficial and mentally profitable to the student, leading him genially on "through Nature up to Nature's God."

In conclusion, I must ask forgiveness of my audience for the roughness and disjointedness of my paper, as but little time was allowed me for its preparation; hence its hurried and somewhat irregular form.

The principal books referred to as containing faithful and valuable plates of *Hepaticæ*, also shown on this occasion, were—

1. "Botany of the Antarctic Voyage," Hooker fil., vols. i., ii., iv., vi., with coloured plates.

2. "Species Hepaticarum," Lindbg. et Gottsche, coloured plates.

3. "Hepaticæ Amazonicæ et Andinæ," Spruce.

4. "British Jungermanniæ," Hooker, coloured plates.

5. "Musci Exotici," Hooker, vols. i. and ii.

And several small but more recent works, containing well-executed plates of various species.

ART. XXXIX.—*On some Recent Additions to the New Zealand Flora.*

By T. F. CHEESEMAN, F.L.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 2nd November, 1891.*]

Alectryon excelsum, D C., var. *grandis*, Cheeseman.

A small tree. Habit, size, and general appearance precisely that of the type, and tomentum also the same. Leaves much larger, the whole leaf being often over 18in. long. Leaflets fewer in number, but much larger and broader in proportion, 5in.–7in. long, $2\frac{1}{2}$in.–$3\frac{1}{2}$in. broad, oblong or ovate, acute. Flowers not seen, and only the remains of old seed-vessels.

Hab. Three Kings Islands: a small clump growing on the cliffs on the northern side of the Great King.

A very handsome and striking plant. It differs widely from the type in the size of the leaflets, which are three or four times as large, and also in their shape. It is possible that it is entitled to specific rank, but I hesitate to so place it until flowering specimens have been obtained.

Olearia suavis, n. sp.

A densely-branched shrub or small tree, 6ft.–18ft. high. Young branches, panicles, and under-surface of leaves covered with pale-yellowish or fulvous tomentum. Leaves usually oblong, but sometimes almost ovoid, occasionally narrower and linear-oblong, obtuse at both ends, $\frac{3}{4}$in.–2in. long, $\frac{1}{2}$in.–$\frac{3}{4}$in. broad, rather thin, entire or with waved margins; primary veins conspicuous below, almost at right angles to the midrib. Panicles loose, elongate, branches slender. Heads small, $\frac{1}{6}$in. diameter; involucre turbinate, scales linear-oblong, pubescent, especially the outer ones. Florets few, small. Ripe achenes not seen.

Hab. Mount Arthur plateau, Nelson, alt. 4,000ft.

It is with considerable hesitation that I describe this as new, for in many of its characters it agrees closely with a species published by Mr. Buchanan under the name of *O. excorticata* (Trans. N.Z. Inst., vol. vi., 241), but of which I have unfortunately been unable to procure authentic specimens. Judging from the description, however, Mr. Buchanan's plant has much larger leaves, said to be acuminate at both ends, and the tomentum appears to be different.

Olearia suavis is allied in some respects to *O. lacunosa*, which is a common plant on the Mount Arthur plateau, but which has much longer and narrower leaves. The tomentum of the two plants is very similar indeed.

Myrsine kermadecensis, n. sp.

A small glabrous tree, with much of the habit and appearance of *Drimys axillaris*. Bark rough, blackish-brown. Leaves 2in.–$2\frac{1}{2}$in. long, obovate-oblong, acute or obtuse, entire, coriaceous, gradually narrowed into short petioles $\frac{1}{6}$in.–$\frac{1}{4}$in. long; margins slightly recurved. Flowers small, diœcious (or polygamous?) in many-flowered clusters on the old wood below the leaves. Pedicels short, rarely over $\frac{1}{5}$in. Calyx minute, lobes short, broad. Corolla about $\frac{1}{8}$in. long, divided nearly to the base into 5 acute lobes, which are fringed at the sides. Anthers nearly as large as the lobes. Drupe globose, $\frac{1}{3}$in.–$\frac{1}{4}$in. diameter, black when fully ripe.

Hab. Sunday Island, Kermadec Group: abundant over the greater part of the island.

This differs from the Norfolk Island variety of *M. crassifolia* in the smaller leaves, which are much broader in proportion, have longer petioles, and are usually more acute than in *M. crassifolia*. Mr. W. B. Hemsley, of Kew, informs me that the Australian *M. variabilis* is a close ally; but I have had no opportunity of comparing the two plants.

Bœhmeria dealbata, n. sp.

A small tree, 8ft.–25ft. high. Branches terete, hoary with minute hairs. Leaves alternate, ovate, oblong-ovate, or ovate-lanceolate, acuminate, obtusely serrate, rounded at the base, 3in.–6in. long, very prominently 3-nerved, and with the secondary veins also strongly marked, green and glabrous and somewhat rugulose above, below white and hoary with minute hairs. Petioles short, stout, grooved on the upper surface. Stipules small, ovate-lanceolate, deciduous. Flowers minute, in small axillary sessile glomerules, monœcious; the female flowers in the glomerules usually expanding before the males. Male flowers: Perianth deeply 4-partite, segments oblong-ovate, acuminate, covered with erect hairs; stamens 4, alternating with the perianth segments, exserted; a minute rudiment of an ovary present. Females: Perianth tubular, compressed, dilated below, contracted at the 2-toothed mouth; ovary included, 1-celled, 1-ovulate; stigma exserted, long, filiform, hirsute. Ripe fruit not seen.

Hab. Sunday Island, Kermadec Group: not uncommon in the lower portion of the island.

This is the plant which I referred to the Norfolk Island *B. australis* in my catalogue of the plants of the Kermadec Group (Trans. N.Z. Inst., xx., 173). Since then Mr. W. B. Hemsley, of the Royal Gardens, Kew, has done me the favour of comparing it with authentic specimens of *B. australis*, and informs me that it is certainly distinct, differing in having comparatively shortly petiolate, 3-nerved, and otherwise strongly-nerved leaves, rugulose above. To this I may add that the leaves are much broader than in *B. australis*, and not cordate at the base. Mr. Hemsley also remarks that it is intermediate in characters between *B. australis* and the Lord Howe's Island *B. calophylla*.

A seedling obtained from the Kermadec Islands in 1888 has stood the climate of Auckland well, and is making rapid growth. Its handsome foliage and compact habit should entitle the species to a place in our gardens.

Caleana minor, R. Br. (Bentham, "Flora Australiensis," vi., 366).

I am indebted to the Rev. F. H. Spencer for numerous fresh specimens of this singular little plant, collected by him in the vicinity of Rotorua township. The discovery is an interesting one, both on account of its adding a new genus to our flora, and from its affording another proof of the close connection between the Orchideæ of New Zealand and Australia. Mr. Spencer's specimens exactly match the plate of the species given in Fitzgerald's "Australian Orchids," and there can be no doubt of the identity of the New Zealand with the Australian plant. Probably it is not uncommon in the Rotorua and Taupo districts, and has been overlooked until now from its small size and inconspicuous character, and from the short duration of its flowering-period. The following description has been drawn up from Mr. Spencer's specimens:—

Very delicate and glabrous, 6in.–8in. high, usually slightly tinged with red. Leaf solitary, radical, very narrow-linear, rather fleshy, channelled. Flowers 1–3, greenish tinged with red, small, barely $\frac{1}{2}$in. long (including the ovary); pedicels $\frac{1}{4}$in., with minute subtending bracts. Sepals narrow-linear, slightly dilated above the middle, nearly equal in size; the dorsal one attached just above the top of the ovary, the lateral affixed to the basal projection of the column. Petals rather smaller. Labellum uppermost, very remarkable in shape, the lower portion claw-like, and articulated on to the basal projection of the column; the upper part expanded into a broad lamina, which is peltately attached to the claw. This lamina is convex on its outer or upper side, concave towards the column or on its lower side, rounded at the base, narrowed towards the apex and bluntly 2-lobed. The concave side is smooth, the convex or outer side covered with close-set reddish tubercles, which are longest on the margins. Column horizontal, rather long, with a broad basal projection, broadly winged, concave, forming a horizontally-placed cup or pouch.

Hab. Shaded places among *Leptospermum*, vicinity of Rotorua. Flowers in December and January.

The flowers have a most singular and bizarre appearance, and are well worth careful study. Owing to the ovary being recurved, the column is the lowest part of the flower, and forms a shallow cup or pouch. Directly over it is the broad lamina of the labellum, hanging from a delicate claw or ribbon which curves upwards from the basal projection of the column. A very slight pressure on the lamina causes it to overbalance, and it then swings over and descends on to the column, which it closes as with a lid. After a period of rest, it again assumes its previous position. No doubt this remarkable movement is connected with the fertilisation of the plant. It seems probable that small Diptera or other minute insects alight on the labellum, which then capsizes, imprisoning the insects in the concavity of the column; that they then disturb the pollinia, and either fertilise the flower with its own pollen, or when escaping convey the pollinia to other flowers. The latter supposition appears to me the most likely; but Mr. Fitzgerald, who has had good opportunities of studying the fertilisation of the plant in Australia, considers that it is almost invariably self-fertilised.

It is perhaps worth mentioning here that some years ago Mr. W. T. Ball collected a single specimen of a species of *Calochilus* between Rotorua and Whakarewarewa, and Mr. Spencer has since found it in the same locality. Judging from dried specimens, the plant is either closely allied to or identical with the Australian *C. paludosus*, Br., which has been collected at Collingwood by Mr. H. H. Travers (Buchanan, Trans. N.Z. Inst., xv., 340).

ART. XL.—*Additional Notes on the Genus* Carex.

By T. F. CHEESEMAN, F.L.S., F.Z.S.

[*Read before the Auckland Institute, 2nd November, 1891.*]

Carex resectans, n. sp.

C. inversa, Br., var. *radicata*, Cheeseman, Trans. N.Z. Inst, xvi., 425.

Forming broad grassy patches often many feet in diameter. Rootstock creeping, stoloniferous. Culms short or almost wanting, rarely more than 2in. high. Leaves numerous, wiry, involute, filiform, 1in.–5in. long, overtopping the culms. Spikelets usually three, but often reduced to a single one, crowded together, pale-green. Bracts long, leafy, sheaths deeply grooved. Glumes ovate or ovate-lanceolate, margins thin, keel stout, 3-nerved. Male flowers at the base of the spikelet, few in number and sometimes altogether absent. Perigynia ovate below, narrowed into a long tapering serrate beak, very prominently nerved. Stigmas, 2.

Hab. Lakes Tekapo and Pukaki, Canterbury, alt. 2,500ft., *T. F. C.* Interior of Otago, *D. Petrie !*

I originally placed this curious little plant as a variety of *C. inversa*, but further study has convinced me of its distinctness. Its chief characters lie in its peculiar habit, wiry filiform leaves, short culms, and in the long-beaked perigynia, which are very sharply toothed above. It forms a short compact turf, and may easily be taken for some creeping rooted grass.

Carex leporina, L.

To the localities mentioned in my previous paper (Trans. N.Z. Inst., vol. xvi.) should be added the Mount Arthur plateau, Nelson, where it is not uncommon from 3,000ft. to 4,500ft. elevation. Specimens from thence are shorter and stouter and have much browner spikelets than those collected in the lowland districts of Nelson, but I can see no other difference.

Carex trachycarpa, n. sp.

C. muricata, Cheeseman, Trans. N.Z. Inst., xvi., 411; *non* Linn.

Stems tufted, 6in.–18in. high, rather slender, grassy, smooth or slightly scabrid. Leaves longer or shorter than the culms, nearly smooth, flat, grassy, striate, $\frac{1}{12}$in.–$\frac{1}{8}$in. broad. Spikelets 4–10, androgynous, pale chestnut-brown, compacted into a spike-like head $\frac{1}{2}$in.–$1\frac{1}{2}$in. long. Bracts ovate and membranous at the base, produced into setaceous points usually longer than the spikelets. Male flowers at the top of the spikelets, usually few in number. Glumes ovate, acuminate or awned, pale-chestnut or pale-brown, with pale-green midribs and hyaline margins. Perigynia smaller than the glumes, not spreading when ripe, plano-convex, ovate in outline, somewhat acute at the base, gradually narrowed into a short bidentate beak, rough with minute projections on both surfaces, strongly ribbed, especially on the convex side. Stigmas 2.

Hab. Nelson Province: Mount Owen, alt. 4,000ft.; Mount Arthur and Mount Peel, alt. 3,500ft. to 4,500ft.

In an immature condition this so closely resembles some states of the northern *C. muricata* that I referred my first specimens to that species. During a recent visit to the Mount Arthur plateau, however, I obtained mature fruiting specimens which prove beyond doubt that it is a distinct species, utterly unlike *C. muricata* in the much smaller differently-shaped perigynia, which do not spread when ripe, and are rough all over with minute projections. This last character is a very peculiar one, and I do not know any species with androgynous spikelets which has the perigynia roughened in a similar manner, except a plant which I have also collected on the Mount Arthur plateau, and which exhibits it in a smaller degree. I refrain from describing this because there is a possibility that it may be a large form of *C. kirkii*, Petrie (Trans. N.Z. Inst., xvii., 297). Mr. Petrie does not, however, describe the perigynia as being rough, and the few specimens which I possess are too immature to settle the question.

In addition to the above peculiarities, the perigynia of *C. trachycarpa* can be readily distinguished from those of *C. muricata* by being shorter, broader, and flatter, with a much shorter beak, and by the strongly-marked ribs.

Carex wakatipu, Petrie.

This is not uncommon on the slopes of Mount Arthur and Mount Peel, ascending to over 5,000ft. I have also a specimen collected by Mr. Tryon on Mount Burnett, near Collingwood. This locality is the most northern yet recorded for the species.

Carex decurtata.

C. cryptocarpa, Cheeseman, Trans. N.Z. Inst., xvi., 412 (1883). Non *C. cryptocarpa*, E. Meyer (1831).

When describing my *C. cryptocarpa* I accidentally overlooked the fact that the name had been previously applied to a species common in northern Europe and in some parts of North America. As a new name is therefore required I propose that of *C. decurtata*. It has been recently collected by Mr. Petrie in several localities in the interior of Otago, and is probably not at all rare in the middle and southern portions of the South Island. Some of Mr. Petrie's specimens differ from mine in having reddish or reddish-brown culms and leaves; but this feature is common in many of our species, and is so variable and inconstant that it cannot be used even as a varietal distinction.

Carex uncifolia, Cheeseman.

Add to the localities Mount Pisa, Otago, from whence I have specimens collected by Mr. Petrie. I have also gathered it on Mount Peel, in the Nelson Provincial District. Attains a somewhat larger size than that given in my description.

Carex petriei, Cheeseman.

This species also extends northwards into the Nelson Provincial District, and is of comparatively common occurrence on the Mount Arthur plateau. I find that the glumes are not always so pale in colour as I supposed, and in exposed localities are quite a full chestnut.

Carex comans, Berggren.

C. cheesemanii, Petrie, Trans. N.Z. Inst., xv., 358.

In my "Revision" I hinted that Mr. Petrie's *C. cheesemanii* would probably prove to be a variety of *C. comans*, and further investigation has fully convinced me that that is the case. What I take to be the true plant of Dr. Berggren occurs in several localities near New Plymouth, and only differs from Mr. Petrie's specimens in the pale-green colour, shorter culms, shorter stalks to the spikelets, and rather narrower perigynia; and I have many specimens from Nelson and Canterbury quite intermediate in character. The plant from Lake Tekapo, mentioned in my "Revision," is much stouter, with shorter culms and strict erect leaves, and has much broader perigynia. It has a very distinct appearance, and may be entitled to specific rank, but for the present I prefer to place it under *C. comans* as var. *stricta*. I have a form of *C. testacea* which approaches it in habit, but the shape of the perigynia and number of styles at once separate the two plants.

Carex litorosa, Bailey, "Memoirs of the Torrey Botanical Club," vol. i., p. 72.

C. littoralis, Petrie, Trans. N.Z. Inst., xv., 358 (1882). Non *C. littoralis*, Schweinitz (1825).

Several years ago Mr. Arthur Bennett, a well-known student of the genus *Carex*, pointed out to me that Mr. Petrie's name of *C. littoralis* had been preoccupied as far back as 1825 for a North American species published by Schweinitz. I retained the name in my "Revision" because it seemed to be doubtful whether Schweinitz's species was a good one. Since then Mr. L. J. Bailey, who is engaged in a critical examination of the North American *Carices*, has satisfied himself that *C. littoralis*, Schweinitz, is the oldest name for the plant known of late years as *C. barrattii*, and must stand. He therefore suggests the name of *C. litorosa* for the New Zealand species.

In my previous paper I neglected to mention that it occurs in immense profusion in the large brackish-water marshes fringing Kaipara Harbour.

Carex flava, L.

Add to the localities the Mount Arthur plateau, Nelson, where it is not uncommon, and which is the most northern locality yet recorded in New Zealand.

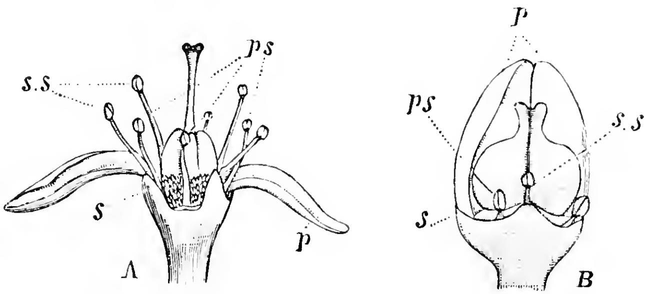
Art. XLI.—*Note on the Cleistogamic Flowers of* Melicope simplex.

By Geo. M. Thomson, F.L.S.

[*Read before the Otago Institute, 10th November, 1891.*]

Melicope simplex is a common shrub in Otago, and in the east coast districts produces its small greenish-white flowers in October and November, but in the interior a month or so later. These average about $\frac{3}{8}$in. in diameter, and are fragrant. I have not, however, detected any nectar in them, nor do I know how they are fertilised. In a paper on "Fertilisation of Flowering-plants" (Trans. N.Z. Inst., vol. xiii., p. 257) I suggested that these flowers were probably fertilised by "the numerous small Diptera which so commonly frequent the edge of the bush," but I have never been able to verify this surmise. Though sometimes quite hermaphrodite, it is frequently the case that they are so in structure only, being unisexual in function; while others again are strictly diœcious, the male form having no pistil, and the female flowers having stamens with more or less imperfect anthers, and little or no pollen. This feature is remarkably common among New Zealand flowering-plants, and in several species it is possible to find transition stages between perfectly-hermaphrodite and perfectly-diœcious plants. But truly cleistogamic flowers, self-fertilised and remaining quite closed until the fruit is considerably developed, have hitherto been recorded from very few species.

When at Lake Wanaka some two years ago I landed on Pigeon Island, on which *Melicope simplex* is abundant, and found that all the plants were covered with closed flowers, which were freely setting seed. I collected a number of these flowers, but had not the opportunity till this spring of comparing them with the ordinary form. In the normally flowered specimens of this species growing near Dunedin the 4 petals spread widely open. The 8 stamens are in two whorls, those of the outer or sepaline whorl being distinctly longer than those of the inner or petaline whorl. The 4 carpels are crowded closely together in flower, and their styles are united into one, which is crowned by a capitate stigma showing no trace of divisions; but as the fruit ripens the carpels tend to grow away from one another. Of the two ovules present in each carpel, only one ripens, as a rule, the other remaining undeveloped.



A. Normal flower. *B*. Cleistogamic flower.
s. Sepal. *p*. Petal. *s.s*. Stamens of the outer or sepaline whorl. *p.s*. Stamens of the inner or petaline whorl.

In the cleistogamic flowers of my Lake Wanaka specimens the sepals were normally produced. The petals are perhaps shorter, but do not otherwise differ in form from those of the ordinary flowers. They do not open, however, their edges remaining in close contact until forced apart by the expansion of the ovaries. The outer or sepaline stamens are either reduced to minute pointed rudiments of filaments, or they bear small—apparently aborted—anthers on very slender filaments, which stand close up to the base of the carpels, and are pressed in between the lobes. On the other hand, the stamens of the inner whorl have large anthers on very short filaments. The carpels, though standing close together, are quite distinct from one another throughout their whole length, and, instead of having one style common to all 4 carpels, there are 4 separate or nearly-separate styles. In other respects the carpels develope normally, producing, at most, only one mature seed. Fertilisation must either take place at a very early stage in the development of the flowers, or, which is more probable, the pollen must be shed early into the pendulous flowers, and, being caught in the sac made by the closed petals, is thus brought into contact with the stigmas. In all the flowers examined by me the ovaries stood always too high to receive pollen directly on their stigmas, unless it reached them in the manner suggested.

No definite cause has been assigned for the occurrence of cleistogamic flowers in plants. The Rev. George Henslow, in "The Origin of Floral Structures" (p. 262), gives several examples of species which produce normal flowers in one district or country and cleistogamic flowers in another, showing that the change appears to be due to variations in climate or soil, &c.; but no law can be adduced from the examples given. That the occurrence of this phenomenon depends largely on the supply of moisture is suggested by the following fact: Some plants of violet (cultivated forms of *Viola odorata*) growing in my garden, in a border against a wall—a position in which they were subjected to great heat and where they got very little moisture—were found covered with cleistogamic flowers, and bore very numerous seed-capsules, although they produced no conspicuous flowers. Other violets of the same variety, growing only a few feet away, but in a border where they were exposed to the weather and got abundance of moisture, had abundance of normal but no cleistogamic flowers.

I can give no explanation of the specimens of *Melicope* from Lake Wanaka, as I have no record of the soil or climatic conditions of Pigeon Island; but the profusion of flowers, not one of which was open, and of maturing fruit, arrested my attention at once, and I noticed that all the plants seen by me were so covered with these peculiar self-fertilised closed flowers.

Art. XLII.—*Remarks on the Genus* Abrotanella, *Cassini, with Descriptions of New Species.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

Plate XXXVI.

Abrotanella was founded by Cassini in 1825 on a plant from the Falkland Islands, which for some years was considered to be the only species. In 1845 Sir Joseph Hooker constituted the genera *Trineuron* and *Ceratella* for the reception of two plants from the Auckland and Campbell Islands, and pointed out their close relationship to the original *Abrotanella emarginata* of Cassini, in Hooker's *London Journal of Botany*, v., 437: he also formed the genus *Scleroleima* for the reception of another closely-related plant from the summit of Table Mountain, Tasmania. A few years later Professor Asa Gray, in Proceedings of the American Academy, v., 137, showed the propriety of reducing all these genera to *Abrotanella*: his views were adopted by Hooker in the "Handbook of the New Zealand Flora," 139, and by Bentham in "Flora Australiensis," iii., 553. As now constituted the genus comprises about a dozen species, of which one, or possibly two, are found in South Chili, the Magellan Straits and Falkland Islands, &c.; one in the mountains of Victoria; two in Tasmania; and six or seven in New Zealand and the Antarctic Islands.

Most of these plants are inconspicuous moss-like herbs, forming small patches, with stems from $\frac{1}{4}$in. to $\frac{1}{2}$in. high, resembling a large-leaved *Tortula*, or a *Bryum*. *A. spathulata*, Hook. f., however, sometimes attains the height of 3in., with an erect stem and crowded flower-heads, so that the moss-like appearance is completely lost. *A. linearis*, Bergg., occasionally developes leaves upwards of 2in. in length, but even under the most favourable conditions they are neither conspicuous nor attractive; the flower-heads are terminal, and are usually more or less concealed by the apical leaves, but *A. spathulata* and *A. linearis* are marked exceptions in this particular. The flower-heads may be solitary or numerous. The involucre is cylindrical or cup-shaped, and consists of from 5 to 12 linear-oblong scales, arranged in 2 series: usually they exhibit 3–5 translucent veins, and are broadly obtuse: the receptacle is very small, naked, slightly convex, and papillose: the florets vary in number from 5 to 20, those of the disc being ☿ with a truncate style and 4 stamens, and those of the ray, which are more numerous, being female with a shortly bifid style: the corolla is always tubular, and very slender; in the disc-florets rather deeply 4-cleft, with incurved apices; in the ray-florets 4-toothed, the teeth usually spreading. Anthers partially coherent. Achenes either somewhat compressed, or tetragonous, narrowed below, with 4, rarely 3 or 2, prominent ridges, glabrous or rarely setose; pappus reduced to a slightly-raised annulus. In one species the ridge is produced into a short horn-like process at each angle, in another into a spine as long as the achene.

It is hoped that the following descriptions of the known New Zealand species will be found useful to students of the genus.

Abrotanella, Cassini.

1. **A. linearis,** Berggren, Physiograph. Saltskaps, Mineskrift Lund, 1878, p. 14, t. 3, f. 28–38.

A tufted scapigerous herb, rarely exceeding 2in. in height. Leaves radical, spreading, equalling or slightly exceeding the scapes, $\frac{1}{2}$in.–1$\frac{1}{2}$in. long, linear, obtuse or apiculate, with sheathing bases which are slightly hairy. Scapes $\frac{1}{2}$in.–1$\frac{1}{2}$in. high, with 1 or 2 or several linear obtuse bracts. Head solitary: involucral scales 8–12, subacute, obscurely 3-nerved; ovary of ray-florets 4-angled; achenes clavate, with 4 ribs.

Hab. South Island: Mountains of Nelson, Westland, Canterbury, and Otago, but often local; 2,000ft.–3,000ft. Stewart Island; sea-level to 2,000ft.

Diminutive specimens are sometimes less than $\frac{3}{8}$in. in height; on the other hand the leaves occasionally exceed 2in. in length, and the rootstock is sometimes largely developed, the decaying bases of the old leaves being more or less persistent. The lateral nerves of the involucral leaves are sometimes very faint, and disappear in drying, while the median nerve becomes more prominent.

2. **A. cæspitosa,** D. Petrie, MS.

Tufted. Stems $\frac{3}{8}$in.–$\frac{1}{2}$in. high. Radical leaves recurved, $\frac{3}{8}$in. long, linear, obtuse, concave above, with a scarious margin when young, coriaceous. Scapes naked or with 1 or 2 short bracts. Head solitary: involucral scales 7 or 8, 3-nerved, with broad scarious margins, broadly rounded at the apices, often erose. Florets about 6. Corollas not seen. Achenes (immature) ovoid, compressed, with broad margins.

Hab. South Island: Otago, Mount Kyeburn, *D. Petrie!*

A curious little plant, with the leaves of *A. spathulata*, and the solitary head of *A. linearis*, but smaller in all its parts than either. The achenes appear to differ widely from both; they are not at all tetragonous. Better specimens must be obtained before a good description can be drawn.

3. **A. spathulata,** Hook. f., Handbk. N.Z. Fl., 139. *Trineuron spathulatum*, Hook. f., Fl. Antarct., i., 23, t. 17.

Tufted; 1in.–3in. high. Leaves rather close-set, spreading, $\frac{1}{2}$in.–1in. long, coriaceous, obtuse or acute. Scapes sparingly leafy or with 1, 2, or more leafy bracts near the apex. Heads pedunculate, crowded near the top of the scape. Involucral scales 8–10, oblong, with 3 translucent nerves. Florets 8–12; those of the disc with short patent teeth. Achenes ovoid compressed with 3 cellular ribs, abortive; or tetragonous compressed with 4 ribs, perfect.

Hab. Auckland Islands; 1,000ft.–2,000ft. Campbell Island; 500ft.–800ft.

The largest species. The achenes with 4 ribs do not appear to have been noticed by Sir Joseph Hooker, probably owing to his visit having been made at an early period of the season. The cellular structure of the ribs of the achenes, and of the veins of the involucral scales, becomes greatly obscured after maturation.

4. **A. rosulata,** Hook. f., Handbk. N.Z. Fl., 139. *Ceratella rosulata*, Hook. f., Fl. Antarct., i., 25, t. 18.

A small tufted herb, with prostrate or suberect stems, $\frac{1}{2}$in.–1$\frac{1}{2}$in. high. Leaves $\frac{1}{4}$in.–$\frac{1}{3}$in. long, narrow-ovate or lanceolate, acute or subacute, patent, tips recurved, concave above, very coriaceous, 5-nerved beneath, dense. Heads 3–6; terminal partially hidden by the apical leaves. Involucral leaves 8–10, linear-oblong, 3-nerved; disc-florets about 4, corolla 4-angled, swollen at the base; ray-florets, corolla tubular, with 4 spreading teeth. Achene tetragonous, 4-ribbed, narrowed below; each rib produced upwards into a short horn.

Hab. Campbell Island; rare and local; 1,000ft.

A harsh, rigid plant, easily distinguished from all other species by its peculiar habit, and by the 4-horned achenes.

5. **A. inconspicua,** Hook. f., Handbk. N.Z. Fl., 140.

A moss-like plant with naked stems $\frac{1}{2}$in.–2in. high, densely leafy. Leaves $\frac{1}{4}$in.–$\frac{1}{3}$in. long, spreading or ascending, subulate or linear-oblong, concave at the base, subacute, rigid and rather flat when dry. Head solitary, almost hidden by the upper leaves; involucral scales linear-oblong, 3-nerved, obtuse. Florets 15–20, crowded; of the disc, tubular, deeply 4-cleft; of the ray, with 4 spreading narrow lobes. Achenes linear-clavate, with 4 prominent ribs.

Hab. South Island: Otago, Mount Alta, *J. Buchanan!* Ben Lomond, Dunstan Range, Mount Pisa, *D. Petrie!* 5,000ft.–6,000ft.

Mr. Petrie's specimens from Mount Pisa are very robust, and contrast strongly with the original specimens collected by Mr. Buchanan, which are less than $\frac{1}{2}$in. high. When dry the leaves appear to be partially flattened, with a strong marginal nerve which is scarcely observable in fresh specimens.

6. **A. pusilla,** Hook. f., Handbk. N.Z. Fl., 139. *Trineuron pusillum*, Hook. f., Fl. N.Z., i., 130.

A slender wiry species. Stems 1in. long, puberulous, emitting long fibrous roots. Leaves $\frac{1}{6}$in.–$\frac{1}{3}$in. long, narrow-linear, acute, flat above with a prominent midrib below. Heads solitary, shortly pedunculate, sunk amongst the upper leaves; involucral leaves linear, obtuse, ribbed. Achenes linear-clavate, 4-angled.

Hab. North Island: Snowy places amongst the Ruahine Mountains, *Rev. W. Colenso, F.R.S.*

I copy the above description from Hooker, as this species has not been found since its original discovery, more than forty years ago.

7. **A. muscosa,** n.s.

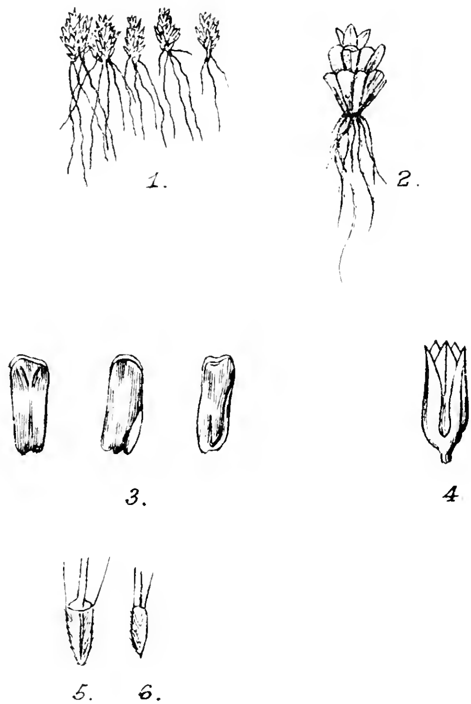
A minute herb; stems $\frac{1}{5}$in.–$\frac{1}{4}$in. high; solitary or forming matted patches $\frac{1}{2}$in.–1in. in greatest diameter. Leaves dense, imbricating, $\frac{1}{8}$in.–$\frac{1}{7}$in. long, erect, linear, concave above, excessively coriaceous, truncate or retuse, with a stout marginal nerve, rarely obtuse. Heads hidden amongst the apical leaves, shortly pedunculate. Involucral scales 5, oblong acuminate, obtuse or acute; nerves indistinct. Florets 4 or 5; of the disc, with 4 bristles from the base of the narrow tubular corolla, which is indistinctly 4-lobed; of the ray, ovary 4-angled. Achene tetragonous, shortly clavate, 4-angled, with a bristle as long as the achene at each angle; setose.

Hab. Stewart Island: Summit of Rakiahua; 2,300ft.

This singular little plant is allied to *A. rosulata* in the spreading horn-like bristles, which, however, are much longer than the short stout horns of that species. In general appearance it resembles a *Tortula* or *Bryum*, and may easily pass unnoticed. At present it has only been observed in the locality stated above, where it occurs in very small quantity. It closely approaches the original *A. emarginata*, Cass., from the Falkland Islands, and, with the exception of *Lemna*, is the smallest flowering-plant in the colony. It is the only species with setose achenes.

EXPLANATION OF PLATE XXXVI.

Fig. 1. *Abrotanella muscosa*, natural size.
Fig. 2. The same magnified.
Fig. 3. Leaves, magnified.
Fig. 4. Capitulum, magnified.
Fig. 5. Achene of the ray, magnified.
Fig. 6. Achene of the disc, magnified.



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ABROTANELLA MUSCOSA. n.s.

Art. XLIII.—*Descriptions of New Plants from the Vicinity of Port Nicholson.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

Cruciferæ.

Lepidium obtusatum.

A glabrous much-branched herb; stems prostrate, 6in.–12in. long; leaves elliptic or elliptic-ovate, fleshy; lower leaves gradually narrowed into long petioles, upper sessile, rounded at the tips, crenate or crenate-serrate or coarsely toothed. Racemes terminating short leafy branches. Flowers tetramerous, petals small, pedicels slightly exceeding the pods; pods ovate-cordate, emarginate, slightly winged above; style never exceeding the notch; stigma capitate.

Hab. North Island: Maritime rocks at the entrance to Port Nicholson, *Miss Kirk.*

This plant approaches *L. oleraceum*, Banks and Sol., in general appearance, but is less robust, and further differs from that species in the long petioles of the radical leaves, and in their crenate margins: the cauline leaves also are broad and always obtusely toothed. The pods are emarginate and winged above, while the style never exceeds the notch.

In *L. oleraceum* the leaves are acutely toothed; the cauline leaves are linear-cuneate, and acutely toothed at the apex only; the racemes are usually paniculate, while the pods are subacute and quite entire, with projecting styles.

Note on Lepidium oleraceum, *Banks and Sol.*

This plant is more variable than is generally supposed. Sir Joseph Hooker, in "The Flora of New Zealand" and in the "Handbook of the New Zealand Flora," includes the plant represented in M. Richard's drawing, t. 35, Fl. Nouv.-Zel.: this differs from Hooker's description in the slender habit, somewhat flexuous branches, short racemes, and in the emarginate pod with the stigma exceeding the notch: the leaves are sharply serrate. I have only seen a single specimen of this form, which is sufficiently distinct to demand varietal rank.

The original drawing of Banks and Solander represents a remarkably robust plant, the lower leaves of which are fully 4in. in length by upwards of 1in. in breadth, with short broad petioles; acute, and the margins rather coarsely serrate. The racemes are paniculate, and bear "ovate subacute pods, not winged on the back." I have never met with this form of the plant.

It is matter for regret that year by year the large succulent Lepidia are becoming increasingly rare. Wherever sheep have access to them they are closely eaten off, and speedily die out, although if only a single stem is allowed to mature its fruit seedling plants appear in abundance. Happily for *Lepidium obtusatum*, it grows in a few spots which are inaccessible to sheep, so that it will probably hold its ground for many years. *L. oleraceum* is stated by Captain Cook to have occurred in such abundance that he was able to obtain boatloads of it, which proved of good service to his crews when troubled with scurvy; but the plant has become so rare that some New Zealand botanists have never seen it in the recent state.

Tillæa diffusa.

A very slender herb, with prostrate or erect, matted, filiform stems, 1in.–3in. long, reddish. Leaves opposite, fleshy, $\frac{1}{12}$in.–$\frac{1}{8}$in. long, linear-oblong, flat above, convex beneath, minutely apiculate when fresh, narrowed into a short petiole, petioles connate, forming a membranous sheath round the stem. Flowers on short axillary peduncles, solitary, tetramerous, calyx-segments broadly ovate, obtuse; petals equalling the sepals; scales, 0; carpels, 4, minute, ovate, enclosed in the persistent perianth, 2–4-seeded.

Hab. North Island: Miramar. In places where water has stagnated during the winter.

Allied to *T. debilis*, Colenso, from which it is distinguished by its larger size, broader leaves, broad obtuse sepals, and 2–4-seeded carpels.

Coprosma buchanani.

A much-branched shrub, 5ft.–10ft. high, branches spreading ascending; bark reddish-grey, papery; branchlets puberulous or pubescent. Leaves opposite, distant, or in opposite pairs on abortive branchlets, $\frac{1}{2}$in. – 1in. long, puberulous, obovate, obtuse, narrowed into a short puberulous petiole, minutely ciliate when young; stipules triangular, puberulous or minutely ciliate. ♂ flowers not seen; ♀ solitary axillary, lobes of cupule large; calyx-limb membranous, 4–5-toothed, not ciliate nor pubescent; corolla campanulate, deeply 4–5-cleft, segments acute; stigmas 2, robust. Fruit, 0.

Hab. North Island: Near Cape Terawhiti.

This perplexing plant was first observed by me in 1874, but, although many miles of coast have been carefully searched, I have failed to find the ♂ plant. Mr. Buchanan, F.L.S., in whose honour I have named it, informed me that, although it had for many years been known to him in the locality where it was seen by me, he had searched for it in vain elsewhere. As the remaining specimens are few in number, and appear to be dying of old age, it seems advisable to publish this imperfect description in the hope that it may lead to the discovery of the plant in some other district.

Its nearest ally is *C. rigida*, Cheeseman, from which it differs in the compact ascending branches, which never divaricate at right-angles; in the larger and broader pubescent leaves, and especially in the ♀ flowers, which have a larger calyx-limb which is never pubescent; in the campanulate corolla, and more robust style. In some respects it approaches *C. spathulata*, A. Cunn., but is readily distinguished from that species by the much-branched habit and obovate or linear-spathulate puberulous leaves. Its true affinities, however, must remain in abeyance in the absence of the ♂ flowers and the fruit.

ART. XLIV.—*Notice of the Occurrence of Australian Orchids in New Zealand.*

By T. KIRK, F.L.S.

[Read before the Wellington Philosophical Society, 24th February, 1892.]

Caleana minor, R. Brown.

This remarkable plant was detected near Rotorua in 1890 by my friend the Rev. F. H. Spencer, who after protracted search succeeded in obtaining four or five specimens, which he generously presented to me. It is one of the most interesting additions to the New Zealand flora that have been made during recent years, and is, moreover, extremely rare outside the colony, having been observed only in two localities in New South Wales and another in Tasmania, occurring very sparingly in all its habitats. It was originally described by R. Brown in 1810. On account of the interest attending its discovery here, and for the convenience of New Zealand botanists, I append a somewhat detailed description.

Root of two or three short fibres and two small oblong tubers, which are irregularly narrowed towards their extremities. Stem and leaf glabrous, reddish; the former almost filiform, 4in.–6in. high: the leaf extremely narrow-linear, flat, from one-third to one-half the length of the stem. Flowers 1 to 3, on slender pedicels ¾in. long, with a small acute bract at the base, inverted: sepals and petals almost equal, about

$\frac{3}{8}$in. long, linear, sometimes with infolded margins; the dorsal sepal narrow linear-spathulate, 3-nerved. The lateral sepals spring from either side of a strap-shaped process or hinge which carries the labellum, and is about $\frac{1}{12}$in. long, and unequally waved or wrinkled at the margin. The labellum itself is broadly pear-shaped, but, owing to a constriction at the middle, is unequally 2-lobed: it is peltately attached by its broad end to the process just described, and is margined with rather large purplish-red tubercles, the largest being situate at the free extremity: the exterior surface is green. The column is nearly as long as the sepals, and is furnished with a large dilated wing on each side, the whole forming a cup-shaped cavity, which is capable of being closed by the labellum. Owing to the inversion of the flower, the anther occupies the lowest part. The entire flower presents a strange resemblance to a spider, the body of which is formed by the expanded and dilated column, the legs by the narrow-linear sepals and petals, and the cephalothorax by the labellum: the resemblance is increased by the dull-red or reddish-brown coloration of the column and the tips of both sepals and petals. The pollen-masses are four in number.

The position of the labellum when not closed is nearly horizontal, the free extremity being more or less ascending at first. One of my specimens has an apparently ripe capsule, with perfect seeds.

The following instructive and interesting remarks on the hinge of the labellum and on the probable mode of fertilisation in *Caleana major*, R. Br., are copied from the splendid work on "Australian Orchids" by R. D. Fitzgerald, F.L.S., and will be welcomed by all students of New Zealand plants: although the hinge is shorter in *C. minor*, there is no other difference:—

"The labellum is not sensitive, but when raised remains in unstable equilibrium, subject to be closed by a slight touch. The mechanism of the hinge by which this end is obtained is curious and simple. Imagine a thin strap of indiarubber having its edges slightly contracted: the result would be that the centre would bulge to one side or the other, and according to the side on which the convexity or concavity lay the strap would be bent. It is evident that a lid so supported would be ready to fall on a slight pressure from behind; but in this flower the column has taken the position usually occupied by the labellum, and an insect alighting on it would not bring down the lid, a touch or even a push from the front having no effect, while the falling of the lid from a touch on the back would be but to exclude the insect. . . . It struck me that the weight of the insect might here act to bring down the labellum, which in other cases springs up by elasticity against the weight. My first experiment was with a blow-fly, hung by a thread and let swing against the labellum. But the blow-flies were either too restive, or, by grasping the cup as well as the lid, prevented their weight from being felt by the labellum. I therefore had recourse to ladybirds as more tractable. One of the ladybirds which attack the Solanums was induced to climb up a match till it reached the end, when it readily left the wood for the labellum, and immediately the labellum descended and the insect was fairly caught in the cup. It remained imprisoned for about two minutes, when it forced itself out, but did not fertilise the flower or remove the pollen. Other ladybirds similarly entrapped escaped in from one to twenty minutes, but none of them fertilised the flower, the obvious reason being that they were caught with their backs to the column, and the breadth and smoothness of the back prevented the pollen or stigma from being touched. I had frequently placed *Caleanas* where house-flies would be likely to alight upon them, and had occasionally observed that they had closed the flowers, but the flies were never caught, and I believe the labellums were *sprung* by being struck from the back. To help nature and make the flowers more attractive in the proper part, I now placed a little honey on the front of the labellums of a dozen flowers, and was soon rewarded by the capture of several flies, only two of which, however, fertilised plants, and one perished in so doing—it was so firmly united to the stigma that it could not help itself. Six hours was the longest time noted as the imprisonment of a fly, but the labellum never rose until the insect escaped or (as in the one instance) died. The usual time for the flowers to remain shut when no insect is enclosed is from a quarter of an hour to an hour."

Mr. Fitzgerald states that in all probability the right insects were not experimented with; and, whatever may be the cause, ripe capsules are very rarely produced.

It may be added that four species of *Caleana* have been described, all except *C. minor* being restricted to Australia.

Calochilus campestris, R. Brown.

Calochilus is a small genus comprising only three species, which until a few years back were supposed to be absolutely restricted to Australia. In 1882 Mr. J. Buchanan, F.L.S., reported the occurrence of *C. paludosus* in the Collingwood district;* and in 1887 Mr. T. Ball showed me a single flower of another species collected by the late Mr. E. B. Dickson, B.A., in the Rotorua district.; but it was not until 1890 that I was able to obtain good specimens, through the kind exertions of my old friend the Rev. F. H.

* Trans. N. Z. Inst., vol. xv., 340.

Spencer, who, although on the eve of leaving for England, gave himself considerable trouble in searching for the plant, and was rewarded with success. I am indebted solely to him for the opportunity of examining good specimens, which, although differing in one or two points from the Australian plant, must be identified with *O. campestris*, R. Br.

The specimens of this plant figured on t. 106A in Hooker's "Flora Tasmaniæ" represent a somewhat robust plant with a very short leaf, little more than a sheathing bract, several cauline bracts, and a short broad labellum, clothed with a red fringe on the margins and surface, except at the short beak-like point, which is naked. The Rotorua plant differs in having a long broad basal leaf, and one or two sheathing cauline bracts, and especially in the longer labellum, with its long naked flexuous tip, and the upper portion of the labellum clothed with large red calli. Mr. Fitzgerald's fine drawing in "Australian Orchids" represents the habit and structure of the New Zealand plant exactly, but differs in the coloration, the calli and fringes in all the Rotorua specimens seen by me being of a deep velvety red throughout, and showing no trace of blue or even of purple.

The Rotorua plant is usually robust, 9in. to 18in. high, with a leaf from one-third to two-thirds the length of the stem, $\frac{3}{8}$in. to $\frac{5}{8}$in. broad, and one or, less frequently, two sheathing cauline bracts. Flowers 3–6; pedicels, exceeded by the acuminate sheathing bracts, $\frac{1}{2}$in.–$1\frac{1}{2}$in. long. Sepals 4–5 lines long, upper broadly ovate, almost galeate, lateral narrower, rather strongly veined; lateral petals shorter; labellum $\frac{5}{8}$in.–$\frac{3}{4}$in. long, terminating in a narrow flexuose naked tip, strongly fimbriate on the margins and upper surface for two-thirds of its length above, most of the upper portion being covered with rather large naked calli, which gradually pass into hairs on the expanded portion of the labellum; above the calli is a small naked bar which is slightly thickened. The column is furnished with two short broad wings reaching to slightly above the stigma, and broadly rounded in front, with a large intramarginal gland at the base of each wing; anther bent forward and projecting, so that the base of the pollen-masses projects beyond the rostrum, and comes in close contact with the stigma even before the flower is fully expanded, thus insuring self-fertilisation. Pollen-masses 2, clavate.

ART. XLV.—*On a New Mistletoe.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

Plate XXXVII.

WHEN botanizing in the Castle Hill Basin with my friend J. D. Enys, F.G.S., in 1876, we found the curious little *Viscum* represented in the plate (Pl. XXXVII.) growing on *Coprosma propinqua*, A. Cunn., at an elevation of fully 3,000ft.; but, as the specimens were in an imperfect state, they were laid aside in the hope that an opportunity of collecting both male and female flowers in good condition might be afforded at no distant date. Unhappily, the expectation has not been realised; but when visiting the district during January, 1891, Mr. Enys and myself found the plant growing on *Aristotelia fruticosa*, Hook. f., in another habitat; and, although we failed to find flowering specimens, I venture to publish an imperfect description in the hope that some of my fellow-workers may be induced to keep a look-out for it.

It belongs to the section Ploionuxia, and is most nearly related to *V. lindsayi*, Oliver, which, although rare and local, is found in lowland districts from Hawke's Bay to Otago.

Viscum clavatum.

A small, much-branched, leafless shrub, 1in.–2in. high, glabrous in all its parts, and rather succulent. Branchlets crowded, more or less divaricate. Joints of the stem linear-clavate, flat, $\frac{1}{4}$in.–$\frac{1}{2}$in. long, $\frac{1}{20}$in.–$\frac{1}{8}$in. broad. Spikes jointed, solitary, lateral or terminal, $\frac{1}{2}$in. long or more. Flowers in 2-4, rarely 5, rather distant whorls: ♂ flowers not seen; perianth of ♀ flower minutely 3-lobed, lobes persistent. Berry (immature) minute, pyriform, viscid.

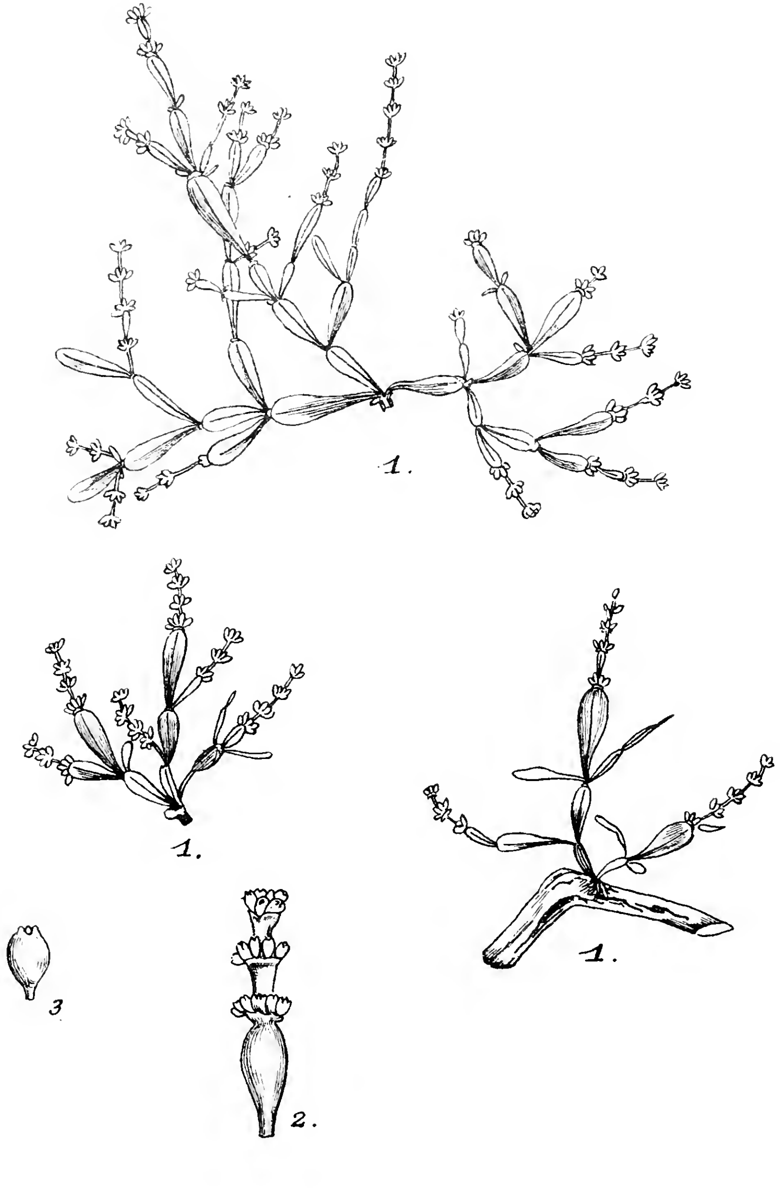
Hab. South Island: Canterbury, Castle Hill Basin; 2,300ft.–3,000ft. Parasitic on *Coprosma propinqua*, *Aristotelia fruticosa*, *Discaria toumatou*, &c.

This remarkable little plant is of a dark-green hue, which exactly matches the dark foliage of its hosts; so that, although occurring in profusion, it may easily escape notice. Its nearest ally is *V. lindsayi*, from which it differs in the form of the articulations and in their length being more than twice their breadth; in the spikes being always solitary; and in the pyriform fruits. The membranous crown or margin at the apex of each joint, also, is larger than in *V. lindsayi*, while the whorls are more distant and the flowers less crowded.

The joints of the spike, or peduncle, show in some instances a gradual transition from the normal articulations of the stem to a simple terete or slightly-flattened condition. The basal joints are often distinctly clavate, and as large as the ordinary joints; the upper joints gradually lose the clavate form, and diminish in size towards the apex. Not infrequently some of these joints closely resemble the stem-joints of *V. salicornioides*, A. Cunn., belonging to the section Aspiduxia.

EXPLANATION OF PLATE XXXVII.

Fig. 1. *Viscum clavatum*, natural size.
Fig. 2. „ „ spike, magnified.
Fig. 3. „ „ young fruit, magnified.



L. M. K. del.

VISCUM CLAVATUM. T. Kirk.

IV.—MISCELLANEOUS.

Art. XLVI.—*On the Ancient Relations between New Zealand and South America.*

By Dr. H. von Jhering, Rio Grande do Sul, Brazil.

Communicated by Professor Hutton.

[Translated from the German by H. Suter.]

[*Read before the Philosophical Institute of Canterbury, 6th August, 1891.*]

The following communication is due to the elaborate papers of Professor F. W. Hutton "On the Origin of the Fauna and Flora of New Zealand,"* which were made accessible to me by the great kindness of the author. On the whole, the views contained in those papers agree with my own ideas of the former connection between the areas under consideration, which are in opposition to Mr. Wallace, from the views of whom I, with Professor Hutton, differ in very essential points.

In my opinion, an important defect in Mr. Wallace's studies is the fact that he makes too little distinction between the different groups of the animal kingdom. Birds and mammals, whose living genera appear only in the Tertiary era, must evidently show a different geographical distribution from the Teleostei, reptiles, &c., which are represented in the Cretaceous and beginning of the Tertiary era; or to the land and fresh-water molluscs, many of which were living already during the Secondary or even the Palæozoic era. Mr. A. R. Wallace ("Darwinism," 2nd ed., London, 1889) still upholds the doctrine of the "permanence of oceanic and continental areas." I am as much convinced of the erroneousness of this doctrine, which quite arbitrarily takes the 1,000-fathom line as corresponding essentially to the limit of the ancient continents, as I am that the ideas of Darwin and Wallace on "natural selection" as the cause of the origin of species will have but a

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* *Annals and Magazine of Natural History*, ser. 5, vol. xiii., p. 425, and vol. xv., p. 77.

historical interest in the coming centuries. Mr. Wallace's supposition that land and fresh-water molluscs, lizards, &c., were distributed over the whole Pacific Ocean by the waves of the sea I think to be more than bold. Under such circumstances, it is but natural that one looks for a less constrained explanation. It is a fact, curiously enough hardly noticed till now, that those land and fresh-water molluscs which appear only in the Tertiary era show a very limited distribution, or else are restricted to a few regions only; whilst genera of the Palæozoic era are cosmopolitan. Thus, *Ampullaria* and *Anodonta*, appearing only towards the end of the Cretaceous period, are found neither in Chile, nor in Australia, New Zealand, or Polynesia. But the genus *Unio*, which we know to occur already in the Jura formation, is not wanting in the countries mentioned, and may perhaps also be found on the Fiji Islands. In Chile and New Zealand *Unio* is the only representative of the family Naiadæ, likewise in south-east and west Australia; but in north Australia a representative of the genus *Mycetopus* is found, more or less allied forms of which occur also in South America, Africa, and southern Asia, and which evidently reached Australia from the latter country.

With still wider distribution than *Unio*, there are in Polynesia representatives of *Limnæa*, *Physa*, *Planorbis*, *Ancylus*, *Amphipeplea*, *Pupa*, *Zonites*, *Succinea*, almost all of these genera being known from the Carboniferous. Too little attention has hitherto been paid to this fact. To give the distribution of the *Nephropneustæ* (*Pulmonata stylommatophora*, aut.) is not possible at present, because the anatomy of the genera is not sufficiently known. A few weeks ago it happened to me that I recognised, by aid of anatomical examination, one of our *Hyalinæ* to belong really to the genus *Microcystis*, a genus which, according to its anatomy—absence of the receptaculum seminis—may be considered as one of the oldest. Yet the oldest known Nephropneust is a Zonitid from the Devonian, perhaps actually a *Microcystis*, which is, at any rate, a nearly-allied genus. Perhaps *Patula*, *Streptaxis*, *Stenogyra*, &c., belong also to this group of very ancient and cosmopolitan land-shells, whose distribution in space and time deserves a close study. This certainly can only be done after careful anatomical researches, and our knowledge may therefore progress but slowly. Further, many of these animals may have been introduced. All this is less to be feared with fresh-water shells, whose introduction may be intentional only as far as it is done with the spawn of fishes, &c.; nevertheless, to a smaller extent. On the other hand, mistakes may be more likely expected in their determination.

All these facts induced me to take up the special study of the Naiadæ and the fresh-water fauna in general, as it proves to be the most reliable guide to the knowledge of the geography of our globe during Palæozoic and Mesozoic times. I am convinced that the importance of the fresh-water fauna in this sense will soon be generally acknowledged, and on this point I fully agree with Professor Hutton, who so clearly pointed out that the immigration of birds and frogs to Australia must have taken place by different ways and at different times. Moreover, I agree with Professor Hutton in thinking that an ancient land-communication must have existed between South America and New Guinea, Australia, &c., to account for the close relations between the two territories in flora and fauna. But, with regard to South America, my own researches, as well as some other new discoveries, have led to so many new and important points of view that some of Professor Hutton's statements require alteration, and it is with reference to this that these lines have been written.

Professor Hutton says: "Our general results, then, are that in early Mesozoic times New Zealand, eastern Australia, and India formed one biological region, land probably extending continuously from New Zealand to New South Wales and Tasmania. During the Lower Cretaceous period a large Pacific continent extended from New Guinea to Chile, sending south from the neighbourhood of Fiji a peninsula that included New Zealand. Nearly all the southern part of America was submerged. This continent supported dicotyledons and other plants, insects, land-shells, frogs, a few lizards and perhaps snakes, and a few birds, but no mammals. In the Upper Cretaceous period New Zealand became separated: the South Pacific continent divided in the middle between Samoa and the Society Islands, the eastern portion being elevated while the centre sank. It ultimately became what we know now as Chile, La Plata, and Patagonia."

Let us examine now the relations of the faunistic and geological evidence to this hypothesis. The investigation of the fresh-water fauna shows a great agreement between Chile and South Brazil. In Chile, as well as in South Brazil, the waters, which are covered with *Lemna* and *Confervæ*, and overgrown with rushes—*Typha*, *Sagittaria*, *Potamogeton*, &c.—contain besides *Unio*, *Cyrena*, *Pisidium*, species of *Planorbis*, *Limnæa*, *Ancylus*, *Physa*, *Chilina*, and, in addition, several genera of frogs and fresh-water fishes, and of Crustacea *Parastacus* and *Æglea*. It is not known how far the alliance of the lower animals goes; but *Æglea lævis* occurs in Chile as well as in the Rio Grande do Sul, in both places with the parasite *Temnocephala chilensis*. This parasite is found here also living on *Parastacus* and *Ampullaria canaliculata*. In

St. Catharina Fritz Mueller found a second species of it. The distribution of *Parastacus* is very peculiar. As well as in Chile species of this genus are found in Entrerios in Argentina (Burmeister), Uruguay (E. Berg), Rio Grande do Sul (Hensel, von Jhering), and St. Catharina (Fritz Mueller). The species of *Chilina* show exactly the same distribution. A short time ago I received a new species, standing between *fluminea* and *gibbosa* (*Chilina muelleri*, mihi), which was collected by Mr. Fritz Mueller in the Itajahy, in St. Catharina, where it is common on stones with *Lithoglyphus lapidum*. This district will probably extend to Parana, but it is not very likely that it will go as far as Rio de Janeiro, where many naturalists have been collecting. The rivers near Rio de Janeiro flowing to the Atlantic Ocean show a special fresh-water fauna, chiefly Naiadæ, whilst those from St. Catharina are more like the forms from Chile. I know about one dozen species of *Unio* from Chile, and six of them are also found in Rio Grande do Sul or in La Plata. These are the following: *Unio diplodon, U. lepidior, U. montanus, U. beskeanus, U. koseritzi, U. auratus, U. rhuacoicus, U. casablancæ, U. æthiops, U. modestus, U. charmanus, U. colchaguensis, U. faba.*

Evidently we have to deal here with a coherent fresh-water area, which no doubt in ancient times formed also a geographically uniform and united territory, for which I propose the name of *Archiplata*. This land, low-lying and abounding with rivers and swamps, must have been in existence before the upheaval of the Andes, because this is the only way by which we can explain the distribution of forms bound and limited to fresh water. The chain of the Andes would have proved an insurmountable obstacle to them, as it really did later on for all the immigrants from north to south, such as *Anodonta, Mycetopus*, &c., or *Ampullaria*, and to the alligators and tortoises, the *Characinidæ, Chromidæ*, &c., and to the representatives of a new tropical fresh-water flora, such as the species of *Victoria* and *Pontederia*. All these are missing in Chile, for the only reason that the upheaval of the Andes had commenced when they began to spread into Archiplata. The Andes may not have been very high then, but they formed a sufficient barrier to prevent migration to the west.

This Tertiary influx has changed the flora and fauna east of the Andes to an enormous extent. The fresh-water fishes, two only of which are known to me as common to Chile and Rio Grande do Sul—*Gobius* and *Trichomycterus*—were retreating southwards, or perished in the struggle with the new immigrants. It is the task of future investigation and research to discover the complete flora and fauna of this Archiplata area. Many things will be understood through it: thus the distribution of the penguins (*Spheniscus magellanicus*) found by me, and of many of the *Lacertidæ* on the coast of Rio Grande do Sul. The species of *Liolæmus*, *Saccodeira*, and *Urostrophus* which I found in the Rio Grande do Sul belong to genera represented chiefly in Chile and Patagonia. Of Patagonian shrubs and trees many are found in the south of Rio Grande do Sul.

In comparing the old fauna of Archiplata with that of New Zealand and Australia many points of contact are found. The perception that the species of *Unio* from New Zealand and many adjoining countries have their near allies only in Chile and South Brazil formed for me the starting-point for the pursuit of the questions here dealt with. I hope that, through the kind aid of Professor Hutton and other scientists in New Zealand and Australia, I shall be enabled to study this question thoroughly, especially with regard to the animals. Günther also unites New Zealand with Chile and Patagonia into one region for the fresh-water fishes. The *Parastacidæ* show the same, and many botanical facts point to a former land-communication between these countries.

Before we enter further on this subject we must try to form an idea of the geology of Archiplata. Relying on the distribution of the Jurassic strata in the Andes, Professor Hutton concludes that the whole of this area has been submerged by the sea during the Jurassic period. No doubt a deep bay occupied then the place of the Andes, but on its sides low-lying land might exist. In the old Archiplata fauna we meet with Mollusca and Crustacea whose genera are already found directly, or in nearly allied forms, in the Jurassic. Besides the very old character of this fauna, which was in existence before the upheaval of the Andes, there is geological evidence to show that parts of Archiplata belong to a very old continent. Outside the Andes the Jura formation has been found neither in La Plata nor in Brazil. In Rio Grande do Sul only the Carboniferous formation has been found. Many times it has been taken for a younger formation, but I have seen myself a beautiful trunk of *Lepidodendron* in the mines of Jeronymo. Liais* says that it has been described by Carruthers as *Flemingites pedroanus*, and that, besides it, *Noeggerathia*, *Glossopteris*, *Odontopteris*, and *Calamites* are found. We leave it undecided whether this flora belongs to the Carboniferous or, as Liais thinks, to the Trias; at all events, it proves that land with a rich flora existed here at the beginning of the Mesozoic era.

The Cretaceous formation is not known in this district outside the Andes, but is well developed between Pernambuco and the Amazon, and has been studied by White in a most

* Liais, "Climats, Géologie, Faune du Brésil," Paris (1872), pp. 201, ff.

admirable way. This scientist also made us acquainted with a fresh-water Cretaceous formation which he discovered near Bahia. During the Tertiary period the sea extended to the Andes, where near Pebas a brackish-water fauna was deposited, which has been the subject of very careful study by Dr. Boettger. But lately Ochsenius* has shown that considerable parts of the Andes were upheaved to their present height towards or after the end of the Tertiary era. In Chile (lat. 37° S.), as well as in Bolivia (Potosi), Tertiary plants have been found, which have been studied by Engelhard. Those from Chile have not been published yet, but they belong to genera living now in tropical South America, eastward of the Andes, indicating a warm, humid climate, and are now extinct on the western side of the Andes. The same applies to the species of *Cassia*, *Sweetia*, *Leptolobium*, *Myrica*, &c., found near Potosi (lat. 19° S.), at an altitude of 4,200 metres, which cannot have been grown at such an elevation as they are found at now.

We therefore have to consider the present flora of Chile, which is adapted to the more rough climate of the Recent period, as having in a great measure arrived from the south. It was preceded during the Tertiary era, when the Andes had only a small elevation, by a tropical flora, which spread to Brazil and the adjoining tropical countries whilst the Andes were being upheaved. How many changes in the animal kingdom may have been going on hand-in-hand with the alterations in the flora? I only wish to point out the absence of *Hyla* in Chile, which genus probably was represented in the Archiplataic area as well as the *Cystignathidæ*, both of which are found in Australia, and missing in Africa—facts of importance awaiting interpretation. Chile, in my opinion, must have had species of *Hyla* during Tertiary times, although no representatives of the Hylidæ maintained themselves in the country.

Ochsenius recalls to mind that, according to Conte, the upheaval of the Sierra Nevada, in California, also took place in Post-tertiary times; that in Lake Titicaca a relic-fauna of Crustacea from the Pacific Ocean is living, and that Agassiz found in its neighbourhood, 900 metres altitude, fossil corals corresponding with recent forms of the Pacific.

The upheaval of the Cretaceous formations in Peru and Bolivia is, according to Ochsenius, essentially due to events during the Quaternary period, whilst the Chilean Tertiary coal-bearing littoral sank at the same time. To such a relative

* Zeitschrift der deutschen Geologischen Gesellschaft, 1886, pp. 766–772; and "Die Natur," Halle, Jahrg. 361, 887, No. 40, 41; and Jahrg. 39, 1890, No. 38.

late subsidence of the Chilean coast points likewise the great similarity of the flora and fauna of Chiloë with those of Chile. The *Unios*, for instance, from Chiloë are identical with those from Chile, and perhaps also with those from New Zealand.

The opinion of Ochsenius is shared by many renowned geologists, but disputed by others. The facts we have mentioned may well be in accordance with it, inasmuch as our zoogeographical reflections lead to the conclusion that with the beginning of the Tertiary era, or soon afterwards, an upheaval, inconsiderable perhaps, must have been going on in the district of the present Andes, which explains why the successively-arriving immigrants of the fresh water could not pass over this barrier. On the other hand, this low central mountain-chain offered a way to the placental mammals of the Argentine Tertiary by which they could accomplish their entrance, probably in the Oligocene, certainly not later than early in the Miocene.

If we inquire after the aspect of the orographical conditions in early Tertiary times, there are, I think, sufficient facts to give a satisfactory answer. The valley of the Amazon was covered by the sea. Deposits of the Cretaceous sea, in some parts perhaps rather belonging to the Eocene, cover large areas south of the Amazon, eastwards in Para, Paranahyba, Sergipe, &c., as far as Bahia, and westwards in Peru and Bolivia. At the end of the Cretaceous period, and during the Eocene, South America was broken through from ocean to ocean by the sea in the direction of the Amazon. In all probability the upheaval of the Andes had begun already in the Eocene period, and soon afterwards the Pebas strata must have been deposited in brackish water on the foot of the still but little elevated chain of the Andes. According to Boettger the Pebas deposits are of Oligocene age. It is to be supposed that during the Oligocene period a land-communication was existent in the district of the present Andes, between the high land of Guyana and Venezuela (Archiguyana) and Archiplata, by way of which the old fauna of placental mammals would arrive in Argentina.

The mammal fauna has its nearest allies in that of the European Oligocene, which was probably represented in Africa by more or less similar forms. It is true that the supposed *Anoplotheria* of Argentina have been recognised as belonging to another genus (*Proterotherium*), but they are, together with the numerous Rodentia, more nearly allied to the European Oligocene fauna than to any other. Schlosser has pointed out that the *Theridomydæ* of the European Oligocene passed over to South America as *Chinchillidæ*, *Echimyidæ*, and *Caviadæ*. Of these Rodentia scanty remains are found on the Antilles and in Africa, and none, either recent or fossil, in

North America. They therefore cannot have immigrated by way of North America, but during different geographical conditions.

Between the Oligocene and the end of the Pliocene period South America was completely isolated, and therefrom it derives its peculiarity in flora and fauna. It was only at the end of the Pliocene, or perhaps even later, that North American mammals appeared in South America, whilst in return South American ones advanced to Mexico. There are no differences of opinion on this point, and the geology of Central America tells us that the Isthmus of Panama did not come into existence before the end of the Tertiary era. But it seems that many scientists think that a land-communication between North and South America might have existed in the beginning of the Tertiary era. No doubt many circumstances have here to be taken into consideration, as, for example, the communication of Florida with the West Indies, as proved by the Miocene land-shells of Florida, elaborately described by Dall, and the many changes which have taken place within the area of the West Indian Islands, a reliable judgment on which we are unable to give at present; but, as for the older period, we must, in my opinion, admit a sharp separation between the territories of North and South America. The fresh-water fauna of both shows enormous differences, in the Naiadæ and other molluscs, as well as in the fishes, tortoises, amphibians, &c. North America, with its *Cyprinidæ*, *Urodela*, &c., is in all these points more nearly related to the palæarctic region, while South America—that is to say, Archiguyana—shows close alliances only to Africa. With regard to the fresh-water fishes this is so well known that I need not dwell on it further, but I would point out that the old common features have been obscured through later relations to the Mediterranean and Indian faunas, wherefrom many elements have been absorbed.

After the upheaval of the Isthmus of Panama, mammals, birds, and Lepidoptera of the adjoining countries rapidly became mixed, and this was also the case with all the other rapidly-wandering creatures. Thus we see *Cinosternum* and other tortoises immigrate to the north of South America; even two species of *Urodela* (*Spelerpes*) advance as far as Ecuador; and even more noticeable is the exchange of *Batrachia* and *Lacertidæ*. Nobody will deny the importance of studying separately the two elements of South America if an account is to be given of the geographical distribution of the frogs. *Ranidæ* are missing in Archiplata just as completely as *Aglossa*, *Urodela*, and others, but are found in Ecuador and Columbia. The *Aglossa* and *Dendrobatidæ* are restricted to Archiguyana, Africa, and Madagascar. Even some genera of the fresh-water fishes, such as *Pimelodus*, have species in South America and Africa, the common area of the *Chromidæ* and *Characinidæ;* and, in the genus *Pontederia* of the water-plants, actually one and the same species, *Eichhornia natans*, occurs in the interior of Africa and South America.

No one studying carefully the fresh-water fauna can fail to perceive the enormous difference between North and South America, while Central America joins to Mexico. The marine deposits of the Cretaceous and Tertiary sea in Central America give us the key. I am of opinion that facts pointing in this direction can hardly be disputed, in spite of their being obscured by the Pleistocene intermixture of both faunas: but since Wallace's severe condemnation great prejudice exists against the assumption of the "Atlantis" (the subsided land-communication between Archiguyana and Africa) having existed up to the Oligocene period. The reason given by Wallace is the very considerable depth of the sea; as if a subsidence of 5,000 metres was more miraculous in itself than an elevation to the same amount! Also, Wallace is not even consistent. If he concedes "Lemuria," and even thinks of a land-communication in Miocene times between New Zealand and South America, then he should not oppose the Atlantis. It will hardly be possible to-day to say where this bridge was situated. The scanty remains of it may have lost, to a great extent, their old fauna, through alternating upheaval and subsidence, like New Zealand. But the subfossil *Bulimus* of St. Helena shows this island to be part of this old bridge across the Atlantic Ocean, and it explains the occurrence of numerous identical species of marine Mollusca in Brazil, the West Indies, and the Atlantic coast of Africa.

In consequence of what has been said hitherto, there can be no doubt about Archiplata being an old continent, existing since the Trias formation. I arrived at this conclusion through the study of the fresh-water fauna,* and it has quite unexpectedly, and almost at the same time, been confirmed from another side. A scientist who deserves great merit for his knowledge of the Tertiary mammals of Argentina—Florentino Ameghino†—has published a treatise on the old mammalian fauna of Patagonia, this fauna belonging partly to the Cretaceous partly to the Eocene formation, but I fancy that the whole of it may be of Cretaceous age. Ameghino includes under the name of *Diprotodonta* most of the Australian Recent marsupials, the Plagiaulacida, and the Mesozoic genera of

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* H. von Jhering, "Die geographische Verbreitung der Flussmuscheln," im *Ausland*, 1890, Nos. 48, 49.

† Florentino Ameghino, "Los Plagiaulacideos Argentinos," Buenos-Ayres, 1890.

marsupials, which are characterized by the syndactyly of the second and third toe, a pair of well-developed upper incisors, accompanied by two pairs of smaller ones, and one pair of strongly-developed lower incisors, and small or missing canines. It now appears that in Patagonia deposits are existent whose fossil mammals are entirely composed of Plagiaulacida. To my knowledge, no Tertiary fauna of a similar composition is known, but Marsh has lately described mammals from the Cretaceous formation of North America which are likewise exclusively composed of Plagiaulacida, and this is the reason why I think it very probable that the Plagiaulacida of the river-banks of the Rio St. Cruz, in Patagonia, belong to a Cretaceous fauna.

These Patagonian marsupials are not more nearly related to any other group of living or fossil marsupials than to many of the recent Australian genera. This is specially seen in the simple quadritubercular structure of the teeth, whilst the European and North American representatives show numerous denticules, arranged in two or three rows, on their molar teeth. This is found neither in Australia nor in Patagonia. On this point I fully agree with Ameghino, but not that the Plagiaulacida came from Patagonia into North America by way of an Eocene migration, which was geographically impossible. Moreover, according to quite recent discoveries made by Marsh, which were not then known to Ameghino, polymastodont and quadritubercular Diprotodonta lived together during the Cretaceous period in North America, and there can be no doubt but that both types were already co-existent during the Jura formation. But the genera with the serieswise disposition of the mammiform tubercles in two or three longitudinal rows do not seem to have reached the Australian Archiplataic territory, or, at least, disappeared again at a very early period. If, as Ameghino thinks, a land-communication between North America and Argentina existed during the Cretaceous epoch, this distribution would be inexplicable. The genus *Didelphys*, which, however, occurs Tertiary in North America, is also found in Europe; and *Didelphys*, as the descendant of its European precursors, the *Peratheria*, may have spread to both Americas without having been compelled to reach South America by way of North America. *Didelphys*, which is wanting in Australia, must therefore be attributed to immigration from the Old World.

When Ameghino from this draws the conclusion that a continent between Australia and Argentina must have been in existence in the Mesozoic era, he only proclaims what Professor Hutton, I myself, and many other scientists who have studied the flora and fauna of both countries have done before, but differing from Professor Hutton so far as to give this continent a higher age. The relative sentence runs as follows: "The recent Australian Diprotodonta therefore must date back in this continent as far as the beginning of the Eocene period at least, whilst the ancestors of the Diprotodonta common to Australia and Argentina must reach to a far more remote epoch, during which they were spreading over a very wide continent uniting Australia with South America in a more or less continuous connection." Ameghino thinks this continent was situated in the Pacific Ocean, and dated back to the Trias formation.

It is evident that these results must alter in many respects the hitherto-prevailing ideas. The theory mentioned by Professor Hutton, which allowed a Tertiary migration of northern types over the Andes into the Antarctic area, fails, for during the Cretaceous and in the beginning of the Tertiary era there was no chain of the Andes existent*; and when it began to rise, though to no considerable elevation, it was covered with a tropical, not alpine, flora. The reasons given allow much less an immigration of northern plants from North America over the whole length of the Andes. So far as an exchange of plants between Australia, &c., and South America took place, it must have gone on over the same land-bridge on which, in other latitudes or at other times, the temporary migration of the Antarctic flora went on. Whether such a rigorous distinction between a South American and an Antarctic flora as has been hitherto made will be possible to the same extent in future, seems to me very doubtful. Those who do not agree with me herein must indeed first study the phytogeographical condition of Rio Grande do Sul, especially the southern part of it, where, besides plants common in Argentina and Uruguay, many of central Brazil are found also: thus *Cedrela*, *Erythroxylon*, *Tecoma*, *Erythrina*, &c., with *Scutio*, *Durana*, *Celtis*, *Jodina*, *Phyllanthus*, *Lacuma*, &c., even the Patagonian *Berberis spinescens*, and, as I believe, *Colletia* also.

It therefore follows that the relations of the South American to other fauna-areas, as I have represented it here, are in strong opposition to Mr. Wallace's views; but, with regard to its relations to Australia and New Zealand (though variously modified in respect of South America), it is in harmony with the theory at which Professor Hutton, and other scientists who have studied the flora and fauna of the Australian region, have arrived.

To conclude, the results arrived at may be summed up as follows: South America was separated from North America from the Cretaceous to the end of the Pliocene period. A

* I suppose this migration to have taken place in the Pliocene. —F.W.H.

South American continent has existed only since the Oligocene period. It then consisted of two parts, united by the narrow isthmus of the Andes, which were completely separated from one another before the Oligocene period. These two parts form Archiplata (the area occupied at present by Chile, Argentina, Uruguay, and South Brazil) and Archiguyana (comprising the high plateau of Venezuela and Guyana). Each of these territories had its own fauna and flora, which differed as much from one another as those of interior Africa and North America do at the present time. Archiguyana must have been united with Africa by a land-bridge, a remnant of which is represented by St. Helena, whilst Archiplata extended to the south in a South Pacific Antarctic continent, which during the whole of Mesozoic times kept this area in communication with the Pacific continent, from which first a number of Polynesian Islands, then New Zealand, and finally Australia and New Guinea became separated. Reserved for further investigation remain the questions: Did the Atlantis reach only Archiguyana, or was a southern arm directed to that part of Brazil which extends between Rio, Bahia, and the Rio S. Francisco? What was its relation to the West Indies? What age is to be attributed to these parts of Brazil and Archiguyana? Were the mountains of the Brazilian coast also upheaved only during Tertiary times?—as I presume. All these questions have yet to be examined, as well as the original participation of each of these parts in that mixed fauna and flora which we call now "South American."

A great deal remains unsolved, but the results obtained regarding Archiplata and its connection with the Antarctic continent seem to me to be an important acquisition. That Archiplata owned an old common flora and fresh-water fauna; that the upheaval of the Andes, beginning at the end of the Cretaceous or commencement of the Eocene period, ending at and after the Tertiary era (in the place of a Jura sea entering with a gulf southwards into Archiplata), formed a barrier which the Tertiary fresh-water fauna migrating to Archiplata could not cross—this essential result of my studies of the fresh-water fauna gives, in my opinion, a very simple and new explanation of a large number of facts, otherwise unintelligible, regarding the geographical distribution of South America's flora and fauna.

These being the results to which, relative to South America, zoogeography and geology are leading, I, on the other side, believe that the North American scientists are able to bring in accord with this their own experiences. Heilprin* has inves-

* A. Heilprin, "The Geographical and Geological Distribution of Animals," London (1887), p. 210.

tigated the history of the Laramie region and its lacustrine deposits, which attain sometimes a thickness of 4,000ft. to 5,000ft., and show in the beginning an entirely marine character, but change later on to the deposits from fresh water. The drainage was into a continental arm of the sea, which projected completely across the United States during the Cretaceous period, and which prevented an exchange of fresh-water animals between North and South America, as well as the migration of marsupials from Patagonia to the United States.

The theory of Wallace is not only to be rejected for our special territory of South America, but it is insufficient also for Australia and Polynesia. Wallace thinks that for Polynesia the birds are the only group of the animal kingdom "on which we could rely." We should be more in the right if we reverse his sentence and say that the mammals and the birds are the only groups on which no reliance can be put if we wish to unravel the whole history of Polynesia, for birds and placental mammals belong in their recent representatives entirely to the Tertiary era, and therefore cannot be taken into consideration for the means of distribution of organisms during the Secondary era. Moreover, birds are almost useless for the discovery of old geographical land-communications, on account of their power of flight, and on account of the passive migrations to which they may be subject when driven away by the wind.

Mr. Wallace's explanation of the distribution of the Lacertidæ through Polynesia as far as the Sandwich Islands by means of a migration across the ocean is just as bold a hypothesis as his attempt to explain the occurrence of identical fresh-water fishes in New Zealand and Patagonia by the transport of their fry on icebergs.* To such theories may those adhere who wish to save Wallace's hypothesis of the stability of the continents and depths of the seas; but one cannot ask unprejudiced scientists to accept such incredible explanations.

If we look at the circumstances as they really are we perceive that the fauna of Polynesia impoverishes from west to east. A wide distribution is seen only in those groups of animals whose origin does not reach beyond the Tertiary era, which are provided with the power of flight, as birds and bats. Active and passive migration would bring them from island to island, whereby the birds show a wider distribution than the bats. If birds fly over the Atlantic Ocean, and accomplish many other distant migrations, then we are really standing

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* It seems much more likely to me that the enormously-wide distribution of pelagic fresh-water Crustacea is due to transportation by birds. But many of them may belong to very old types, living already in Mesozoic lakes, as *Limnæa* and *Physa* did.

on the ground of facts.* Abstracting this Tertiary fauna, we have first to consider those types which undoubtedly have their representatives in the Cretaceous period, such as snakes, serpents, and *Anura*. Their distribution is pretty wide, and especially on the Fiji Islands they are well represented. The *Lacertidæ*, whose remains are the geologically oldest of the now-living groups of reptiles, reach further on to the east. Is this chance? If floating trees and icebergs were the means of their transport, why, then, do they transport only such *old* forms? And has the transport of fresh-water molluscs, such as *Limnæa*, *Physa*,† &c., also been going on across the sea? This is simply impossible, for salt water kills these inhabitants of the fresh water immediately. The land molluscs of Polynesia also belong to a very old group of the fauna. Widely distributed are species of *Pupa*, a genus already represented in the Palæozoic era, and all the other *Nephropneusta* have the simple generative apparatus without the dart of the *Heliceæ*. Genera which, like *Unio*, are known to have existed already during the Jurassic epoch, reach as far as New Zealand, and the Parastacida of the fresh water, which, according to Huxley, must also be attributed to a Jurassic age, to Fiji.

The fauna of East Polynesia has such a well-pronounced Mesozoic character that the supposition of a very old Pacific continent, breaking up in pieces more and more during the Mesozoic era, may give us a natural explanation. And the further we go westwards the more frequently we meet with recent types—in New Guinea the genus *Sus* and *Muridæ*; in Australia, besides *Muridæ*, also *Canis*. The craving only to make of Australia a land completely without placental mammals accounts for *Canis dingo* being considered as a race of the domestic dog. This error has been settled definitely by Nehring.‡ *Canis* no doubt belongs to the oldest Carnivora. Species of *Canis* are found in India and Sumatra, and *C. dingo* is as well a domesticated sporting-dog as *Canis latrans* of the North American Indians, or *C. ingæ* of the old Peruvians.

The reason why more recent mammals§ did not migrate

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* With regard to the bats, it is quite possible that they kept pace with the *Muridæ*, which, according to Wallace, have also been represented in New Zealand.

† Species of *Physa* occur on the Fiji and Tonga Islands, besides numerous species of *Succinea*, but the small islands seem to have been rather unfavourable to the conservation of the fresh-water fauna.

‡ Nehring, Sitzungsber. d. Ges. naturf. Freunde; Berlin (1882), p. 67. Zoolog. Garten (1885), p. 164.

§ Another very surprising immigration is that of *Mycetopus rugatus* of the Victoria River, in North Australia. In my opinion it originates from Asia, and not from South America, where *Mycetopus* originally was missing in Archiplata. My Australian colleagues should see that the anatomy and embryology of this species be studied, as it is still questionable whether it belongs to *Mycetopus s.-str.* or not.

to New Guinea and Australia is evidently that those countries were already occupied by a fauna of marsupials perfectly adapted to the most varied conditions of life, and therefore later comers were unable to maintain themselves. We shall have to give up the theory of the floating trees with *Sus*, *Canis*, *Muridæ*, *Lacertidæ*, fresh-water Molluscs, &c., in their branches, as well as many other things of Wallace's hypothesis; and the botanists will not tarry to reduce the transports by currents and wind to a moderate measure.

Opposed to Wallace's theory of the immutability of the continents and depths of the sea is another which, distinguishing strictly between the distribution of the different groups of animals, endeavours to find the ways of distribution of the genera and families existent on our globe already during Palæozoic and Mesozoic times, along which the organisms spread during the Mesozoic era. May the senior master of zoogeography not be angry with this view, but be cheerful in the thought that, however far opinions on certain questions may be divided, it was he who showed us the way by which progress can be made; that it was he who gave, in an exemplary manner, to zoogeography its modern solid basis, its new method of procedure, its ways of interrogation, as well as its aims and its problems.

ART. XLVII. — *Vestiges: Reminiscences: Memorabilia of Works, Deeds, and Sayings of the Ancient Maoris.*

By W. COLENSO, F.R.S., F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1891.*]

"Ex ungue leonem."—*Prov.*

WHEN relating any peculiar and striking doings of the Maoris of the olden time, which I had either seen or heard of in my early days among them (now nearly sixty years ago), I have not infrequently been asked to commit the same to writing, or, in other words, "to make a book." This latter, however, I am not inclined to do, partly from want of time for such a purpose. Notwithstanding, I have thought I would jot down briefly a few of their more remarkable and little-known ancient acts and deeds, as many of them have long become obsolete, and are scarcely known even by name to the present generation of Maoris; and very likely there is not another European now living besides myself who knows anything about their old doings from actual observation; having frequently visited Maori villages in all parts of the North Island, where no European had preceded me.

§ I. Of the Mako Shark.

Fifty years ago (to go no further back) a Maori chief would be known by wearing certain emblems or insignia indicative of rank, one of which was the tooth of the *mako* as an ear-pendant; and, as such were plentiful, though distributed, the thought often occurred to me in my early travelling days, What a number of the fish *mako* there must have been captured or obtained by the Maoris to yield such a large number of teeth! Moreover, on inquiry I invariably found that all the teeth I saw were prized heirlooms, and had descended to the present possessor through several generations, and (as far as I could learn) none had been recently acquired. And while, when travelling along the sea-coasts for many a league on both sides of the North Island during several years, and always on foot, I had both seen and heard of a number of large sea-animals (fishes and mammals) that were driven on shore on the sandy beaches in severe gales from the sea, I never knew of a single *mako* shark, nor had the Maoris resident on those shores ever heard of one being cast up.

In replying to my numerous inquiries by letter respecting the *mako*, made many years ago, an intelligent aged Maori chief living on the east coast wrote as follows (or, rather, he being of the old school, and unable himself to write, a young adherent did so at his dictation). I give a literal translation of portions of his letter:—

"You ask, did I ever see a *mako* fish? Yes; and it is a very large creature, the biggest of all the sharks (*mango*)—in length 2 fathoms measured (*erua maro whanganga nei*), and in thickness 1ft. It is a true shark, but called by us a *mako* on account of its teeth. You also inquire concerning its fat or oil, and the edible qualities of its flesh, whether considered choice by us Maoris. Now, there are many kinds of shark, as the *mako*, the *karaerae*, the *pioke*, the *ururoa*, the *uatini*, the *tahapounamu*, the *taiari*, the *tatere*, and the *mangotara*, and I have not eaten of them all, and therefore I do not know how nice or how fat they all are; and so of this one, the *mako*. But, my friend, this fish was never desired as an article of food—never so used by us Maoris. The only part of it that we sought and greatly desired to have was its head, and this solely on account of its teeth. When caught out at the deep-sea fishing-grounds its body was never hauled into the canoe, but the head was cut off while it was still in the sea and alongside of the canoe (*ka tapahia moanatia te upoko*): this done, and the head secured, the body was left to drift away on the sea. The head was also immediately wrapped up securely in a clothing-mat (*kahu*), lest it should be noisily wondered at by those who were strangers or unacquainted with it (*koi umeretia e nga tangata tauhou*). You also ask what instrument was used for cutting off the head of the *mako*. What, indeed! Why, the saw made of the teeth of the *tatere* shark firmly fixed on to a wooden blade (*he niho tatere, he mea hohou ki runga ki te rakau*). You further inquire respecting the number of its teeth. There are eight—that is, large ones from within, and also eight smaller ones of them outside. Besides those there were several much smaller ones in front or outside (*o waho rawa*), but these I never counted, and therefore cannot give their exact number."*

He also wrote (in another and subsequent letter) in answer to my further inquiries: "There are four very large teeth from the beginning, or within. These are called *rei*, and are kept for ear-pendants. Altogether there are eight teeth—that is, four very large ones, and four smaller, making eight in all.† The outside teeth resemble those of the *tatere* shark, and are only termed teeth (*niho*); these have no other name, but those that are kept for ear-pendants are called *au-rei*. Then, you wish to know how the *mako* was captured by us Maoris in the olden times. Listen. This fish was never taken as other sharks (*mango*) were, with hook and bait: none of our fish-hooks would be strong enough to hold it, they would soon be broken. Now, when the fishing-canoe was out fishing, and had been a long time there catching fishes of various kinds, suddenly a *mako* would be seen coming leisurely along on the surface of the water (*e hara mai noa ana i te kiri o te wai, ara i te kare o te wai*). Then the man who saw it would shout out to his companions in the canoe, 'Haul up our land' (*Hutia mai to tatou whenua*), not naming the fish;‡ and when the *mako* was pretty near to the canoe, about three yards off, then

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* "E waru nga niho nunui o roto, e waru hoki o waho mai o era, nga mea iti nei, haunga hoki nga niho o waho kaore au e mohio ki te tatau."

† "Ko nga niho nunui rawa e wha o te timatanga mai, he rei ena, nga mea e waiho ana hei tau taringa e waru tonu ana niho, e wha nga mea nunui rawa, e wha hoki nga mea tua ririki, ka waru ai." As there is apparently a discrepancy in the two letters of my Maori informant respecting the number of the prized teeth of the *mako*, I have given here in these two notes his own precise words; he seems to be very exact. He may, however, have counted them by pairs in his second letter—as the old Maoris always did men, *kumara* (sweet potatoes), and fish, and a few other things—but, though understood, was omitted by his younger secretary; and, if so, then his number will be quite correct, and the same in both letters.

‡ Observe here two things: (1) "not naming the fish," from a superstitious belief and custom which also obtained in a few matters on shore; and (2) the peculiar cry of the descrier, which no doubt had reference to the old myth of Maui fishing up the North Island from ocean's depths.

the big tempting bait was let low down before it, and on the *mako* seeing the bait it would bend down its head to seize it (*ka tupou te upoko*), when its tail would be upraised above water. Then a noosed rope would be flung over its tail (lasso-fashion) and quickly hauled tight, which would secure the tail within the noose hard and fast. And away would speed the canoe at a fleet rate towards all sides of the sea and sky, being continually turned about in all directions by the fish, the man who had noosed it always holding on to the rope. At last, being exhausted, the *mako* died; then it floated, when its head would be cut off, as I said before. This was our common manner of catching the *mako* fish (*ko tona hii tonu tenei o tenei ika o te mako*), often also called by us a monster (*taniwha*); and hence arose the term of monster-binding (*here-taniwha*), owing to it being securely noosed and bound with a rope flung over its tail." Here ends the interesting narration of my worthy old Maori correspondent, who died soon after.

I have never seen a *mako* fish, and I am in doubt whether it is yet fully known to science. It is evidently one of the deep-water fishes. The first mention of it by skilled scientific observers that I have noticed is in Sir James Ross's "Voyage to the South Seas," wherein it is stated that on nearing the Chatham Islands, in November, 1841 (within a week after leaving their winter quarters and anchorage in the Bay of Islands), "the long-snouted porpoises were particularly numerous. One of these creatures was struck with a harpoon, and in its formidable jaws we found the teeth which the New-Zealanders value highly as ornaments, and which had puzzled us greatly to ascertain to what animal they belonged" (vol. ii., p. 134). Those Antarctic Expedition ships had spent several months in the Bay of Islands, and the officers had frequent opportunities of seeing and examining the teeth of the *mako*, and very likely had purchased some from the Maoris, as they were diligent in acquiring natural specimens, and curios and ornaments of all kinds.

Professor Hutton, in his "Catalogue of the Fishes of New Zealand" (published by the Government in 1872), considered the *mako* to be the "*Lamna glauca*=tiger-shark;" but he says, "The shark from which the Maoris obtain the teeth with which they decorate their ears is probably this species, but I have seen teeth only" (*l.c.*, p. 77).

Subsequently Professor Julius von Haast (in 1874) read a paper before the Philosophical Institute of Canterbury* on the *mako* of the Maoris, which, he says, is *Lamna cornubica*, the porbeagle shark, and not *L. glauca* as had been supposed

* Trans. N.Z. Inst., vol. vii., p. 237.

by Professor Hutton. But Professor von Haast had only a small young specimen (or, rather, its skin) to examine, which two North Island Maoris, then engaged at Christchurch Museum, pronounced to belong to a young *mako,* and informed him that this fish in its adult state was about 12ft. long. The animal to which the skin belonged was 4ft. 10in. long. Professor von Haast also gives much information relative to the teeth of his small specimen (differing widely from my Maori friend's description given above), their number, form, and size, the colour of its skin, &c. Still, as I take it, there are reasonable doubts as to that specimen being a true *mako ;* I think it is highly probable that his two Maori informants had never seen a real *mako* shark.

Couch, in his celebrated work on "British Fishes," in his account of the porbeagle shark, gives a drawing of it from nature, and also others of its teeth and jaws, which appear to be different from those of the *mako,* being much more slender, and semi-terete, undulate, and sharply pointed (vol. i., pp. 41–44).

My object in writing this notice of the *mako* shark is mainly to relate the ancient Maori mode of capturing it.

§ II. OF THE PREPARATION OF BLACK PIGMENT FOR TATTOOING.

The ancient Maoris had more ways than one of obtaining the black substance used in tattooing, which colouring-matter also varied in quality, partly owing to what it was made from; that for the countenance being superior to that used for the lower parts of the body. One way of obtaining the best kind was as follows:—

First, two proper careful men were selected for the work. This, too, was done with ceremony, they being (for the time) *tapu* (*i.e.*, under the laws of *taboo*)—rigidly set apart. A small kiln-like furnace (*ruangarehu*) was excavated in the side of a hill suitably situated. The substances to be used in burning for their soot—*kauri*-resin (*kapia*) and the resinous veins of white-pine wood (*kapara*)—were got ready; a net made from the *wharanui* flax leaves finely split, composed of very small and close meshes, and beaten well, so as to be rough and scabrous from long broken fibres, in order the better to catch and retain the soot (*awe*), which was intended to adhere only to the network: this net was fixed properly and securely over the top opening or chimney of the kiln, and above it were placed thick mats and suchlike, to prevent the escape of the burning soot and smoke. All being ready, a very calm fine night was chosen for the firing of the kiln—a night in which there should not be the least breath of moving air; and, the kiln being fired, those two men remained all night at their post, attending to their work, carefully feeding the fire. When all the resinous substances were burnt up, and the kiln cold—the calm weather still continuing—the soot was carefully collected and mixed up with the fat of birds, and then given to a Maori dog to eat, which dog had also been early set apart for this work—tied up, made to fast, and kept hungry, that it might perform its part and eat the prepared morsels with avidity. After devouring the mixed food the dog was still kept tied up, and not allowed to eat any other aliment until it had voided the former. When the fæces were evacuated they were carefully gathered, and mixed up and kneaded with birds' oil and a little water, and, when this mixture became dry and hard, it was put up securely into a large shell, or into a hollowed pumice or soft stone, and laid by carefully, buried in the earth, for future use. It is said to have possessed no disagreeable odour when dry (though it had while fresh), and, though long kept, it did not become bad nor spoil through keeping, which, on the contrary, was said to improve it, and it was very much prized.

It was this pigment, so put up and kept, that was the origin of one of their proverbs, "*Puritia to ngarahu kauri*" = Keep to thyself thy kauri-resin-soot pigment. This saying was used when a person was unwilling to give what was asked, the same being some common thing, and not at all needed by the avaricious owner. But there is a double meaning here, in this simple sentence (proverb) — namely, "You may never require it, or live to use it." (See Trans. N.Z. Inst., vol. xii., p. 145.)

§ III. Of the Manufacture of their Long Spears.

Some of their spears were very long. Of these there were two kinds. One kind was made of hardwood, *rimu* (*Dacrydium cupressinum*). This was used in defending their forts and stockades before the introduction of firearms, being thrust through the palisades at close quarters against the legs and bodies of the invaders. The other kind was much lighter, though longer, being made of the light wood of the *tawa*-tree. (*Beilschmiedia tawa*), and used only for the spearing of pigeons when they were sitting on the top of a high tree. This spear was tipped with a flattish serrated bone 3in.–5in. long, usually coarsely barbed on one lateral edge, and sharply pointed; the bone being human, and a portion of that of the arm or leg, and, of course, of their deadly enemies. Seeing that these long spears were always made from heartwood of their tallest trees, it was a mystery to me how they managed to manufacture them, the hardwood ones being from 16ft. to 20ft. and the others from 20ft. to 35ft. long; and it was not until my first visit to the Urewera Tribe, at Ruatahuna, in the interior beyond Waikare Moana, in 1841, that I discovered how it was effected. This patient performance has ever seemed to me a notable example of one of their many laborious and persevering works. For it must never be forgotten, in considering their ancient laborious and heavy works, especially in hard substances, as wood, bone, and stone, that they accomplished all without the use or knowledge of iron or any other metal.

First, a straight, tall, and sound *tawa*-tree was selected in the forest. This was felled with their stone axes. Its head and branches having been lopped off, it was dragged out into the open ground, and split down the middle into two halves. If it split easily and straight, then it would probably serve for two spears, if each half turned out well in the working. The next thing was to prepare a long raised bed of hard tramped and beaten clay, 35ft.–40ft. long—longer than the intended spear—the surface to be made quite regular and smooth (like a good asphalte kerb town walk of the present day). On to this clay bed the half of the *tawa*-tree was dragged, and carefully adzed down by degrees, and at various times, to the required size and thickness of the spear. It was not constantly worked, but it was continually being turned and fixed by pegs in the ground, to keep it lest it should warp and so become crooked. It took a considerable time—about two years—to finish a spear. The last operation was that of scraping with a broken shell or fragment of obsidian, and rubbing smooth with pumice-stone. When quite finished and ready for use a suitable tall and straight tree was found in, or on the edge of, the forest; its trunk was trimmed of branchlets, &c.; the long spear was loosely fixed vertically to it, so as to run easily through small round horizontal loops girt to the tree, and placed at some distance from each other; the tip of the spear concealed, yet protruding near the topmost branches of the tree; and, as the pigeon is a very thirsty bird (especially, I should think, after feeding on the large fruits of the *tawa* and of the *miro*—*Podocarpus ferruginea*—trees, which are hot and piquant), the Maoris made small corrugated vessels of the green bark of the *totara* tree that would hold water, and fixed such on the top of the tree to which the long spear had been lashed, and by-and-by, when the bird was settled above after drinking (for it is a very quiet bird, sitting long after feeding), the spear was gently pulled down by its owner below on the ground, and sent up with a jerk into the body of the pigeon. I have seen the fixed spear thus used in the forests, and have eaten the bird so captured.

I may here mention that I have also seen those totara-bark dishes, with water in them, fixed high up on the big branches of trees in the woods in the Urewera country, having flax nooses so set over the water as to catch and hold fast the pigeon in its drinking. I have seen pigeons so caught, the Maoris climbing the trees naked with the agility of monkeys to secure their prizes.

From the large amount of labour and the time consumed in the making of a long spear, and its great beneficial use when made, arose a good proverb among them relative to industry in tillage, &c., and to being prepared—"*Kahore he tarainga tahere i te ara*"=You cannot hew a bird-spear by the way. Meaning: Without timely preparation you may die from want of food, though the pigeons are plentiful in the forests near you.

§ IV. Of the Hair of the Tail of an Ancient Maori Dog.

A dog with a white flowing tail was greatly prized. It was kept in a house, and always slept on clean mats, so that the hair of its tail should not become soiled or discoloured. (The Maoris had no soap, yet they sometimes used soapstone, steatite, and a soft bluish clay for the purpose of cleansing oily hands, &c.)

Tohutohu, the aged principal chief of Tangoio (also a *tohunga*, or priest), once told me of a very curious operation they were in the habit of performing in the olden times on a living Maori dog's tail—namely, to strip the flowing hairs in long narrow lines or strips, somehow connected by the epidermis, so as not to injure the dog, nor to prevent their growing again.* I got him to repeat his relation twice in order to be sure of it, it seemed so very strange. He assured me that it had been done, that it was a very delicate operation which took a long time, and that it was only effected by a skilled man.

These long flowing white hairs were called *awe*. They were made up neatly into highly-peculiar little queues, each having one-third of its basal length firmly and finely bound round with a very fine cord, spun of best picked flax-fibre, looking somewhat like the silver string of a violin. These were used

* This peculiar operation of theirs seems to be analogous to that of our country people—namely, the regular and stated plucking of live geese for their quills, formerly extensively used for writing-pens. And here I may remark that it was a good thing that steel pens were invented and came into common use; otherwise, I suppose, under our new English laws against cruelty to animals, the owners of geese would be prohibited from so plucking them. I am led to allude to this from having lately read in the Home papers of country farmers having been prosecuted and fined for tying the legs of their fowls when bringing them to market for sale, and others, also, for having put too many live fowls into one basket. *Jam satis!*

for ornamenting the chiefs' carved staffs of rank, made of hard-wood and polished (*hani* at the north, *taiaha* and *maipi* at the south), and were hung around the head of the staff beneath the fixed red feathers taken from under the wings of the large parrot. A large number of those little flowing hair queues (sometimes thirty or more) would be so hung around a single staff, and they remained in good preservation for many years, only becoming soiled.

As may naturally be supposed, the ancient Maoris had several proverbs derived from their dogs, all more or less natural, and some notable and laughable. A few specimens I will give:—

"*He hiore tahutahu*" = An often-singed tail. Taken from a skulking dog lying before the fire, and getting its tail repeatedly burnt. Moreover, such a dog would be early killed for food. Used for an idle fellow.

"*He hiore hume*" = A tail drawn down beneath. "*He whiore hume tenei tangata*" = This man is a dog's-tail, clapped under, between its legs (and sneaks away afraid). Used of cowards. N.B.: A very severe saying with a warlike people.

So that from these sayings we may conclude that the habits and actions of their now unknown Maori dog were much the same as those of other dogs.

§ V. Of their Animal Pets.

Besides their little domestic dog the ancient Maoris had five birds which they occasionally kept in captivity—two of them for their prized feathers; one for use; one for its company; and one solely on account of its repeating a taught Maori song or recitation, and possibly, also, for its beauty, and for its prominently possessing in its plumage those two contrast colours (black and white, or nearly so) which were so highly prized by the old Maoris.

Those two birds kept for their feathers were the *huia* (*Heteralocha acutirostris*) and the *kotuku* or *kautuku* = the white heron (*Ardea egretta*). Of these two birds I have seen but very few in captivity, and always pitied them, as they must have had a wretched existence, and that mainly from lack of their proper food, and, in the case of the white heron, the miserable low cage in which the poor bird was confined not permitting it to stand erect. The Maoris might, however, have succeeded better with them in the olden time, when they had less to occupy their time and distract their attention—and perhaps they did so. One acquainted with their thoughts and old manners and customs is led to believe that they so acted, from the fact of their having suitable natural proverbs relating to this bird, showing that they were close observers of its economy, which they so highly approved as to apply it proverbially as a fitting example to their chiefs—*e.g.*, "*He kotuku kai-whakaata*" (*Eng.:* The white heron eats leisurely, after viewing its food and its own shadow in the still clear water). This is said of a chief who looks after due preparations being made for his expected visitors; also, of one who quietly and courteously awaits the arrival and sitting of others to their repast before he eats his own food.

The Maoris were always passionately fond of the plumes of these two birds, and prized them highly among their most valuable possessions, making beautifully-carved boxes, with their exact fitting lids, of hardwood, to keep their feathers in—real caskets. These two birds were also not common. The tail-feathers alone of the *huia*, being black, tipped with white, were used for adorning the heads of the chiefs; while several of the pure-white feathers of the *kotuku*, from various parts of its body, were of service. Those from within its wings, and near their junction with the body, were of two kinds—the larger of them were called *meremere*, and the smaller *awe*.* These last were sometimes stripped off with the skin adhering, so as to form a ball-like bunch to be worn in the ears. The larger feathers on the outside (secondaries, wing-coverts, and scapulars) were termed *waitiripapa;* while the extreme feathers of its wings (primaries) were called *hikurangi*. This bird, so comparatively common in the South Island, is very rarely seen here in the North Island: in all my travelling I have only seen four between Napier and Cook Strait, and those flying singly and at different times. One was shot here in Hawke's Bay, in the freshwater lagoon between Napier and Meanee, upwards of forty years ago, by W. Morris, the old whaler, who then resided at Rangaika, beyond Cape Kidnappers. He was on a visit in his whaleboat to me at Waitangi at the time, coming round by Ahuriri, when he came across the bird, and, having shot it, was bringing it to me, when he was stopped by the chief Tareha, who claimed the bird as being shot on his grounds.

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* I may here, in a note, point out the curious and apparently contrary meaning of this short word of three letters—*awe*. I have already mentioned it, in section ii. of this paper, as the proper name for *soot* (which is pure black), while here it is also the proper name for the fine gauzy feathers of this bird (which are pure white). This same name is also given to similar white feathers of the gannet and of the albatros. And in section iv. (*supra*) it is again used as the proper name for the long white flowing hairs of a Maori dog's tail. So that it would appear as if the ancient Maoris put aside the colour and the origin of the substances, and only considered their common lightness and airiness. This, again, reappears in this same word being used adverbially for "soon," "early," "in time," with especial reference to travelling, walking to a place, &c., as if denoting quickly, lightly moving.

This was quite in accordance with Maori custom, and, I may say, with our English customs too.) A long altercation took place between them, but Morris was obliged to give way to save his gun. He afterwards called on me and told me of the circumstance, and how much he regretted it. The next day Tareha himself, with a whole posse of his wives and people, came in a canoe bringing me the bird wrapped up in a new garment (Tareha having heard from Morris that he intended it for me); but they had plucked out all its prized feathers, and now wanted £1 (or "a golden sovereign") for what remained. For some time I would not take it at all, seeing it was spoiled as a specimen for preserving; but at last (and to please him) I took it, giving him 4s. for it: and the skin (though deprived of its choice plumes), with head and feet, I preserved with arsenical soap, and sent it to Professor Owen through Sir W. J. Hooker, as, at that time, I considered it to be a new species, and unknown. Another specimen of this bird was kept in a cage by the Maoris at Porangahau, who had managed to snare it alive in the neighbouring stream. They fed it very sparingly with small fresh-water fish, but placed them in such a shallow saucer-like vessel as strongly to remind me of Æsop's fable of the fox and the stork—that is, of the fox's invitation entertainment. It soon, however, died—before that its prized feathers had newly grown. Of course its old feathers were plucked out when it was captured. From the great scarcity of this bird, and its high value, it became proverbial—*e.g.*, "*Kotuku rerenga-tahi*" = Kotuku once (seen) flying. So that the rare visit of any great and friendly chief or welcome visitor was likened to its flying, or rare appearance.

The one bird they kept for use was the common large brown parrot = *kaakaa* (*Nestor meridionalis*). This was used as a decoy-bird to enable them to catch wild parrots. It was always kept securely fastened by one of its legs, enclosed within a bone circlet, and tied by a short thick cord to a hard-wood (*manuka*) spear, but allowed to run up and down the spear, a loose loop being at the end of the cord. It was of great service to them in their clever parrot-catching, and sometimes lived to a great age notwithstanding its hard, confined, and wretched life. This was the only one of all their bird pets that was pretty common among them, especially in the interior, in the forest districts.

There are several good old proverbial sayings concerning the parrot—*e.g.* :—

"*He kaakaa wahanui*" = A noisy-mouth parrot. Applied to a chatterer, or boasting person.

"*He kuukuu ki te kaainga, he kaakaa ki te haere*" = A pigeon at home, a parrot abroad. The New Zealand pigeon is a silent bird, and remains quietly sitting on the high trees;

the parrot is a noisy screamer, and flies about, making the forest resound with its loud cries. This proverb is applied to an inhospitable chief: he does not raise the cheerful cry of "Welcome!" to travellers nearing his village; but when he travels, then, on approaching any place, he sounds his trumpet to get food prepared, and afterwards finds fault with the victuals given him.

"*He kuukuu tangae nui*" = A pigeon bolts its food. Used of a greedy fellow never satisfied.

"*He kaakaa kai honihoni*" = A parrot eats leisurely, bit by bit. Said to a person who eats moderately and slowly.

The fourth of their pets was a sea-bird, a large gull = *ngoiro*, also *toroa* (*Larus dominicanus*). This one fared better than any of the others, as it had its liberty, and ran about, and into the sea, and so (in part) fed itself with its own natural food, and back again to the village, which it seemed to take up with—more so than with the people of the place the dogs and the cats. It was only found in the sea-coast villages, and was kept merely for sociality and companionship. The bird was taken away young from its parents, and fed by hand; having had its pinions broken off, it could not now fly. It often emitted a mournful cry when wandering about in the village, which, to me, was not pleasant to hear, as I always fancied it was bewailing its hard lot. Of this bird, too, they had their proverbial sayings, one of which is very neat and pleasing—"*Me he toroa ngunguru*" = Like a gull folding its wings up neatly. Used of a neat and compact placing of one's flowing mats or garments about one's person, especially by orators when making a speech *à la Maori*, running up and down.

Their true pet, however, was the *tuuii* = parson-bird (*Prosthemadera novæ-zealandiæ*). This bird was taken great care of, and kept in a decent rustic cage, entirely for its Maori song, which it was diligently taught. I have known some to live several years in captivity, to look well in their fine plumage, and to sing or repeat words and sentences parrot-like, but with more of life and energy, as if the bird delighted in being noticed, and was showing off. The old Maoris had an especial Maori song which this bird was brought to repeat. Some of its sentences were very quaint—*e.g.*, (in English) thus: "Lo! hast thou heard? Here is the welcome visitor. Where from? Draw nigh. Call hither the dog. Come hither, welcome visitor. From the south is this welcome visitor? From the north is this welcome visitor?" &c. These words were extremely applicable to a party of friends arriving at a village; and if the *tuuii* in the olden time was so well taught by its owners as to rattle them out on the arrival of visitors it must have been very pleasing to them. At all events, they are a standing memorial to the well-known exuberant hospitality of the ancient Maori people.*

The finest tame *tuuii* I ever saw was the property of Mr. W. G. Puckey, of the Kaitaia Church Mission (that was in 1838). This bird had been in Mr. Puckey's possession several years, and when it rattled off its Maori song it would also inflate its body, appear bulky, and ruffle up its glossy feathers, and so make itself look nearly twice its real size, and all the time move up and down its perch as if with glee. Truly it was a pretty sight to see and hear it. An elegant proverbial saying respecting this bird I may here mention—"*Me he korokoro tuuii*" = As eloquent as the throat of the sweet-singing parson-bird. Spoken in praise of a good orator.

A pleasing anecdote of another *tuuii* may here be mentioned. When H.M.S. "Buffalo" was here in New Zealand in 1834, felling *kauri*-pine spars and loading them for the Government dockyards at Home, and consequently had to remain some time in the New Zealand waters, several of our endemic birds were captured alive to be taken to England, and among them, naturally enough, were many *tuuiis*. On the passage Home, however, all the *tuuiis* died save one, and that was the property of a common sailor on board. As the ship neared England large sums were offered "Jack" by the officers for his bird; but he steadily refused them all, saying (good-sailor-like) the bird was for his darling girl, Polly.

I may also mention that among their very ancient legendary stories is an interesting one of an immense saurian (a man-eater) that was the pet of the chiefs of that district (Trans. N.Z. Inst., vol. xi., pp. 95, 100).

§ VI. OF THE FINE SMELLING-SENSE AND TASTE OF THE ANCIENT MAORIS FOR PERFUMES.

I have already more than once, and in former papers read here before the Institute, touched on the superior powers of sight of the ancient Maoris;† and it has often occurred to my mind that they also possessed a very keenly developed sense of smell, which was largely and quickly shown whenever anything sweetly odoriferous, however fine and subtle, had been used—as eau de Cologne, essence of lavender, &c. Indeed, this sense was the more clearly exhibited in the use of their own native perfumes, all highly odorous and collected with labour. Yet this sensitive organization always appeared to be the more strange when the horribly stinking smells of

* Mention is also made in an interesting old story of a chief's son, in quest of his father, having taught two tamed birds — a *huia* and a *kotuku*—to repeat a sentence in Maori. See Trans. N.Z. Inst., vol. xiii., p. 55.

† Trans. N.Z. Inst., vol. xiv., p. 67, &c.

two of their common articles of food—often, in the olden times, in daily use—are considered: rotten corn (maize, dry and hard, in the cob) long steeped in water to soften it, and dried shark. The former, however, has long been abandoned; yet at one period every village at the North had its steeping-pit.

In a paper I read here at our June meeting* I mentioned some of the very small Hepaticæ (*Lophocolea* and *Chiloscyphus* species) as being used for perfume by the Maoris, who called them *piripiri*. Their scent was pleasant, powerful, and lasting. Hooker, in describing those plants, has mentioned it from dried and old specimens. Of one species, *Lophocolea pallida*, he says, "odour sweet;" of another, *L. novæ-zealandiæ*, "often fragrant;" of another, *L. allodonta*, "odour strong, aromatic;" of another, *Chiloscyphus fissistipus*, "a handsome strongly-scented species;" and he has further preserved it to one of them in its specific name, *C. piperitus*, "odour of black pepper."

There were also two or three ferns—viz., *Hymenophyllum sanguinolentum*, a very strong-smelling species, hence too its specific name; dried specimens not only retain their powerful odour, but impart it to the drying-papers: *Polypodium pustulatum*, having an agreeable delicate scent: and *Doodia fragrans*, a neat little species; this last was so far esteemed as sometimes to give name to the locality where it grew, as *Puke mokimoki*,† the little isolated hill which once stood where the Recreation-ground now is in Napier; that hill having been levelled to fill in the deep middle swamp in Monroe Street.

One of the *Pittosporum* trees, *tawhiri* (*P. tenuifolium*), also yielded a fragrant gum; but the choicest and the rarest was obtained from the peculiar plant *taramea* (*Aciphylla colensoi*), which inhabits the alpine zone, and which I have only met with near the summits of the Ruahine Mountain-range, where it is very common and very troublesome to the traveller that way. The gum of this plant was only collected through much labour, toil, and difficulty, accompanied, too, with certain ceremonial (*taboo*) observances. An old *tohunga* (skilled man, and priest) once informed me that the *taramea* gum could only be got by very young women—virgins; and by them only after certain prayers, charms, &c., duly said by the *tohunga*.

There is a sweet little nursery song of endearment, expressive of much love, containing the names of all four of their perfumes, which I have not unfrequently heard affectionately

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* See above, Art. XXXVII.

† Mokimoki Hill, from *mokimoki*, the name of that fern.

and soothingly sung by a Maori mother to her child while nursing and fondling it :—

Taku hei piripiri,
Taku hei mokimoki,
Taku hei tawhiri,
Taku kati-taramea.

My little neck-sachel of sweet-scented moss,
My little neck-sachel of fragrant fern,
My little neck-sachel of odoriferous gum,
My sweet-smelling neck-locket of sharp-pointed *taramea*.*

Here I may observe that to the last one of the four the word *kati* is prefixed: this word—meaning, to sting, to bite, to puncture, to wound sharply and painfully—is added to indicate the excessive sharpness of the numerous leaves and leaflets of the *taramea* plant (hence judiciously generically named by its early discoverer, Forster, *Aciphylla* = needle-pointed leaf), and the consequent pains, with loss of blood, attending the collecting of its prized gum, thus enhancing its value.

This natural and agreeable little stanza, one of the olden time, has proved so generally taking to the Maori people that it has passed into a proverbial saying, and is often used, hummed, to express delight and satisfaction—pleasurable feelings. And sometimes, when it has been so quietly and privately sung in a low voice, I have known a whole company of grey-headed Maoris, men and women, to join in the singing: to me, such was always indicative of an affectionate and simple heart. How true it is, "One touch of nature makes the whole world kin"! †

In the summer season the sleeping-houses of their chiefs were often strewed with the large sweet-scented flowering grass *karetu* (*Hierochloe redolens*). Its odour when fresh, confined in a small house, was always to me too powerful.‡

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* See Trans. N.Z. Inst., vol. xii., p. 148.

† It is pleasing to notice that the observant artist Parkinson (who was with Sir Joseph Banks as his botanical draughtsman, and Cook on his *first* voyage to New Zealand) makes special mention of those little sachels in his Journal, saying of those Maoris who came off to the ship in their canoes, "The principals among them had their hair tied up on the crown of their heads with some feathers, and a little bundle of perfume hung about their necks" (Journal, p. 93). Captain Cook, also, has similar remarks respecting the young women.

‡ Sir J. D. Hooker thus writes of this fine, sweet-smelling grass in his Flora Novæ Zelandiæ: "A large and handsome grass, conspicuous for its delicious odour, like that of the common vernal grass (*Anthoxanthum*) of England, that gives the sweet scent to new-made hay" (*l.c.*, vol. ii., p. 300). A closely-allied northern species (*H. borealis*), which was also supposed to be found here in New Zealand, is also used on the Continent of Europe for similar purposes. In some parts of Germany it is dedicated to the Virgin Mary (hence, too, its generic name of *Hierochloe* = sacred grass), and is strewed before the doors of the churches on festival days, as the *sweet sedge* (*Acorus calamus*) is strewed on the floor of the cathedral at Norwich for the same purpose at such seasons.

Here, in conclusion, I may briefly mention an instance of their correct discrimination on the contrary side, clearly showing how well and closely the ancient New-Zealander agreed in his opinion of a plant with the highly-civilised scientific visitor already named above, the botanist Forster. Forster named the *Coprosma* genus from the fœtid odour of the first species he discovered in the South Island, which signification he also continued in its specific name, *C. fœtidissima*: this shrub also bears a similar Maori name, *hupiro*, highly expressive of its very disagreeable smell.

§ VII. Of their House-decorations.

These were mainly of three kinds: 1. Their peculiar manner of making a smooth surface to the large flat and broad hardwood pilasters of their principal houses by dubbing them down. These were closely worked into little shallow semi-symmetrical ridges and hollows, somewhat imitating the trunk of the larger fern-trees; and the work was called, after them, *ponga*, *pongaponga*, and *mamaku*, and all done, of course, with their stone adzes. It had rather a pleasing effect. 2. Their strange and bold regular designs drawn on the larger roof-rafters and beams of their chiefs' houses, which had been previously smoothed and prepared, reminding the beholder at first sight of stencilwork. These traceries were of various patterns, and coloured red and white. All the patterns of their ornamental-border carvings and coloured tracings bore different proper names; and so of branches or parts of the figures, when compound, as *mango-pare* (the hammer-headed shark), *hikuaua* (herring-tail),* *kowhai*, from the flower of the *kowhai*-tree, &c.; and all from real or fancied resemblances—correlations, as it were, of the Maori mind. One, in particular, I may mention and explain: This pattern was called *rengarenga*, from being an imitation of, or ideal association with, the curved anthers of the flowers of that plant, the New Zealand lily (*Arthropodium cirrhatum*). Here we have another curious and pleasing instance of coincidence of ideas in natural close observation and naming between two widely opposite peoples, the ancient New-Zealander and the highly-civilised European—the German botanist Forster who accompanied Cook on his second voyage to New Zealand, and who gave the appropriate specific name of *cirrhatum* to this plant from its peculiar closely-curved and revolute anthers.† 3. Their striking and neat variegated reedwork,

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* *Lit.* tail of the *aua*, a small sea-fish, *Agonostoma forsteri*.

† I give in a note that portion of Forster's full and able description of this fine plant which applies to its anthers: "Antheræ oblongæ erectæ, bisulcæ, candidæ. Barbata corpuscula duo filiformia, purpurea, pubescentia ab antherâ ad basin filamenti longitudinaliter dependentia,

displayed in the inner walls and ceilings of their best houses, and also in their verandahs.* 4. Their famous boldly carved and sculptured work. This, however, I omit, from want of room, and because much of it yet remains with us, as may be seen here in our local Museum.

§ VIII. Of the Peculiar Modes of preparing some Articles of Animal Food, as practised by the Ancient Maoris.

Under this head I would briefly notice a few which were both singular and strange, and confined to themselves, in which also they excelled; these (like many other of their good and useful preparations) having long become obsolete among the Maoris. I am the more inclined to do this from my having already given in a former paper† their striking and curious modes of obtaining and preparing and laying up in store some of their wild indigenous vegetable food for winter use, particularly the fruits of the *karaka* (*Corynocarpus lævigata*) and of the *hinau* (*Elæocarpus dentatus*), the pollen of the *raupo* (*Typha angustifolia*), and the roots of the *aruhe* = common fern (*Pteris esculenta*).

1. Of their little rat, once so plentiful and now extinct. This animal was sometimes prepared in this way for their chiefs' and first-class visitors' meal: It was carefully singed, and so denuded of its fur, and then its bones were broken within the body and extracted by the anus, without breaking the skin; this done, it was cooked in their earth-ovens, and, being very fat, made choice plump morsels, somewhat resembling large sausages. The contents of its stomach (being a frugivorous animal) were also eaten, much as in England those of a woodcock or snipe. Another mode adopted by the old Maori cooks was to stuff small rats into the belly of a large one. For both of these gastronomic preparations they had proper names.

In the early times, before the creation of the colony, when lands were sold at the North, I have known a chief to lay claim to a share of the price paid for the land from the fact of his ancestors and himself being entitled to the fat of rats caught thereon; and such claim was allowed.

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ibique cirrhi in modum revoluta, parte cirrhi formi flavissimâ." Forster, however, had described it as being a species of *Anthericum;* but Brown made a new genus of some Australian plants (*Arthropodium*) very near to the old Linnean genus *Anthericum*, and so included this one. I see Sir J. D. Hooker has given Brown's name after our New Zealand plant in his N.Z. Flora, but I think Forster's name should have remained.

* For more particulars, see my note about the same, Trans. N.Z. Inst., vol. xiv., p. 50.

† Trans. N.Z. Inst., vol. xiii., p. 3.

2. Of fish they made large store in the summer season by drying them for winter use. Of these I would especially mention the mackerel (*tawatawa* of the Maoris), which they caught in great numbers in their big seine-nets.* This fish was managed thus for storing: They gutted them, took off their heads and tails, and split them into halves, and cooked them by steam in large earth-ovens made expressly for the occasion on the sea-beaches, always using a peculiar kind of wood for heating the ovens. When cooked the fish were carefully separated unbroken, and placed on raised stages to dry in the sun and wind, and when dried packed in large flax baskets for winter use. This fish, once so very plentiful, arriving annually on the shores of New Zealand in immense shoals (much as it does on the shores of England), has now and for many years past become very scarce.

Of the smaller kinds of shark (generally known by the common appellative of *mango*), and also of fresh-water eels (common name *tuna*), the old Maoris caught and dried great numbers for winter use, and perhaps this is still being done by them in several suitable localities at the North. Of the larger dried eels I have myself eaten, and considered them very good. In drying them they split them down the back, as the Cornish fishermen formerly did the great sea-eel, or conger, for salting and drying.

A small, delicate river fish—the *inanga* (of at least two species, yet going together in small shoals, and both distinguished by the Maoris)—was also in some places caught in large quantities in the summer season, and carefully dried in the sun for storing. Of these, also, I have frequently partaken in travelling among the Maoris, and liked them very much. My usual plan was to put a handful of them into the iron pot to boil with the potatoes, when the potatoes were nearly quite cooked. [N.B.—There were neither mutton nor sheep in those days.]

They also dried for winter use large quantities of bivalve

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* Cook's remarks on the great plenty of mackerel he obtained from the Maoris are worthy of a notice. While at Mercury Bay, in November, 1769, Cook writes: "The natives who came to the ship this morning sold us for a few pieces of cloth as much fish of the mackerel kind as served the whole ship's company, and they were as good as ever were eaten." And, again, he subsequently writes: "On the 9th, at daybreak, a great number of canoes came on board loaded with mackerel of two sorts—one, especially, the same with those caught in England. We imagined the people had taken a large shoal. . . . . they were very welcome to us. At 8 o'clock the ship had more fish on board than all her people could eat in three days; and before night the quantity was so much increased that every man who could get salt cured as many as would last him a month." (Voyages, vol. ii., pp. 335, 336, and 440.)

shellfish of different kinds of cockles, especially the *kokota* (*Mesodesma novæ-zealandiæ*). These were first cooked in their shells in earth-ovens, and then the fish extracted and dried in the sun. Of course, these and all kinds of their dried animal food were softened when required for use, in cooking by steam in their close earth-ovens.

But the most curious mode of preparing and drying was that practised on their crayfish (*koura*). This perfectly astonished me when I first witnessed it. At the proper summer season (November) this crustacean would be caught in great numbers, and taken on shore near to a running stream of fresh water. Into this water they would be securely and closely packed in rows across the stream, like tiles on a house-top, and kept down with stones placed upon them. When dead they were taken out, and their shells stripped off. These came off very easily, and the whole body of the fish, with its legs and feelers, came out from the shell in one piece unbroken. These were quickly prepared, flattened, with their legs, &c., confined and compressed on their bodies, and hung up high in tiers on erected hollow stages in the wind and sun to dry, and when dried were securely packed into flax baskets. Each fish when dry presented a most curious appearance—small, thin, light in weight, and whitish, somewhat resembling a half-baked scone. A stranger would be sure to be deceived from their greatly-altered appearance—scarcely a trace of their legs, &c., to be seen—merely a small oblong cake of tough fish, in its dried state, and always considered a *bonne bouche* with the Maoris, and, like the other kinds of dried sea-fish, often sent into the interior as presents.

§ IX. OF THEIR TEXTILE MANUFACTURES.

These were formerly prominent among the great industrial achievements of the Maoris, and always elicited the admiration of their wondering visitors.

I divide them into two great classes—(1) of garments, which were woven; and (2) of threads, cords, lines, and ropes, which were spun.

Nature had given to the Maoris one of her choicest gifts in the well-known flax plant (*Phormium*), of which there are two ascertained and valid species (*P. tenax* and *P. colensoi*) and several varieties. These plants are pretty general throughout New Zealand, and are well known to the Maoris by the common names of *harakeke*, *wharanui*, *wharariki*, and *tihore*—excluding those of the many varieties, as known to them.*

* Sir James Hector, in his book on the *Phormium* plants, enumerates fifty-five named varieties; but it is doubtful whether more than half of that number are permanent ones.

So that what they may have lost on the one hand through not having the valuable wild edible fruits of other South Sea islands (as the cocoanut, bread-fruit, plantain, &c.) they more than merely gained in their flax plant, which is also common, and almost endemic, being only found outside New Zealand in Norfolk Island.

And here I may briefly mention an anecdote of the flax plant. On my arrival in this country the Maoris (who knew nothing, or very little, of any other land) would often inquire after the vegetable productions of England; and nothing astonished them more than to be told there was no *harakeke* growing there. On more than one occasion I have heard chiefs say, "How is it possible to live there without it?" also, "I would not dwell in such a land as that." This serves to show how highly they valued it. Moreover, at first and for many years the principal export from New Zealand prepared by the Maoris was the fibre of this plant—all, too, scraped with a broken shell, leaf by leaf.

1. *Of their Woven Articles* (*or Garments*).—I do not intend to say much of them in this paper. Many of them are well known, and still to be found in use among the Maoris, but their manufacture has for many years sadly deteriorated: indeed, I have not seen a newly-made first-quality clothing-mat for the last twenty to thirty years, and I very much doubt if such can now be made at all. Not that the art of weaving them has been entirely lost, but the requisite taste, skill, and patience in seeking and carefully preparing and using the several parts (including their dyes) are no longer to be found among the Maoris. I sometimes indulge in a contemplating reminiscence—an idea—a pleasing reverie of the long past—of great gatherings of Maoris, tribes and chiefs; and at such times the figures of some head men I have known, clothed in their handsome, clean, and lustrous dress-mats (*kaitaka* and *aronui*), would stand forth in pleasing high relief. The close and regular weaving of such flax dresses, having their silky threads carefully selected as to fineness and uniformity of colour, and their smooth, almost satiny, appearance, as if ironed or calendered when worn new, was to me a matter of great satisfaction—a thing to be remembered—"a joy for ever."

Those best dress-mats were always highly prized, both by Maoris and Europeans, and brought a high price. I well recollect a young lady, daughter of very respectable early English settlers in the Bay of Islands, who, when she came across the inner harbour in a boat with her parents to attend the English Church service on Sunday mornings in the Mission chapel at Paihia, often wore one of them folded as a shawl, and to me it seemed a neat and graceful article of dress.

Three things more in connection with these fine mats I will just relate: one, the cross-threads in weaving were always of a different sort of flax—the weft and the woof of these mats were not both taken from the same kind of flax; the second, that extremely soft lustrous appearance was given to the flax-fibres by repeated tawing done at different times—it was a pretty sight to see the various skeins of flax-fibres in their several stages of preparation neatly hung up in the weaving-shed; the third, that in the weaving of one of these garments, if a thread showed itself of a different shade of colour, that part of the garment was carefully unravelled to take it out, and to substitute another better suited in its stead. It was also from this superior knowledge and close attention to their work that the principal chiefs frequently took women who were clever at making those things to be their wives, in order to secure to themselves their valued manufactures.

They also wove very good and useful floor- and bed-mats of unscraped flax-leaves, split into narrow lengths and carefully bleached in the sun—these were very strong and lasting; also baskets and kits of all sizes. Some of them were woven in regular patterns with black (dyed) and uncoloured flax; others were skilfully and pleasingly semi-damasked (if I may so term it) by changing sides to the flax-leaves used to form the pattern, the upper side of the leaf being smooth and shining, the under side not shining and of a glaucous colour. The little kit, or basket, for a first-born child was often a little gem of weaving art, and made by the mother.

Besides the flax plant they had other fibrous plants whose leaves and fibres were also used in making articles of dress: (1.) The *toii* (*Cordyline indivisa*), of which they made black everlasting wraps or cloaks. The making of these was confined to the natives of the mountainous interior, where alone those plants grow. (2.) The long orange-coloured leaves of the *pingao* (*Desmoschænus spiralis*), a prostrate, spreading sea-side plant, also afforded them good materials for weaving useful folded belts, which were strong, and looked and wore well, and were highly valued. (3.) The climbing *kiekie* (*Freycinetia banksii*) was also used; likewise the long, slender, and soft leaves of the *kahakaha* (*Astelia banksii*), but not frequently. (4.) Of the leaves of the common swamp plant *raupo* = bulrush (*Typha angustifolia*), they formed large sails for their canoes. These leaves the Maoris curiously laced together. (5.) I should not omit to mention their flying-kites (*pakaukau* and *manuaute*), formerly in great esteem among them, and made of the manufactured bark of the *aute* shrub = paper-mulberry (*Broussonetia papyrifera*), which was formerly cultivated by the ancient Maoris for its bark. Inferior ones, however, were made of the prepared leaves of some of the larger sedges. They were prettily made, requiring both time and skill in their construction, and much more resembled a bird flying than our English ones. They always served to remind me of those of the Chinese, as we see them in their own drawings and on their chinaware. The old chiefs would sometimes quietly spend hours amusing themselves in flying them and singing (*sotto voce*) the kite's song, using a very long string.* Kites being flown at any village or fort was a sure sign of peace. These, too, gave rise to proverbs, some being quaint and highly expressive. A pleasing one I give as a sample: "*He manuaute e taea te whakahoro*" = A flying-kite made of paper-mulberry bark can be made to fly fast (away, by lengthening the cord). Used by a lover, expressive of impatience at not being able to get away to see the beloved one.

2. *Of their Spun Fibrous Articles.*—These were very numerous in kind, size, and quality, according to the particular use for which they were required; and, while the larger number of them were composed of scraped and prepared flax-fibres there were also other fibrous-leaved plants used by the Maoris, particularly the leaves of the erect cabbage-tree = *tii* (*Cordyline australis*) and of the *kiekie*, already mentioned. Here, too, in this department, the different kinds or varieties of the flax would be used for making the different sorts of threads, cords, and ropes, some of the varieties of flax enduring much greater strain when scraped and spun into lines than others; and of such their deep-sea fishing-lines were made. It was ever to me an interesting sight to see an old chief diligently spinning such lines and cords—always done by hand, and on his bare thigh. The dexterity and rapidity with which he produced his long hanks and coils of twine and cord, keeping them regular, too, as to thickness, was truly wonderful. Some of their smallest twisted cords or threads were very fine. Such were used for binding on the barbs to their fish-hooks, and for binding the long queues of dog's hair to their chiefs' staffs. One of those peculiar cords was a very remarkable one; it was a small cord, bound closely round throughout its whole length with a much smaller one (something like the silver or fourth string of a violin). I never saw this kind but once, and that was at the East Cape, in 1838. A specimen of it I shall now exhibit. This cord was used for a single and particular purpose, attached to the small under-aprons of girls—chiefs' daughters.

Their larger cords and ropes were composed of several strands, well twisted and put together. Besides their round

* See an interesting historical tradition respecting such (Trans. N.Z. Inst., vol. xiii., p. 48).

ropes so made, they had also flat ones of various widths, which were plaited or woven, resembling our webs and bands, and much used as shoulder-straps in carrying back-loads; also double-twisted ropes, and three-strand ones; likewise a remarkably strong one that was four-sided. This was made of the unscraped leaves of the cabbage-tree, that had been gathered, and carefully wilted in the shade, and then soaked in water to make them pliant. It was used for their anchors, and other heavy canoe and house requirements. The leaves of the flax would not be suitable for this purpose. I have had all those different kinds of cords and ropes made for me in former years, but I much fear the art of making them is lost.

There were also their nets for catching fish and for other purposes, with their meshes of various dimensions. Their smaller ones (hand-nets) were made of all manner of shapes and sizes. Some of them were dexterously stretched over circular skeleton framework. And their large seine-nets, used for catching mackerel and other summer fish that swam in shoals, were very long and very strong, made of the leaves of flax, split and prepared, but not scraped, and completely fitted up with floats, and sinkers, and ropes, and other needful appurtenances. Cook, who was astonished at their length, has written much in praise of them. I make one striking quotation: "When we showed the natives our seine, which is such as the King's ships are generally furnished with, they laughed at it, and in triumph produced their own, which was indeed of an enormous size, and made of a kind of grass [*Phormium*] which is very strong. It was five fathoms deep, and by the room it took up could not be less than three or four hundred fathoms long."* (Voyages, vol. ii, first voyage, pp. 369, 370.)

In residing at Dannevirke, in the Forty-mile Bush district, during several months, I have often noticed the Maoris from neighbouring villages coming to the stores there to purchase tether and other ropes and lines (large and small) for their use with their horses, ploughs, carts, pigs, &c., while on their own lands and close to them the flax plants grew in abundance. These Maoris had very little to occupy their time, and could easily have made common lines and ropes for their own use if they knew how to spin them as their fathers did, and also possessed their forefathers' love of work.

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* An interesting historical tragic story of the cleverly-planned taking and death of a large number of Maoris in one of these seine-nets, together with the fish (illustrating what Cook has written of their immense size), and of the deadly warfare that followed, is given in the Transactions N.Z. Institute, vol. xiii., p. 43.

Art. XLVIII.—Status quo: *A Retrospect.—A Few More Words by way of Explanation and Correction concerning the First Finding of the Bones of the Moa in New Zealand; also Strictures on the Quarterly Reviewer's Severe and Unjust Remarks on the Late Dr. G. A. Mantell, F.R.S., &c., in connection with the same.*

By W. Colenso, F.R.S., F.L.S., &c.

Mark now, how plain a tale shall put you down.
Shakesp., "K. Henry IV.," Part I., Act 2.

No pleasure is comparable to the standing upon the vantage-ground of truth.
Bacon, Essay I., "Of Truth."

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

My attention having lately been called to a book published at Wellington by the Government in 1889, entitled "The Literature relating to New Zealand: a Bibliography," by J. Collier, I obtained a copy.

In looking into it I was greatly surprised on reading the following remark made by the compiler (p. 134): "Dr. Mantell sought to claim for Mr. Colenso priority in the discovery of the struthious character of the moa. The *Quarterly Review*, xc., 404, 405, note, disposes of the claim. Professor Owen's first memoir was despatched to New Zealand in December, 1839, and received in 1840. Mr. C.'s paper, dated May 1, 1842, appeared in *Tasmanian Journal*, vol. ii., No. 8, 1844."* And, although this note of the Quarterly Reviewer was made forty years ago, I had never before heard of it.

I much regret this, for I had again written on the moa in 1879,† fully and exhaustively, as I then supposed, and so had quite done with it.

On the other hand, I am pleased in now detecting that remark and the note, as I think I shall be able clearly to show its error, and this with respect to the late Dr. Mantell as well as to myself.

As a matter of course, I sought to know much more than Collier's brief remark communicated. I endeavoured to obtain a copy of the *Quarterly Review* vol. xc., but for some time failed. None were to be found in Napier, and, as far as I could learn by repeated inquiry, none in Wellington—save, probably, in the General Assembly Library. Consequently I

* Corrected in a footnote to "No. 7, 1843."

† Trans. N.Z. Inst., vol. xii., p. 63.

made application there, and was promptly and courteously supplied with the volume required.

The Reviewer's "note" in question is a very long one, amounting to nearly a whole page in quantity and of very small type. It seems to me as if a certain infelicitous animus pervaded it, with particular reference to Dr. Mantell. Such, however, may have arisen from two causes on the part of the Reviewer —the one, his ignorance from not going deeply and fully into the subject; the other, his omitting to weigh and consider all matters in connection therewith: perhaps others might (in England) be assigned.

It is, however, given by the Reviewer as being necessary to his statement made in the body of his review, where he says, "All criticisms and misgivings as to the original audacious induction from the fragment of the supposed marrow-bone being thus quashed, *there remained only attempts at detraction from the merit of the discovery.* One of these amenities Mr. Owen has disposed of in a note to his third memoir, and *we shall devote a note to another.*" (*Loc. cit.*, p. 404.)

In order the better to take up and answer the charges made and implied in this long note, and as the book whence I extract it is both old and scarce here among us, and as the matter itself is purely, or mainly, a New Zealand one, I shall necessarily be obliged to quote it pretty largely:—

"Dr. Mantell, in a paper 'On the Fossil Remains of Birds collected in New Zealand by Mr. Walter Mantell' (*Quarterly Journal of the Geological Society* for August, 1848), says, 'I do not deem it necessary to enlarge on the question whether the *Dinornis* and *Palapteryx* still exist in New Zealand. On this point I would only remark that Mr. Colenso, who was the *first* observer that investigated the nature of the fossil remains with due care and the requisite scientific knowledge (having determined the struthious affinities of the birds to which the bones belonged, and pointed out their remarkable characters, ere any intelligence could have reached him of the result of Professor Owen's examination of the specimens transmitted to this country), has given in his masterly paper before quoted very cogent reasons for the belief that none of the true moas exist, though it is probable the last of the race was exterminated by the early inhabitants of those islands.' The emphasis of the italics is Dr. Mantell's; the paper he cites is from the number of the *Annals and Magazine of Natural History* for August, 1844. In it Mr. Colenso refers to a visit which he made in the summer of 1838 to the tribes of the East Cape district, and to the stories which he heard from them. . . . So much for the journey in 1838. In December, 1839, Professor Owen despatched to New Zealand copies of his first memoir, as printed in the Proceedings of the Zoological Society; and they were received before the close of 1840. Mr. Colenso's paper is dated the 1st May, 1842. 'In 1841–42,' proceeds Mr. Colenso, 'I again visited those parts.' He procured from the natives some bones declared by them to be true moa-bones. 'These bones, seven in number, were all imperfect, and comprised five femora and one tibia, and one which I have not been able satisfactorily to determine. . . . Leaving Waiapu, and proceeding by the coast towards the south, I arrived at Poverty Bay, where the Rev. W. Williams resided. This gentleman had had the good fortune to procure a nearly whole tibia of an immense bird, without, however, the entire processes of either end. Mr. Williams wishing to send this unique relic to Oxford, I left a pair of femora to accompany it, in order, if possible, to obtain from that seat of learning some light on these interesting remains.' . . . Dr. Mantell, who takes no account of the influence of the dispersion of the first memoir in New Zealand between 1839 and 1841–42, seems only to be acquainted with Mr. Colenso's paper as printed in the *Annals of Natural History* in 1844. We have been at the pains to look through the numbers of the *Tasmanian Journal*, and we find Mr. Colenso's account of his excursion in 1841–42, in vol. ii., No. 8, printed in 1844. From this it appears that Mr. Colenso embarked on the excursion which led to his *first* recognition of the remains of large birds in New Zealand on the 19th November, 1841—just two years after the publication of Owen's first memoir on the New Zealand struthious birds. . . . The statement of these facts detracts nothing from the merit of Mr. Colenso's observations; but what becomes of Dr. Mantell's affirmation 'that Mr. Colenso was the *first* observer that investigated the nature of the fossil remains with due care and the requisite scientific knowledge'?" (*L.c.*, pp. 404, 405.)

Here it is apparent that the Reviewer hits Dr. Mantell very hard; but I cannot see any real grounds for his so doing—rather, much to the contrary. No doubt, had Dr. Mantell wholly ignored, or slightingly, or even slightly, mentioned Professor Owen's early discovery, the Reviewer would have had fair grounds for his heavy charges. But Dr. Mantell could not do that. And now, what did Dr. Mantell say? (I quote from *the very same paper* that the Reviewer had quoted from—*Quarterly Journal Geographical Society*, August, 1848.)

The doctor thus begins his very excellent paper "On the Fossil Remains of Birds collected in Various Parts of New Zealand by Mr. Walter Mantell, of Wellington:" "It is not a little remarkable that one of the most interesting palæontological discoveries of our times—namely, the former existence of a race of colossal ostrich-like birds in the islands of New

Zealand—though made in a British colony, and announced to the scientific world by an eminent British physiologist, has not hitherto been brought under the immediate notice of the Geological Society of London. . . . . The first relic of this kind was made known to European naturalists by Professor Owen in 1839. It consisted of the shaft of a femur, or thigh-bone, but a few inches long, and with both its extremities wanting; and this fragment so much resembled in its general appearance the marrow-bone of an ox as actually to have been regarded as such by more than one eminent naturalist of this metropolis. And if I were required to select from the numerous and important deductions of palæontology the one which of all others presents the most striking and triumphant instance of the sagacious application of the principles of the correlation of organic structure enunciated by the illustrious Cuvier—the one that may be regarded as the *experimentum crucis* of the Cuvierian philosophy—I would unhesitatingly adduce the interpretation of this fragment of bone. I know not among all the marvels which palæontology has revealed to us a more brilliant example of successful philosophical induction—the felicitous prediction of genius enlightened by profound scientific knowledge. The specimen was put into Professor Owen's hands for examination, . . . and from this mere fragment the Hunterian Professor arrived at the conclusion 'that there existed, and perhaps still exists, in those distant islands a race of struthious birds of larger and more colossal stature than the ostrich or any other known species.' . . . In 1843 the correctness of these views was confirmed in every essential particular by a large collection of bones obtained by the Rev. W. Williams, and transmitted to the Dean of Westminster; and still further corroborated by another interesting series brought to England in 1846 by Percy Earl, Esq., and by the collection which forms the immediate subject of this communication." (*L.c.*, p. 226.)

Surely this language is clear enough. Dr. Mantell, the Vice-President of the Geological Society, voluntarily and largely gives to Professor Owen the highest possible meed of scientific praise for *his being the first to announce* to the scientific world at Home his great discovery.

After this, Dr. Mantell goes fully into the large and rare collection of moa-bones he had then recently received from his son here in New Zealand, containing 900 specimens. And, in his doing so, he further says, "I will now describe in general terms the most interesting specimens in the collection formed by my son; the anatomical details, and the important physiological inferences resulting therefrom, will be laid before the Zoological Society by Professor Owen, to whom, as a tribute of respect due for his masterly interpretation of the bones previously transmitted from New Zealand, I have offered the examination and description of every object in the series that he may consider worthy his attention." (*L.c.*, p. 231.)

Then Dr. Mantell takes up seriatim my paper on the moa, and quotes therefrom—not merely with reference to the few bones of the moa that I had obtained, but also the many and sundry other particulars I had brought forward relative to their places of deposit (geologically), their apparent age, whether the moa was still living or extinct, researches, inquiries, traditions of the Maoris, &c.; and finally he says, "I do not deem it necessary," &c., as quoted in full above; which has caused the onslaught of the Reviewer.

Now, knowing, as I do, so much of the olden time—"fifty years ago"—in New Zealand, including the very, very few and isolated Europeans then resident who cared for scientific matters at all, and our seeking the moa's remains, I must again say that Dr. Mantell, in so writing, meant to say, and verily says, that I was "the *first*" person to do so out here at the Antipodes, and that this saying had nothing whatever to do with Professor Owen's masterly scientific deductions previously made in England, and already, very properly, prominently, and kindly, brought forward by Dr. Mantell in the beginning of the very same paper.

Indeed, I can hardly comprehend why the Reviewer should have so chosen to run his head bang against a post unless his eyes were shut; for (as I read them) Dr. Mantell had chosen several words in his sentence which would not so well apply to Professor Owen and his deductions from his *one* small and broken fragment—*e.g.*, "first *observer* that *investigated* the nature of the *fossil remains*" (*plural*) "with *due care*," &c.

And this is yet further and clearly shown in Dr. Mantell's words on the same subject in his work on "The Fossils of the British Museum" (published several years after, in 1851, and almost certainly before the Reviewer penned his aggression), in which the doctor says (writing on the moa), "The first European who appears to have taken cognisance of these facts, and paid attention to the native traditions on the subject, was the Rev. W. Colenso," &c. Then Dr. Mantell (again) goes on to say ("History of the Discovery"), "In November, 1839, British naturalists were first made acquainted with the discovery of bones of colossal ostrich-like birds in New Zealand, by the fragment of a thigh-bone of a bird much larger than that of the ostrich, which had been brought to England by a Mr. Rule, who lent the specimen to Professor Owen, by whom it was described in the Zoological Transactions." (*L.c.*, pp. 93. 94.)

Moreover, Dr. Mantell says, "The first collection sent to England by my son, in 1847, consisted of nearly nine hundred specimens. I gave Professor Owen the exclusive privilege of describing the specimens." And then, in a footnote, Dr. Mantell adds, "The following is an extract from a letter now before me from Professor Owen, dated 'Royal College of Surgeons, Christmas Day, 1847': 'I feel very sensibly the mark of kindness and confidence which you have given me in placing your son's unique rarities in my hands for description; the more so as this liberal and generous conduct contrasts with that of others from whom I had expected better things.'" (*L.c.*, "Appendix," p. 487.)

So that it appears the utmost kindness, disinterestedness, and liberality was existing and active between Dr. Mantell and Professor Owen—not only at that early time (and during a long subsequent period), but with especial reference to the discovery of the moa and of the moa-bones, when the Reviewer so diligently laboured to place Dr. Mantell's conduct in the most malevolent light. And to call Dr. Mantell's few simple and truthful remarks "*attempts at detraction from the merit of the discovery*"! *Jam satis!*

Before I leave this portion I would also observe, seeing so much stress is apparently laid by the Reviewer on my paper on the moa in the *Annals of Natural History* for 1844, as being the only one known to Dr. Mantell, that that very paper was kindly inserted in that serial by Professor Owen himself (who had received it from Sir W. J. Hooker, the Director of the Royal Botanic Gardens at Kew),* who also subsequently favourably refers to it in his large work (*passim*).† Moreover, I know not of any difference in that paper as published in England, and dated "May 1, 1842," and the same published in the *Tasmanian Journal* in the previous year. And, further, the Reviewer takes care to tell us that my paper ("Account of my Excursion," &c., in 1841–42, being mainly botanical) in the *Tasmanian Journal* was "*printed in 1844;*" but he omits to state what is given by the editor, within brackets, at the head of my paper—namely, "The following paper was transmitted by the author twelve months ago, but its publication in the *Tasmanian Journal* has been unavoidably postponed" (*l.c.*, p. 210). And, since the Reviewer also says, "We have been at the pains to look through the numbers of the *Tasmanian Journal*, and we find" (as above), why did he not notice what is pro-

* Sir W. J. Hooker thus mentions it in the *London Journal of Botany:* "We have lately received from Mr. Colenso a valuable monograph of several new ferns of New Zealand; and an admirable memoir on the fossil bones of a bird allied to the ostrich, which, together with the specimens of the bones themselves, I have placed in the hands of Professor Owen" (*loc. cit.*, vol. iii., p. 3, Jan. No., 1844).

† "Memoirs on the Extinct Wingless Birds of New Zealand," vol. i., p. 115.

minently stated at only two leaves before my paper on the moa — namely, "Government House, 17th May, 1843.—Present: Sir John Franklin, &c. Three communications had been received from Mr. Colenso, one of November 4th, 1842, with an amended copy of his paper on the moa" (*l.c.*, vol. ii., p. 77)?

Then the Reviewer goes on to say, in his note, "In December, 1839, Professor Owen despatched to New Zealand copies of his first memoir, as printed in the Proceedings of the Zoological Society, and they were received before the close of 1840. Mr. Colenso's paper is dated May 1, 1842. . . . Dr. Mantell, who takes no account of the influence of the dispersion of the first memoir in New Zealand between 1839 and 1841–42, seems only to be acquainted with Mr. Colenso's paper as printed in the *Annals of Natural History* in 1844." He had previously said in the body of his review, "Copies of the memoir were despatched forthwith to many residents in New Zealand, and special letters were addressed to the few personally known to Mr. Owen, strongly urging the prosecution of inquiries among the natives as to the existence of such fossil or semi-fossil remains" (*l.c.*, p. 402). Assuming, of course, that Professor Owen's *first* memoir had been received here in New Zealand, that it had been distributed, and that I had seen it, &c.—*ergo*, my paper!

The Reviewer does indeed say, "The statement of these facts detracts nothing from the merit of Mr. Colenso's observations;" but no other person, I suppose, reading them could so think with him. On the contrary, if all that might be reasonably inferred therefrom was true, then, of course, my paper and myself should be dealt with accordingly.

Now, I positively affirm that I not only never saw Professor Owen's *first* memoir, but that I had never once heard of it, neither did I ever hear of any resident in New Zealand who had seen it. And it must not be overlooked that, residing as I was then in the Bay of Islands, in a part of New Zealand where no moa-remains had ever been found, and where the name was unknown, very far away from Cook Strait, the head-quarters of the New Zealand Land Company, and also distant from Auckland, the seat of Government, with only few and far-apart means of communication between our localities, and that only by small coasting-vessels, I was not in the way of receiving or hearing information of that kind.

But (apart from this negative statement) those assumptions and insinuations of the Reviewer are best answered by Professor Owen himself in his own words (please note particularly *dates*):—

"A fragment of bone was brought for sale to the College of Surgeons in 1839. . . . Drawings of it, with my descriptions and conclusions, were submitted to the Zoological Society, London, November 12th, 1839. . . . There was some hesitation in the Publication Committee as to the admission of the paper, with the plate, into the Transactions. . . . Ultimately the admission of this paper into the Transactions, with one plate, was carried at the committee, the responsibility of the paper 'resting exclusively with the author.' On the publication of the volume in 1838* (*sic*) one hundred extra copies of the paper were struck off, and these I distributed to every quarter of the Islands of New Zealand where attention to such evidences was likely to be attracted. In this distribution I was efficiently aided by Colonel William Wakefield, at that period zealously carrying out in New Zealand the principles of colonisation advocated by his brother, Mr. Edward Gibbon Wakefield; by J. R. Gowen, Esq., a director of the then recently-established 'New Zealand Company;' by my friend Sir William Martin, the first Chief Justice; and by the Right Rev. Dr. Selwyn, the first Bishop of the Islands." ("Memoirs on the Extinct Wingless Birds of New Zealand," vol. i., pref., pp. iv., v.)

I copy again from Professor Owen's large work: "*Addendum.*—J. R. Gowen, Esq., a director of the New Zealand Company, has obligingly forwarded to me the subjoined indication of a further discovery of the bones of the *Dinornis* from a new locality in New Zealand: Extract of a letter from Colonel William Wakefield to J. R. Gowen, Esq., dated Wellington, *19th September, 1843.—'I received lately your letter respecting the moa, with Professor Owen's notice.* I have taken steps to procure some of the bones, which are much larger than the one represented in the sketch.'"

This, I think, sufficiently answers the Reviewer's hasty conclusion as to "the influence of the dispersion of the *first* memoir in New Zealand between 1839 and 1841–42"—that is, as far as what had been made known and done throughout that period by the New Zealand Land Company.

The Chief Justice, Sir William Martin, arrived in New Zealand by the ship "Tyne," in 1841. His residence was at Auckland; and I have good reason for believing that both he and the officers of the Land Company had vastly too much of higher and more important public matters to attend to. The Bishop of New Zealand, with the Rev. W. C. Cotton, did not arrive in New Zealand until June, 1842, after my paper on the moa was written.

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* This is an error: it may be 1839, but is more likely (considering the former date mentioned by Professor Owen, and what followed—including "the publication of the *volume*" of 1839) to be 1840.

Professor Owen also says the replies to his letters, &c., "anxiously expected through the years 1840, 1841, and 1842, at length arrived, in the letter from Rev. William Cotton, in that from Colonel Wakefield" (*supra*), "and in the collection of bones transmitted by the Rev. W. Williams, and received in 1843 by the Rev. Dr. Buckland at Oxford" (*l.c.*, p. v.). And, again, "The first letter received by me from New Zealand, confirming this announcement, and acquainting me with the existence of the specimens" (above mentioned), "was written by my friend the Rev. William Cotton, M.A., 10th January, 1843" (*l.c.*, p. 74).

Dr. Dieffenbach, the naturalist attached to the New Zealand Land Company, who was in New Zealand during the years 1839, 1840, and 1841, certainly never heard while here of Professor Owen's *first* memoir. During his last year in New Zealand he lodged in a house very near mine at Paihia, and we often conversed on the moa and on kindred matters.

In 1842 Dr. Sinclair (afterwards Colonial Secretary) lodged at that same house, and with him I was also well acquainted; and I am pretty sure that Dr. Sinclair during that time had not seen Professor Owen's *first* memoir. And so, I think, I may say of Sir J. D. Hooker and the other officers of the discovery-ships "Erebus" and "Terror," which wintered there in the Bay of Islands in that same year—that they had not then seen a copy of it while in New Zealand.

Also, the Rev. W. Williams I may mention here, drawing my inferences from his communications with me while staying several days at his house, and from his letters to me; and more particularly from his long and interesting letter to the Rev. Dr. Buckland which accompanied the collection of bones (*supra*), in which letter Mr. Williams is not only wholly silent respecting Professor Owen and his "first memoir," but says, "If the bones are found to be of sufficient interest, I leave it to your judgment to make what use of them you think proper; but if the duplicates reach you, perhaps one set may with propriety be deposited in our museum at Oxford." And Mr. Williams concludes his letter with these words: "Should I obtain anything more perfect, you will not fail to hear from me; and, in the meantime, may I request the favour of your opinion on these bones, and also *the information whether any others of similar character have been found elsewhere?*" (*L.c.* pp. 75, 76.) This letter is given *in extenso* by Professor Owen, and is dated "Feb. 28th, 1842."

I may here briefly remark that I was not a little surprised to find that the Rev. W. Williams had not specially mentioned in his interesting letter to Dr. Buckland the pair of femora

I had left with him for Oxford;* seeing too that I had recently brought them from the East Cape, sixty miles further north and in a different geological country.

Moreover, I may here fairly quote from Professor Owen's *first* letter to me, as affording an additional gleam of light on my present inquiry. It is a long letter, a large portion of it being occupied with the *Apteryx:* "Royal College of Surgeons, Lincoln's Inn Fields, London, 23rd October, 1843.—Sir,—I am encouraged by Sir William Hooker to hope that you may interest yourself in transmitting me information and specimens relative to a point in natural history which I have been for some years endeavouring to elucidate—viz., the nature and affinities of the gigantic bird which appears to have become extinct, like the dodo of the Mauritius, within the historical period in the North Island of New Zealand. The Proceedings of the Zoological Society for January, 1843, which I take the liberty to transmit, will put you in possession of the amount of information which I had obtained on the subject of the *Dinornis* at that period." And, at the close, "As soon as I have published the memoir I am now preparing on the *Dinornis*, I shall forward it to the Rev. W. Williams and to yourself."

That letter, sent through some private hand, only reached me on the "17th January, 1846"!† I never received the Proceedings of the Zoological Society therein mentioned; but I did subsequently receive from Professor Owen a copy of his paper, "On *Dinornis* (Part II.). Read June 26, 1846;" which is also contained in his larger work above quoted, vol. i., pp. 115–137.

In conclusion, I confess to a feeling of disappointment at my never having seen Professor Owen's *first* paper, with the drawings of the first fragment of bone of *Dinornis* that had been taken to England; which disappointment was increased on my finding that such were not contained in his large work on "The Extinct Wingless Birds of New Zealand." An "abstract," however, of that paper is given by him in the "Introduction" to his "Memoir on the *Dinornis*," in that work (*l.c.*, pp. 73, 74).

The review is headed "Progress of Comparative Anatomy," and includes fifteen of Professor Owen's works, from 1830 to 1849;‡ it extends over fifty pages of the

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* Mentioned above, p. 470.

† As per my indorsement thereon. Here is, also, a kind of confirmation of what I have stated above, at p. 474.

‡ Omitting many special memoirs and monographs. The chief of them, however, are enumerated in another very long footnote in two pages, 370 and 371.

Quarterly, from p. 362 to p. 413, containing many lengthy extracts, and is certainly a very ably written one. Indeed, a thought (or something more fixed and stable) has occurred to me that the reviewer of those able works, who wrote the body of the said review, did not write the long note at pp. 404, 405, the tenor, tone, and language are so very different, so discourteous, so largely exceptional, so far from truth!

Art. XLIX.—*The Tradition respecting the Aboriginal Inhabitants of Whakatane.*

By the late Lieut.-Colonel St. John.

Communicated by T. Kirk.

[*Read before the Auckland Institute, 2nd November, 1891.*]

Turning over an old note-book, I came across a note given to me in 1872 by the late Lieut.-Colonel St. John, and, as it seems worth preserving, notwithstanding its extreme brevity, I send a copy of it herewith. If read at a meeting of the Institute it may elicit a fuller account. It is as follows:—

The first man who landed was Toe, of Ngapuhi. Disembarking at Kohi Point, and the clouds obscuring the sun, he found it cold, and sang a *waiata* (preserved by tradition) for the clouds to clear off. On Kohi, between Kapu and the point of the headland, existed, at his landing, a pa containing aborigines, with whom he dwelt until the arrival of the next party, which came from Hauwhaiki, under a man named Taukata, who introduced kumaras. The aborigines knew of no other food than mamaku and fern-root, and did not know how to light a fire.

The remainder of the tradition is merely a genealogical table accounting for the ancestors of the various tribes in the Bay of Plenty, with fabulous accounts of their doings.

The Whakatane natives still point out a spot on the summit of the hill as the original pa found by Toe. If trenches were opened on this site some implements or skulls might be found which would throw light on the original population of New Zealand.

The tradition expressly states that the aborigines remained in their own pa, while Taukata took up his dwelling on the beach. After Toe's arrival they seem to have been absorbed into Toe's tribe, Rahiri of Ngapuhi, and eventually left Whakatane for the Bay of Islands.

ART. L.—*On the Working of Greenstone or Nephrite by the Maoris.*

By F. R. CHAPMAN.

[*Read before the Otago Institute, 14th October, 1891.*]

Plate XXXVIII.

NEARLY ten years ago Professor Ulrich, of the Otago University, handed me a letter which he had received from Professor Fischer, of Freiburg, in the Grand Duchy of Baden, the great authority on nephrite, making a series of inquiries on the subject of the Maori lore concerning this mineral and its uses. Professor Fischer is the author of a treatise or monograph on nephrite,—which, however, I have never been able to see,—and of several, probably numerous, scientific papers on the same subject. Professor Ulrich asked me to endeavour to answer the questions in so far as they related to Maori lore; but, as learned Maoris are rarer than black swans in the South Island of New Zealand, and as the North Island is a long way off and I have few opportunities of going there, I set to work to turn Professor Fischer's questions into English, add a few to them, and get them printed for circulation. Through the kindness of Mr. Hanson Turton, a Maori scholar, holding the office of Native Commissioner here, I obtained the names of many suitable men in the North, but I am sorry to say that the long printed paper which I sent out only came back four or five times with answers. I believe, however, that the answers which I did get give pretty nearly all that is to be learned on the subject of most of the questions; and some of the matter is undoubtedly of the very highest authority: but for satisfactory answers to Question No. 16, as to the customs, superstitions, traditions, and other lore concerning greenstone, further inquiries will have to be made in the North Island.

I sent copies of the answers to Professor Ulrich from time to time as I received them, and with them I wrote him several letters, of which I retained no copies, and in which I gave him the result of inquiries I had made on a flying visit to the North Island, and of some observations of my own. In the course of time I received from Professor Fischer a paper, which does not show in what scientific journal it has appeared, entitled "Ueber die Nephrit-industrie der Maoris in Neuseeland." I was a little shocked to notice the number of errors to which my loosely-written letters had given birth. I found myself styled Professor Chapman—due probably to the circumstance that Professor Ulrich had referred to "my former colleague," in reference to the fact that I had once been a Law Lecturer at the University where he was Professor of Mineralogy. I found many slight mistranslations and misunderstandings; and when I submitted the whole thing to my friend Mr. Helms, of Greymouth (now, I think, of the Geological Survey of New South Wales), he pointed out several more. Again, I found that, with all the care which I and those who answered my questions had used, some of the Maori names had gone wrong.

I have lately determined to republish the results of my inquiries in English, for the above and several other reasons. In the first place, Professor Fischer's paper seems to have come out before he received the last instalment of matter—namely, a set of answers by the late Mr. John White, our leading popular Maori scholar, and those of Dr. Shortland, our most learned and philosophical writer on Maori matters. Now Mr. White has died, leaving his *magnum opus* the "Ancient History of the Maori" incomplete, and I have reason to think that the paper he sent me embodies some of the matter of the History, which may otherwise never see light. Another reason for going into print is this: I am told that Professor Fischer's paper has been reproduced with additional information in an American scientific publication—I do not know which. Now, as a rule, whatever the Americans do they do well, and the additional information ought to be published in New Zealand; but I have too appreciative a recollection of Washington Irving's story of the Art of Book-making to allow me to care to contemplate my ill-considered, roughly-written private notes to Professor Ulrich first Germanised by Professor Fischer, and then Englished by some one else. The author of the paper I have heard of will not, I am sure, object to a revised version. The questions are included in this paper, and are followed by the correspondence answering them; to which I have ventured to add some notes and criticisms of my own, by way of clearing up certain matters inadequately expressed, and certain apparent contradictions. I hope my correspondents will accept these notes in the spirit in which they are offered. Having now been nineteen years in the field as a collector and observer, I have a fair claim to be allowed a part in the discussion.

In the title of this paper the word "greenstone" occurs, and this word is used throughout the text. I am quite conscious that the term is not geologically or mineralogically correct; but the stone of which I am writing is known by that name throughout New Zealand, and, though here as elsewhere the scientific man employs that word to describe a totally different class of rock, I should run the risk of being misunderstood were I to use any other word for what is under that name an article of commerce and manufacture in New Zealand. It is called *pounamu* or *poenamu* by the Maoris, and "jade," "jadeite," or "nephrite" by various writers, while old books refer to the "green talc" of the Maoris.

Too little has been said and too little is known of the way in which stone implements were made and used; and the reason is this: When the savage acquires an axe of steel his beautiful but ineffective stone weapon becomes useless, and falls from his hand. The rude whaler, who is his ideal white-man, looks curiously at the stone which yesterday served as a tool: but there the matter ends; and by the time a man who not only feels a little curiosity on the subject but desires to impart a little information to his curious countrymen dwelling in the remote Old World comes round, the savage and his savage children have gone to shadow-land; and the white-haired old whaler who witnessed the change points to the sandhills, which he calls Measly Beach, as the landmark between the two races, and shows where all his old acquaintances are buried. "Yes, Jacky Jack used a stone hatchet; have seen him make one." But it is too much to expect the old man to describe how this was done; it happened fifty years ago. Even Mr. Wohlers, an intelligent missionary, whose letter I publish, picked up some erroneous notions in the early whaling days; but fortunately my communication was in time to induce the Rev. J. W. Stack, whose knowledge of Maori affairs and Maori ways is unsurpassed, to draw his information directly from the pure and undefiled well of surviving ancient cannibalism, and was also in time to secure answers from such men as Mr. John White and Dr. Shortland, each of whom had half a century's experience of the Maoris to draw upon.

With the exception of the *tangi-wai*, the various kinds of greenstone are all found in a restricted locality on the west coast of the South Island. The Taramakau River is one of the numerous rivers flowing from the main range to the sea on that coast. Like the others of that region, it is in size out of all proportion to the country which produces it: this is owing to the great rainfall. This river, at the mouth of which Brunner and Heaphy found a village in which greenstone was worked in 1846, coupled with the Arahura and the sea-beach between and about the two, is in all probability the Wai-pounamu (Water of Pounamu) of the Maoris, which has given its name to this great island. The name "Arahura" is more often mentioned in the traditional history of greenstone. It is a much smaller stream, nine miles south of the Taramakau. The next river is the Hokitika, a little farther south, where the chief town of Westland stands, in the bed of which, however, greenstone is not found. The word "Hokitika" means in Maori "Return direct." Its course is the nearest road, *via* Browning's Pass, to the east coast, and it plays an important part in the history of the subject.

It must be remembered that on the West Coast shingly river-beds are highways. In the primitive times the dense forest between them was almost trackless. The greenstone is found in boulders in the deposits of gravel in the two valleys referred to; and these boulders are also cast up on the beach by the waves, having been formerly carried into the sea by the rivers. I do not know whether the dyke, or vein, has ever been found. In the early days the stone was rare and expensive. Litigation about the ownership of a block reached the Court of Appeal—an expensive matter in those days—and disclosed the fact that the stone had a high pecuniary value. It is now very cheap, as it is washed out of the great gravel-beds in the valley of the Taramakau in the process of sluicing for gold, and the gold-miners sell it to the storekeepers at a very moderate rate. Picked stone is only worth 1s. per pound, but exceptionally fair pieces command a higher price. A great deal is now thrown away owing to the want of a regular market. It is not easy even now, however, to get a perfect piece of large size. When Professor Ulrich and I, at the request of the Germans of Melbourne, chose the piece for a presentation paper-weight for Prince Bismarck, we had a difficulty in getting a perfect piece of the best quality as large as an octavo volume, though we had some tons of stone to choose from. The kind of stone known as *tangiwai* (tear-water) is very inferior, and is easily scratched with a knife; but it is sometimes very beautiful. It is found at Piopiotahi, or Milford Sound, and perhaps at other places. It is sometimes taken in slabs off serpentine boulders, and may be obtained on the beach at Anita Bay, near the mouth of the sound. Damour, of Lyons, has analysed it, and finds that it is chemically quite a different stone from the *pounamu*.

Myths.

Cook, living in the days when mere myths were unvalued untruths, missed an opportunity. He thought, from the description of the Maoris, that the greenstone-country was near at hand to his winter-station at Queen Charlotte Sound, and regretted not being able to visit it, "as we were told a hundred fabulous stories about this stone, not one of which carried with it the least probability of truth, though some of their most sensible men would have us believe them. One of these stories is that this stone is originally a fish, which they strike with a gig in the water, tie a rope to it, drag it to the shore, to which they fasten it, and it afterwards becomes stone." This was too much for a North Country sailor in the eighteenth century. Cook probably mistook the learning of the priests for a narrative of current events.

Pounamu was one of the sons of the great Polynesian deity Tangaroa (Lord of the Ocean), who was the son of Rangi (Heaven) and Papa (Earth). Tangaroa married Te Anu-matao (the Chilly Cold), who became the mother of four gods, all of the fish class, of whom Pounamu was one. The substance *pounamu*, it is said, was formerly supposed to be generated inside a fish (the shark), and only to become hard on exposure to the air.

Poutini was one of the brothers of Pounamu. He gives the name to the mythical stone brought by Ngahue to New Zealand commonly called in story the Fish of Ngahue (*vide post*). The stone *pounamu* was by learned Maoris classed with fish. The traditions respecting its discovery at Arahura state that Ngahue found it "in a lifeless state"—that is, unformed.

Tamatea-pokai-whenua, a celebrated ancestor of Maori tribes, in addition to his faithful wives, had three—Hinerau-kawa, Hinerauharaki, and Te Kohiwai—who deserted him. He sailed right round the South Island in search of them, naming the rivers and headlands as he passed. Though he listened for every sound indicative of their presence, it was not until, passing up the west coast, he reached the Arahura River that he heard their voices. He failed, however, to discover his wives, for he did not know that their canoe had been upset here, and they and all the crew had been transformed into stones. His slave, happening to burn his fingers while cooking some birds they had killed, impiously licked them, urged by the pain. He was instantly turned into the mountain Tumuaki, which stands there still; and as a consequence Tamatea never found his wives. Since then the flaws which sometimes discolour the best kinds of greenstone are called *tutae-koka*—the excrement of the birds the slave was cooking when he did this wrong.

MYTHS, TRADITIONS, AND HISTORY.

Several ancient Maori stories refer to dissensions which took place in Hawaiki before the great migration of the Maori people from that country to this. From them we learn something of the causes of the migration, and the mode in which it was designed and carried out. Later we learn from tradition, and finally from the history of this century, the part played by greenstone in the affairs of a nation whose history is war.

LEGEND OF POUTINI AND WHAIAPU.

The very discovery of New Zealand is connected with greenstone. Poutini and Whaiapu both rested in the same place, and Hine-tu-a-hoanga (the Lady of the Rubber), to whom the stone Whaiapu belonged, became excessively enraged with Ngahue and with his stone Poutini. At last she drove Ngahue out of the place, and Ngahue departed to a strange land, taking his jade-stone, followed, however, by Hine-tu-a-hoanga. Ngahue arrived at Tuhua (Mayor Island, in the Bay of Plenty; it is the Island of Obsidian) with his stone; and Hine-tu-a-hoanga also landed there, and began to drive him away. Then Ngahue sought a place where his jade-stone might remain in peace, and he found in the sea this island Aotearoa (North Island), and contemplated landing there. Thinking he would there be too close to his enemy, and lest they should quarrel again, he left, carrying off his stone. So he carried it off with him, and they coasted along, and at length arrived at Arahura (on the west coast of the South Island), and he made there an everlasting resting-place for his jade-stone. Then he broke off a portion of his jade-stone, and with it returned; and as he coasted along he at length reached Wairere (believed to be on the east coast of the North Island), and he visited Wangaparoa and Tauranga, and returned thence direct to Hawaiki, and reported that he had discovered a new country which produced the moa and jade-stone in abundance. He now manufactured two sharp axes from his jade-stone, named Tutauru and Hauhau-te-rangi. He manufactured some portions of one piece into images for neck-ornaments (*hei-tiki*), and some portions into ear-ornaments. The name of one of these ear-ornaments was Kaukaumatua, which was recently in the possession of Te Heuheu, and was only lost in 1846, when he was killed with so many of his tribe by a landslip. [This has since been recovered.] The axe Tutauru was only lately lost by Purohokura and his brother Reretai, who were descended from Tama-ihu-toroa. When Ngahue, returning, arrived again at Hawaiki, he found them all engaged in war; and when they heard of his description of the beauty of this country of Aotea some of them determined to come here.

They then felled a totara-tree in Rorotonga, which lies on the other side of Hawaiki, that they might build the Arawa from it. The tree was felled, and thus the canoe was hewn out from it and finished. The names of the men who built the canoe were Rata, Wahie-roa, Ngahue, Parata, and some other skilful men who helped to hew out the Arawa and to finish it. The Tainui was also built by Hotu-roa; also, other canoes—viz., Matatua, Takitumu, Kura-hau-po, Toko-maru, and Matawhaorua. These, the Maori historians say, are the names of the canoes in which their forefathers departed from Hawaiki and crossed to this Island. The axes with which their canoes were built were made from the block of greenstone brought back by Ngahue to Hawaiki, which was called "the fish of Ngahue."

The earlier part of this story is probably a myth. A contention arises between two precious stones. The Lady of the Stone-rubber harries the owner of Poutini, the precious greenstone, who, however, ends by establishing a new nation. It is, in effect, the same as Cain (the agriculturist) turning upon Abel (the pastoralist) and forming a stronger nation—a process which goes on actively in these colonies to this day. His name, "The Swarm," does not appear to connect itself with the subject. Flying from Hawaiki, the land of shades or night, he first comes to Tuhua. This means "obsidian," and is the name of an island in the Bay of Plenty—Mayor Island—where quantities of that stone are found. Disturbed there, he comes to Aotea, the Land of Bright Day. At Arahura, where he at last lands, he plants his stone, and so the story accounts for our now finding it there. He returns and tells of the new land of the moa and the jade-stone. The place "Wairere," wherever it was, frequently occurs in Maori story in connection with the extremely vague traditions of the moa. The story may be a mythical version of the discovery by a real personage of the distant land; and it is possible that the bringing home of this rare stone may have occurred. The rest of the story is the well-known tradition of the migration to New Zealand, the true historical value of which has yet to be determined. The names of the canoes and their builders are good Maori names.

The foregoing is abbreviated from Sir George Grey's "Polynesian Mythology" and Maori legends. Another version discards the mythical cause of contention, but gives the story of the contention, and tells how Ngahue, taking up his abode at Arahura, found during his residence there a block of greenstone "in a lifeless state"—*i.e.*, unworked—which he took back with him to Hawaiki, from which were made the axes used in building the Tainui and Arawa. An earring (*tara pounamu*) called Kaitangata (man-eater), also made from this block, was in the possession of the Ngatitoa for ages, and was by the famous chief Rangihaeata presented to Sir G. Grey in 1853. There are several versions of the story, generally agreeing, most of which refer to the eardrop as Kaukaumatua.*

* The various references to "Kaitangata" and "Kaukaumatua" in books are somewhat bewildering, and leave me uncertain as to whether they are the same ornament; if not, which of them was given to Sir G. Grey. Kaukaumatua frequently crops up in history and poetry. It was brought from New Zealand to Hawaiki; it became the property of Tamatekapua, who was a son or kinsman of Ngahue, and navigated the Arawa to New Zealand; it was buried by his son Tuporo, and recovered [Tregear]; it passed through the hands of many other celebrities, and is an important muniment of title.

Of this story it may be remarked that, though we have no means of determining its historical accuracy, it is, of course possible that preliminary exploring expeditions visited New Zealand and returned to the ancestral home, wherever that was, as we have evidence that, as a rule, the islands of the Pacific were discovered by regularly-equipped exploring expeditions. The report of the discovery of a great country, with no formidable inhabitants, arriving in an over-populated island the inhabitants of which were constantly at war with each other, is just the kind of circumstance that would stimulate a great migration, such as that which the traditions describe with such minute detail. The chief difficulty in this story and others relating instances of a return to Hawaiki lies in the degree of accuracy required to navigate a small vessel back to a very small island, while we know that for ages before Cook's time New-Zealanders had not made such voyages. It is, however, more than probable that the Maori navigators of ancient times possessed far superior knowledge and methods to those of Cook's time. Possession of a great territory had made them cease to be navigators of the ocean. The same thing had happened to our own race for two centuries at least before Alfred's time, and it is not difficult to point out that four or five times in history the possession of more than sufficient land-extension has caused the English or the Saxons to turn their faces from the sea.

Several traditions exist in New Zealand attached to particular implements or ornaments of greenstone besides the two mentioned, suggesting that they were brought from Hawaiki. Reference to one of these is made by Mr. Stack in his replies to my questions given later. I am informed by the Rev. Mr. Hammond, a missionary at Patea, that when the Maoris lose a treasured keepsake they make another like it, and always refer to the new one as if it were the identical original: in this way a paddle of one of the ancient canoes may be preserved in name. Possibly the precious Kaukaumatua may thus represent an ancient jewel of some other material.

Waitaha.

The history of the South Island (leaving out of consideration for the present its west coast, separated by an alpine barrier, and certain local settlements in the northern part of the Island) begins with the tribe called Waitaha. They came from the east coast of the North Island, and became extremely numerous; and to them are attributed by tradition the vast shell-heaps which lie near the beaches. They were exterminated by Ngatimamoe,—Mr. Stack thinks, three hundred years ago. They are vaguely connected by tradition with the extinction of the moa; but this touches the controverted question as to the date of that extinction. I cannot find, however, that they are traditionally connected with greenstone.

NGATIMAMOE.

This tribe conquered the above, and dominated this Island for about a century. They then became extinct as a tribe, but some hapus or sub-tribes incorporated with the conquering Ngaitahu still trace their blood to Ngatimamoe ancestry. It is a subject of reproach to have pakeha or European blood; and a half-caste lady once told me that, being thus reproached by relations, she replied that that was necessary to neutralise the bad strain of Ngatimamoe blood in our veins. The extent to which Ngatimamoe are traditionally connected with greenstone is discussed hereafter.

NGAITAHU INVASION OF THE SOUTH ISLAND.

Mr. A. Mackay, Native Commissioner, who is well versed in South Island affairs, describing Nga-i-tahu, who were an emigrant offshoot from Ngati-kahu-ngunu, the tribe which occupies the east coast of the North Island south of Hawke's Bay, says the desire to possess themselves of the greenstone which was only to be found in the South Island is supposed to have been the chief inducement which urged large bodies of this tribe at different times to invade the country of the Ngatimamoe, who had become celebrated as possessing this treasure. The story of the introduction of the stone to the knowledge of Ngaitahu, however, contradicts this version, which is not accepted by Mr. Stack, and is doubted by Mr. Mackay himself. Ngatimamoe in all probability did not possess much greenstone, perhaps did not know it, for it was after Ngaitahu had acquired their knowledge, and fought for and conquered the West Coast, that they carried on their bloodthirsty war of extermination against Ngatimamoe, fighting over the district surrounding this city (Dunedin), and ultimately destroying them in Southland.

GEOGRAPHY OF THE WEST COAST.

It is necessary that I should endeavour to give a clear idea of the West Coast region and its approaches, in order that the events hereafter mentioned may be properly appreciated. That portion of the West Coast region which lies south of Martin's Bay may be disposed of at once. It can be entered by none but very high alpine passes, only recently discovered, and probably not used by Maoris. Its shores are so steep that there is no travelling along them. In its northern extremity, however, is Piopiotahi, so often mentioned as the place where *tangiwai* is found, to which reference will be made hereafter. North of this lies the West Coast, so famous twenty-five years since for its enormous yield of gold, and still occupied by a population of twenty-five thousand energetic people devoted to mining pursuits. It may be entered in several different ways, thus: (1.) By sea from north or south. No doubt at times the coast was visited by sea. Mr. Wohlers mentions this, though he apparently refers to Piopiotahi, not to Arahura. But the coast is fearfully exposed and the sea excessively rough, and boating even with powerful crews must have been highly dangerous. (2.) By land *viâ* Lake Wanaka, the Haast Pass, and the Awarua or Haast River, and thence up the coast by land or sea. This route, or one by a neighbouring pass to the coast a little to the south, was described to Dr. Shortland by the Maori Huruhuru in 1842. It was the meeting-point of old Maori roads up the Waitaki and the Molyneux (Matau) and others. There was an old Maori settlement at Jackson's Bay, where this track reaches the shore; and until destroyed or dispersed by Rauparaha's West Coast party there were Maori settlements at Hawea and Wanaka. From Jackson's Bay the road up the coast to Arahura must have been difficult and dangerous, as there are some twenty rivers to cross. (3.) By the seashore from Cape Farewell in the extreme north. The possibility of walking by the shore from Cape Farewell to Arahura was demonstrated by Brunner and Heaphy in 1846. They found it excessively laborious, and passed over bluffs and headlands by means of rude ladders constructed years before by Rauparaha's raiders, who had come down this way. Even as late as that date they found old Maoris living near Cape Farewell who told them of the feuds which had prevailed in their young days, the character of which showed that the occupants of the greenstone country never had had friendly neighbours in the district to the north of their own. They were consequently utterly isolated until the passes from the East Coast became known. (4.) By the passes from Canterbury. North of the Haast Pass the next met is Whitcombe's Pass, one hundred miles north, connecting the south branch of the Hokitika River with the Rakaia. Next is Browning's Pass, connecting the Kokotahi, or north branch of the Hokitika, with the Rakaia. Then comes Arthur's Pass, the most convenient of all, crossed by the coach-road, but probably unknown to the Maoris, connecting an affluent of the Taramakau with one of the Waimakariri. Next is Harper's Saddle, on the borders of the Provinces of Canterbury and Nelson, connecting the Taramakau with the Hurunui, which was still used thirty years ago by the Maoris, who rafted themselves down the river on *mokihi* (rafts made of *Phormium* stems). (5.) By the passes from Nelson. These lead into the

Grey and Buller valleys, and as these enter into the historical narratives I will mention them later.

In order to rightly understand the position of a tribe of Maoris in primitive times occupying the West Coast country, the relative positions of the east and west coasts of the South Island, and of each to the North Island, must always be borne in mind. We have thus seen that an immense range of mountains separates these two territories. Between the Otago and Canterbury passes we have a range which the Rev. R. Green describes as "a great mountain-wall sending off numerous spurs rising into bold alpine peaks, and for over a hundred miles possessing no col or pass free from eternal snow and ice." North of this the main range is for another one hundred miles a little lower, and through it are three or four practicable alpine passes already referred to. The West Coast has a rainfall of over 100in., and is everywhere clothed to an altitude of 3,000ft. or 4,000ft. with dense forest with a wet undergrowth of ferns and mosses. The numerous rivers liable to sudden floods have wide gravelly boulder-beds, and these are the highways. Up these the passes are approached, and then the traveller crosses amid a wilderness of rare white alpine flowers. Steep mountains, innumerable torrents, constant landslips, sudden snowstorms—all nature conspired to make the passes fearfully dangerous until engineering skill took them in hand. It requires even now an effort of imagination to recall the difficult and dangerous task of the greenstone-raider of olden times where—

In Höhlen wohnt der Drachen alte Brut,
Es stürzt der Fels, und über ihn die Fluth.

The difficulties which beset the first miners who worked their way across are half forgotten now that a splendid road exists. In truth, however, to the last the two countries were separated by a wall which none but the bravest climbed, making the isolation of the two territories almost complete. Had Hannibal had such a country to deal with he would not have crossed the Alps in the face of a resolute enemy. To this day each region has more traffic with the North Island than with its immediate neighbour. It is, then, quite intelligible that a people long lived on the West Coast, holding occasional intercourse with the North Island, fighting constantly with the tribe immediately to the north of them, and utterly unknown to the tribes of the East Coast, neither knowing the way to penetrate to the other district.

It is, of course, possible that Ngatimamoe or even Waitaha had known of roads to the West Coast, of which no record was transmitted to their conquerors; but it seems more likely that, if they had possession of a little greenstone, it had come to them either by way of the North Island or by a line of communication leading to Nelson and Queen Charlotte Sound, passing through the hands of some intermediate tribe. The Ngaitahu traditions are very precise as to the time when and place where they first heard of it.

Ngaitahu Conquest of the West Coast.

The West Coast, including the valleys of the Taramakau and Arahura, had for ages been in the possession of Ngatiwairangi, who were its original occupants. According to Mr. Alexander Mackay they sprang from the Ngatihau or Wanganui Tribe. Mr. Stack considers that they came from the east coast of the North Island, and were of common descent with the Ngatimamoe and Ngaitahu. They were settled on that coast before Ngaitahu invaded the East Coast. The latter, or a remnant of them, whose chiefs are the Hon. H. K. Taiaroa, M.L.C., and Topi, of Ruapuke, were busy conquering the Ngatimamoe in the northern part of this Island and had got as far as Horowhenua when they first became acquainted with greenstone.

It is said that a woman named Rau Reka, sometimes called a mad woman, with a small travelling party, found the way up the Hokitika River over Browning's Pass across the mountains theretofore considered impassable, and thence to the East Coast. Arrived at Horowhenua, in the Geraldine district, she saw some men engaged in making a canoe, to whom she remarked how blunt their tools were. They asked her if she knew any better. She replied by taking a little packet from her bosom from which she unfolded a sharp adze of the kind of greenstone called *inanga*. This was the first they had ever seen, and they were so delighted with the discovery that they sent out three Ngaitahu to accompany the visitors to the coast and fetch some. On their return they stated that it was found at Arahura; after which it came into general use for tools and weapons, those of inferior material being, according to Mr. Stack's informants, discarded.

This led in time to a skirmish between Ngaitahu and Ngatiwairangi, in which blood was shed. Te Rangitamau led an expedition up the Rakaia and across the ranges to avenge this. Uekanuka, a great chief of the western tribe, was killed, and the expedition returned. A second expedition fared disastrously, being defeated at Mahinapua. A third expedition was followed by others, which effected the conquest, and, pursuing the fragments of this tribe, continued the war up to recent times—perhaps the first quarter of this century—when Ngatiwairangi were finally destroyed as a tribe in the battle of Paparoa, and their survivors incorporated with Ngaitahu. The branch of the latter tribe which settled there took the name of Poutini—I suppose, from the mythical name of Ngahue's fish-god or stone.

The Poutini-Ngaitahu had shortly after their first occupation to fight for their conquest, being attacked by Ngatitumata-Kokiri, a tribe dwelling farther north on that coast and about Massacre Bay, with whom they had frequent fights about the right to catch ground-birds in the upper Grey and Buller districts. This tribe, which seems to have had a warlike career, and was ultimately destroyed to the last man in fighting North Island invaders, is supposed to be the same which attacked Tasman's boat in Massacre Bay in 1642.

Mr. Stack puts the visit of Rau Reka about 1700; but thinks that traffic in greenstone had probably sprung up between Ngatiwairangi and the North Island tribes bordering on Cook Strait long before it became known to Ngaitahu. The existence of such a traffic is proved by reference to greenstone implements in North Island traditions of earlier date; but apparently these references are very rare in the earliest traditions.

NGA-TI-TOA INVASION OF THE SOUTH ISLAND.—RAUPARAHA.

Mr. W. T. L. Travers, in his charming but sanguinary narrative of "The Life and Times of Te Rauparaha" (Trans. N.Z. Inst., vol. v., p. 19), shows the connection between the bloody raids of that great Ngatitoa chieftain into this Island and the lust for greenstone. Rauparaha had been squeezed out of his own country, Kawhia, and had, in conjunction with his allies Ngatiraukawa, who likewise had wandered from their home in the centre of the Island, occupied as a stronghold the Island of Kapiti, in Cook Strait, and as much as he could hold of the mainland. A chief of Ngaitahu named Rerewhaka imprudently boasted that he would rip open Rauparaha's belly with a shark's tooth. Nominally to avenge this, but really out of lust for conquest, Rauparaha made a series of sanguinary expeditions down the coast of this Island, in the course of which Rerewhaka was killed and many of his people made slaves. The Ngaitahu were known to be rich in greenstone, and, according to Mr. Travers, Rauparaha longed to add the acquisition of such treasures to the gratification which he would derive from wreaking vengeance on the Ngaitahu chieftain for the insult under which he had so long suffered. Ngaitahu of Kaikoura and Amuri had long been in the habit of sending war-parties across the Island for the purpose of killing and plundering the inhabitants of the district in which it was obtained, and at this time a branch of their tribe held that country as conquerors. There were two routes in this quarter. The expedition sometimes passed through the Tarndale country to the upper Waiauuha, and thence through Kopiokaitangata, or Cannibal Gorge, at the head of the Maruia River, into the valley of the Grey, whence they ran down the coast to the main settlements from the mouth of that river to Jackson's Bay. At other times they passed from the Conway and other points on the East Coast through Hanmer Plains to the valley of the Ahaura, a tributary of the Grey, and so to the same localities. On the line of the former route Mr. Travers's shepherds have frequently found stone axes and many other objects. During their journeys to the coast through these rugged scenes the war-parties lived entirely on eels, wekas (*Ocydromus australis*), and kakapos (*Stringops habroptilus*), which at that time were numerous in the ranges; whilst on their return, after a successful raid, human flesh was carried by the slaves they had taken, and the latter were not infrequently killed in order to afford a banquet to their captors. During these expeditions large quantities of greenstone, both in rough blocks and in well-fashioned weapons—the art of fashioning these being especially known to the West Coast natives—were often obtained if the approach of the invaders was not discovered in time to permit the inhabitants to conceal themselves and their treasures. And it was the accumulated wealth of many years which Rauparaha expected to acquire in case he should prove victorious in his projected attack upon Rerewhaka and his people. In one of the expeditions the famous Te Pehi was treacherously killed while on a visit to a pa: not, however, before he had secured some fine specimens of South Island art, as his grandson Wi Parata, of Waikanae, formerly a member of Parliament, has now in his possession two beautiful *meres* of *inanga*, besides other objects. His friendly visit was to obtain some presents of *pounamu*, including a *mere* for himself, though why he should take a hundred men with him on that journey, the place being a hundred miles from Kaikoura, where the main force remained, is not quite clear. When finally the disaster overtook Ngaitahu at Kaiapoi Pa by which their power was broken it is said that they threw great quantities of greenstone into the deep swamp behind the pa, whence it has never been recovered.

West Coast Branch Expedition.

The narrative would be incomplete without a brief reference to this. The invaders, under Niho and Takerei, passed down the coast from Cape Farewell by land, sealing the otherwise almost impassable cliffs by means of ladders, which they made of climbing-plants. The numerous rivers — some of great volume—were crossed by means of rafts and of the canoes found on their banks. The local tribes were massacred wherever found, save such as were able to find refuge in the dense forests. Thus the country was conquered as far as

Hokitika. Among the prisoners taken was Tuhuru, chief of the Poutini-Ngaitahu, who on the return of more peaceful times was ransomed for a greenstone *mere* called Kai-kanohi (Eat the eye), which is still in the possession of the tribe. Later a party of more adventurous spirits continued the journey down the west coast, and, crossing by the Haast Pass, or one in that neighbourhood, surprised and massacred the natives settled at Hawea. One boy, Rangitapu by name, who still lives, an old man, at Port Molyneux, escaped, and warned his father, the chief at Wanaka, and he and his family fled down the Waitaki. The invaders, making rafts of *Phormium* stems with the help of their prisoners, floated down the great and rapid river Matau, or Molyneux, whose volume is said to equal that of the Nile, and thus passed right through Otago. Their appearance on the south coast, near the mouth of the Mataura, led to a hurried assemblage of fighting-men, headed by Tuhawaiki, from all quarters, including, it is said, white whalers and sealers from Foveaux Strait; and this ended in the defeat and almost total destruction of the invaders. The remnant were made slaves, one chief being kept a prisoner for many years. The tale has only been preserved in an obscure form. Since this invasion Maoris have never inhabited the interior of Otago. There is evidence that at one time a large population lived at or regularly visited Lakes Te Anau, Manapouri, Wakatipu, Hawea, and Wanaka. At the two former lakes numerous objects of greenstone have been found, and recently a great number have been ploughed up at Lake Wakatipu.

RESULTS.

The military overthrow of Ngaitahu at Kaiapoi never became a conquest giving a title to their territories; but in after-years the first white travellers who reached Arahura found the population strangely mixed. Nominally the tribe was the Poutini branch of Ngaitahu, with some of the remnants of the original Ngatiwairangi incorporated; but some of Rauparaha's Ngatitoa and Ngatiraukawa had detached themselves from the expedition, which swept that coast in a murderous man-eating raid, and settled with their old enemies there. Besides, there were some of the scattered fugitives from Kaiapoi, who had fled in terror from Rauparaha's arms, and even some from Otago, who had probably accompanied them. These had just effected the sale of their territory to the Queen when the miners swarmed into the country, from which in a few years they sent out gold to the value of ten millions sterling.

The practical outcome of all the sanguinary wars to which I have briefly alluded has been considerable. Considered in detail their study leads to nothing; considered as a whole they can only be regarded as a precursor of white settlement, which has proceeded in the South Island almost unobstructed by the native difficulties which have arisen in the North Island, repeating here the history of the Roman Britons, whose petty contentions gave to the northern invaders the power to sweep them back to the western ranges.

Age of the Art.

As to the date at which the Maoris commenced to work greenstone, we have only the uncertain traditions which I have already narrated. It is very probable, however, that the North Island had been long colonised before it was known. This would still be probable even if credit could be given to the story of Ngahue bringing back a single stone to Hawaiki, and making implements and ornaments of it, a story which Mr. Tregear thinks we probably do not rightly understand, for the place where that stone was obtained would have to be discovered anew. Mr. Stack thinks, as will be seen from his answers (Nos. 4 and 5), that Ngatiwairangi occupied the West Coast in very early times, and that the story told him at the Thames that a *hei-tiki* held by the natives there was brought by their ancestor Marutuahu from Hawaiki may indicate that some of the Taranaki and Cook Strait people obtained greenstone from these Ngatiwairangi at a very early date, long before it became widely known. This seems very probable, as Ngatiwairangi, working up only small quantities, would not for a long time push a very active trade, and would probably keep the secret of the locality where the stone was found. It did not, in all probability, get extensively into use until visitors were allowed to search for it and carry it away in bulk, or came as invaders and did this without permission; though no doubt travellers from the greenstone coast spread a certain amount among their distant friends and relatives. "Notwithstanding," says Cook, "the divided and hostile state in which the New-Zealanders live, travelling strangers who come with no ill-design are well received and entertained during their stay, which, however, it is expected will be no longer than is requisite to transact the business they come upon. Thus it is that a trade for *poenammoo*, or green talc, is carried on throughout the whole Northern Island."

If it be the case that the Waitaha, who, according to Mr. Stack, must have flourished in this Island before 1577, and whose destruction by Ngatimamoe began about that date, were the people who destroyed the moa (*Dinornis*) and the pouakai (*Harpagornis*), then there is some evidence, though it cannot be deemed very satisfactory, that the Waitaha had something to do with greenstone. The recent observations of

Mr. H. O. Forbes at Monck's Cave, Banks Pensinsula, point in this direction. The cave was at some remote period closed by a landslip, and for many years the colonists have carted away the slipped material for road-making. In this way the existence of the cave was discovered quite recently. The cave was found to be in the condition in which its Maori inhabitants had temporarily left it when the slip occurred. On the floor were found beautifully-made implements of greenstone. Scattered about were numerous largish fragments of moa-bone, and fish-hooks and barbed spear-tips of the same material. On the surface were bones of swans, a bird extinct beyond the memory of man in New Zealand. "Just below the surface of an untouched part of the midden," says Mr. Forbes (Trans. N.Z. Inst., vol. xxiii., p. 374), "I myself picked out pieces of moa-egg shells, each with its internal epidermis perfectly preserved."

Whatever other evidence there may be, there is nothing in this absolutely to refute the idea that these objects may have lain for generations—perhaps for centuries—in a dry cave to which the air had so little access that its dryness was always preserved, as even in the destructive climate of Funk Island the eggshell of the great auk is sometimes found when taken from the ground to have the epidermis still adhering to it. It can only be offered as suggesting that the owners of these implements knew the moa and its eggs. Mr. Forbes has kindly given me the opportunity of inspecting the eggshell in his possession. The pieces are small, and if preserved in undisturbed dry ground may be very old. The greenstone objects in the Christchurch Museum taken from this cave are undistinguishable from those constantly found in Maori camps.

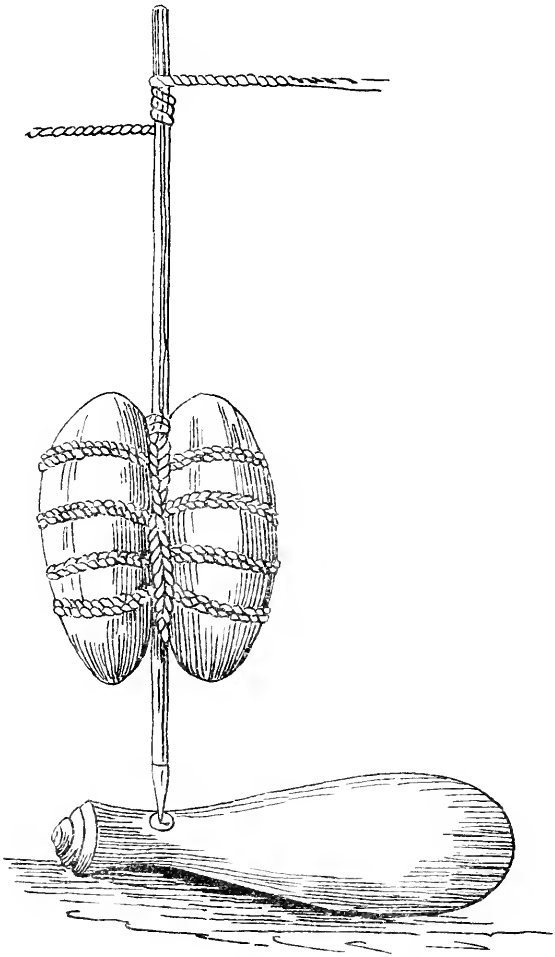
The character of the objects found in the cave shows that the inhabitants were probably North Island Maoris; and von Haast long ago found that the articles in the neighbouring Sumner Cave, left there by a people contemporaneous with the moa, pointed in the same direction, being made of wood growing exclusively in the North Island.

If this be so they were probably visitors from Cook Strait. As von Haast did not find greenstone among the objects referred to, it is on the whole more probable that that found in Monck's Cave belonged to a people of later date, who in using the cave had not greatly disturbed the relics of its former denizens. The evidence derived from the state of the eggshells must therefore be regarded as inconclusive.

In a somewhat extensive examination of the great beds of moa-bones at Shag Point, which Mr. A. Hamilton and I made in January, 1891, he found one piece of greenstone. It is 6in. in length by $1\frac{1}{2}$in. in width and $\frac{3}{4}$in. thick, and is of a tolerably good quality of *kawakawa*. It bore no distinct resemblance to any familiar implement, being more like one of the rubbers or polishers which we find in numbers there, having the two opposite broader sides distinctly concave. I do not agree with Mr. Hamilton in thinking that it has been used as a sharpening-stone for putting a final edge or polish on implements, as I do not know of any stone in the polishing of which greenstone would offer any advantage for such a purpose over common sandstone. I find, moreover, on submitting it to inspection by means of a hand-glass that it has been shaped by grinding by means of a coarse *hoanga* or sandstone; that the striæ run across it at an angle of 45°, as is usual with unfinished greenstone implements; and that these traces of workmanship run over every part of it evenly, which would not be the case had it been used as a tool merely. It has been sharpened by means of considerable labour, and is of great interest, as it was found imbedded in the great bed of moa-bones broken by human hands, in a zone where, amid masses of fractured bones, implements of moa-bone and cut fragments were also found.

Though no greenstone has ever been reported from this zone, the situation was such as to satisfy Mr. Hamilton and myself that those who fed upon the moas—who it is now universally admitted used polished-stone implements, of which we found a few fragments—also knew and worked greenstone, though probably only as a very rare stone received through the indirect channels already suggested. It is, of course, very difficult to exclude every possibility of error, but we could neither see nor conceive any, though we carefully directed our attention to the subject at the time. The only source of error we could imagine was that it was possibly buried in a hole dug for the purpose; but its situation rendered this extremely improbable. Indeed, we found none of the indicia of secondary displacement of the heap there or in any part. The broken moa-bones were interlaced over the implement in the same way as elsewhere. It was several feet under the surface, and within a few inches of the sand-bed on which the mass of bones lay, and in the near neighbourhood we found many moa-skulls, attached to long strings of vertebræ, lying *in situ*.

In von Haast's case in the Christchurch Museum, devoted exclusively to Shag Point, among a collection of schist drills, implements of moa-bone, &c., are three very small polished greenstone chisels of *kawakawa* and a larger one of an inferior stone. There is no label to explain from what zone they were taken—and greenstone objects are often found on the surface there—and the ordinary presumption would be that he placed them in that case with objects which he



PIRORI OR MAORI DRILL.
after Shortland.

F.C. del.

formerly insisted were not relics of the Maoris, but of an older race of moa-hunters, as being of contemporaneous origin with those objects. However, for what it is worth, I should mention that von Haast has placed the chert knives on one side of this case, and has marked *them* from the moa-hunters' encampment.

MODES OF WORKING.

There can be no doubt that the highest expression of Maori art is a thing of the past. The highly-skilled woodcarvers who worked with tools of stone, or bone, or sea-shell are all gone, and have given place to rougher workmen who use steel tools: still, some of the work of the present day is beautifully done, and good workmen should be encouraged. Thomson, in "The Story of New Zealand," says few specimens of mechanical skill are furnished by the natives, the highest example being the fashioning of hard greenstone into *meres* and ornaments. This is done by friction with flint and wet sand. The greenstone-cutter of olden times has almost disappeared, though Captain Mair, a high authority, informed me a few years ago, contrary to the opinion I had expressed, and which had been published by Professor Fischer, that some few old men still worked *hei-tikis*. A better notion, however, of the modern method is, I think, to be derived from a retranslation of what I wrote to Professor Ulrich: "When the political prisoners were down here (at Dunedin) two years ago, I saw more than a hundred men cutting greenstone in a most systematic way. These people worked in companies. They had gridiron-like apparatus made of fencing-wire, having each ten or fewer bars. This apparatus was worked backwards and forwards with a sawing movement between two of them, while a third fed the machine with water and sand out of an old teapot or some similar vessel. In this way a slab was cut into eleven narrow strips, which were then rubbed down into ear-pendants on a flat stone, and afterwards drilled through at one end. When afterwards liberated the Maoris had thus accumulated a little capital in the shape of manufactured goods, the Government having supplied the raw material. They also made *meres*. I saw them making one in the gaol-yard on the grindstone. This occupation tends to keep them in bodily and mental health. One day I saw two of them cutting a piece of malachite in two. This they called 'Pounamu no Ingirani'—*i.e.*, 'Greenstone of England.'"

It is evident from an examination of numerous specimens in my collection that greenstone was cut by means of a very blunt instrument. I should say that a cutting-edge $\frac{1}{4}$in. wide was used for large pieces, while for cutting smaller pieces a narrower though still a very wide tool was used. I find in old

Maori camps numerous pieces of fine sandstone shaped so as to exhibit cutting-edges suitable, and probably used, for this purpose, though probably only in cutting the smaller objects. Dr. Shortland gives the word *mania* as representing thin laminæ of sandstone used for cutting the *pounamu*, and says the natives fasten them in frames after the manner of a stone-cutter's saw. These must have been something like that represented in Schliemann's "Ilios" (p. 583) as a flint saw. Much rarer are implements known to collectors as "hard cutters," made of trap or some similar rock. If these were used, as apparently they were, it must have been with sand and water.

I have been told, and can readily believe, that a great deal of cutting was done with wood and wetted sand, and Dr. Shortland in the documents set out later confirms this. The Rev. Richard Taylor, in "Te Ika a Maui," refers to the use of greenstone wherewith to cut greenstone: "He saws it by rubbing the edge of one slab on another, and for this purpose suspends a calabash of water with a small hole in the bottom over the stone he is working so that it drops continuously but slowly. He then takes some of the finest quartz-sand, which he continually adds to the groove he is making. Thus, by patience and perseverance he succeeds in sawing it up."

Brunner, who first explored the West Coast in 1846, makes frequent reference to a kind of micaceous slate used on that coast for cutting and polishing greenstone—probably the *kiri-paka* of Stack. He says it is found in the bed of one of the rivers of that coast, and in quality resembles a Newcastle stone, though somewhat closer in grain and texture, with a fine cutting quality. He carried two large pieces of greenstone and some polishing-stones with him on his return; and on an exploring journey lasting 560 days, during which he never heard English spoken, he found polishing greenstone a great amusement on wet days.

In cutting a slab in two the ancient workman lightened his labours by working his cuts from both sides, and, when they nearly met, knocking the piece off. The rough break is sometimes a third of an inch through, or even more; and to effect this considerable force, or a heavy blow, must have been necessary.

Major Heaphy, who was Brunner's companion on one of his expeditions, says, "In order to make a *mere*, a stone is sought of a flat, shingly shape, say, of the size, and roughly of the shape, of a large octavo book. Among the primitive rocks of the Middle Island stones are not wanting of sufficient hardness to cut even the *pounamu;* and the Arahura natives lay in a large stock of thin pieces of a sharp quartzose slate, with the edges of which, worked saw-fashion, and with plenty of water, they contrive to cut a furrow in the stone, first on one side, then on the other, until the piece may be broken at the thin place. The fragments that come off are again sawn by women and children into ear-pendants. With pretty constant work—that is, when not talking, eating, doing nothing, or sleeping—a man will get a slab into a rough triangular shape, and about 1½in. thick, in a month, and, with the aid of some blocks of sharp, sandy-gritted limestone, will work down the faces and edges of it into proper shape in six weeks more. The most difficult part of the work is to drill the hole for the thong in the handle. For this, pieces of sharp flint are obtained from the Pahutani cliff, forty miles to the north, and are set in the end of a split stick, being lashed in very neatly. The stick is about 15in. or 18in. long, and is to become the spindle of a large teetotum drill. For the circular plate of this instrument the hardened intervertebral cartilage of a whale is taken. A hole is made through, and the stick firmly and accurately fixed in it. Two strings are then attached to the upper end of the stick, and by pulling them a rapid rotatory motion is given to the drill. When an indentation is once made in the *pounamu* the work is easy. As each flint becomes blunted it is replaced by another in the stick, until the work is done. Two *meres* were in process of formation while we stayed at Taramakau, and one had just been finished. A native will get up at night to have a polish at a favourite *mere*, or take one down to the beach and work away by the surf. A piece of *pounamu* and some slate will be carried when travelling, and at every halt a rub will be taken at it. Poor fellows! They had no tobacco, and a grind at a piece of hard *inanga* seemed to be a stimulant."

The condition of many of the pieces separated as above described, by means of two cuts and a break, attests the fact that the workman often had a very indifferent eye, the two cuts not coming opposite each other. In a piece before me less than 1in. thick they are nearly ¼in. "out," giving a very awkward edge to rub down afterwards. I attribute this to the fact that, on the East Coast at least, the workers were generally very old men, past their fighting-days, whose eyes had become impaired with smoke and dirt, as they often are among these people.

What strikes me as very remarkable is the very poor pieces of stone on which a vast amount of labour is expended. It looks as if when a Maori workman could not get a good piece he cheerfully spent months, perhaps years, of labour on a bad, perhaps a very bad, piece. It was, perhaps, only at rare intervals that a tribal expedition returned from the remote West Coast with a new supply. A block which lies before me seems to have some very fine stone in it, with some very poor stone round the edges. The cut in it suggests the idea that the workman was proceeding to work the good centre to waste, and leave the rubbish to work up into implements, while the cut he is making longitudinally through the centre of the slab, cleaving it into two thin slabs, is not straight. However, he may have known his business better than I do. I have certainly seen instances where the best of the stone has been wasted in the cutting. In the magnificent collection in the possession of Mr. John White, of Anderson's Bay, Dunedin (not to be confused with the late Mr. John White, the author of the "Maori History"), there are twelve pieces showing cuts. The cuts are, as a rule, beautifully clean. Some of them meet perfectly true. In one instance the distance to which the cuts are "out" is so great that one has been turned in with a long slope to make them meet. In some cases apparently rather purposeless cuts are made; in one a very broad axe is cut longitudinally down the centre to make two chisels of ordinary proportions. His finest specimen is a boulder of *kawakawa*, or *auhunga*, $13\frac{3}{4}$lb. in weight, one-third of which is being taken off by a longitudinal cut. The proportions of the stone are 12in. by $5\frac{1}{2}$in. by 4in. The cut is 1ft. long, and is $\frac{15}{16}$in. to $1\frac{3}{16}$in. deep, and from $\frac{12}{16}$in. to $\frac{15}{16}$in. wide. On the other side of the block is the commencement of a cut which would meet the other neatly. In another case, working on a flat stone, the cuts have so nearly met that the stone was found parted, the two pieces lying together.

In doing the fine work of the *hei-tiki* and other objects, where something like true carving appears, I am told the shell of the common pipi, or cockle, so much used by the Maoris as a ready-made tool, was commonly employed.

I have no doubt that fine-sandstone cutters, which we find in numbers in old Maori camps, were used where procurable. I find the finest class of sandstone *in situ* at Shag Point, Taiaroa Head. Dr. Shortland says the Maoris obtained it from a place which I take to be the vicinity of the Pleasant River, where Mr. A. Hamilton has found traces of their quarrying operations. In my collection there are many neat little tools of this stone.

It is an obvious feature of Maori stone implements that they never reached the point exemplified, I think, only in Scandinavia, of having a regular hole for a handle. But occasionally Maori implements have a hole through which a string is put to carry it. I have one such of greenstone and one of a commoner stone. In general it is a rare feature. In Mr. J. White's splendid collection, embracing six hundred pieces, there are eighteen pendants, needles, and shawl-pins, and thirty-four other objects, consisting of chisels, fish-hook points, and large pendants so drilled. Some of these large pendants are mere lobes of highly-polished stone of special colour, one weighing as much as ½lb.

Nearly all these things, it will be observed, require a hole. The *mere* invariably had a hole, through which was passed the thong which held it tightly to the wrist in action. The hole is usually a wide-mouthed crater sunk in each side of the handle end until the two meet—often meeting rather badly. The work of drilling stone seems to have been most laborious. Smaller objects, such as greenstone needles, and pendants, and *hei-tikis*, are often drilled, but even then the hole is often unskilfully made, with a great crater mouth, again exhibiting the difficulty of the work. In some cases two or three attempts are made before success is reached. The explanation is to be found later in my note on the drill. In some *hei-tikis*, however, a piece of stone is left above the crown of the head, and through this a hole is neatly drilled.

WORKING-PLACES.

No doubt greenstone was worked in all Maori villages in this Island, but certain localities must have been special workshops. At a certain spot at Longbeach, in the Purakanui district, and at a similar spot at Warrington, I find innumerable minute fragments, as if some chipping process had been carried on there on a large scale; though my authorities assert that chipping did not form part of the process. Curiously enough, these fragments are often polished, as if finished implements had been chipped or shattered there; but the fragments are invariably very small.

In the vicinity of this spot at Warrington (the Maori name of which is Okahau) numerous unfinished objects intended to be of a superior type have been found. The late Captain Pitt, who lived there for years, had a number of these, and I have recently found a very fine one. Here, too, many fine finished implements have been found. Mr. Pratt, member of Parliament for the Southern Maori District, tells me that a small stream near here is called Hohopounamu, or "Rubbing the greenstone;" but the name appears to refer to the dripping of water in the process of rubbing.

By far the richest spot for finished and unfinished implements in this district is Murdering Beach, formerly called Wauakeake. Mr. and Mrs. Hunter, who owned the little farm there for many years, dug up immense numbers in making their garden, and since then numbers of objects have been found by others. In all, some six or eight *hei-tikis* have been obtained there.

Mr. John White tells me that of his collection, comprising six hundred objects of worked greenstone, about four hundred come from Murdering Beach or its immediate vicinity. Murdering Beach comprises, perhaps, twenty acres of ground within the limits of which objects are found. This beautiful spot was evidently thickly peopled, and must have been the aristocratic quarter of the district. Remains of burnt whares are found all over the flat ground. Warrington, too, was thickly populated; and it is not difficult even now to dig the remains of old whares out of the sand. The great variety of stone hammers, anvils, and cutting-tools found there shows that it was a regular manufacturing centre.

In Mr. John White's collection are two singularly beautiful spindle-shaped chisels, each 6in. long, and a small axe, all made out of a stone of rare colour. I have never seen stone at all like it. The colour is cream-colour, with patches, streaks, and spots of *inanga*-green sparsely dotted over it. These three pieces were found together, and it may be assumed with certainty that they were worked there from one block. In the same way there are in the same collection four *hei-tikis* of a very peculiar streaky asbestos-like stone, answering to that described in the latter part of Question 11. These three were found at Murdering Beach, which lies between the Otago Heads and Purakanui. The finding of these three, apparently made from one block of stone, seems to indicate that they were made there, though, as will be seen, the evidence of the Maori authorities consulted by my correspondents leans to the conclusion that they were never made on this Island, though not conclusive on the point.

One of the most remarkable objects in this collection is an unfinished *hei-tiki* found at Waikouaiti. All that remains to be done is to finish off the parts which have to be rounded—*e.g.*, nose, arms, legs, and abdomen. Its lowest edge is at present as sharp as the edge of a chisel. This has to be rounded off and notched so as to form that curious semilune which represents the lower part of the legs and the meeting toes in a well-ordered *hei-tiki*. There is also a very remarkable *hei-tiki* in the Christchurch Museum. It has evidently been a large one, the bowed legs of which have been broken off by accident. The artist has then set to work to change the design. He has commenced by obliterating the face by neatly grinding it flat.

No doubt greenstone is still worked in many places in the North Island. Mr. J. B. Reid, of Dunedin, tells me that when he visited Lake Waikaremoana some years ago he saw numerous Uriweras working it. They generally worked with a sandstone rubber on the side of a canoe, which had in the bottom a little water, used for wetting the stone.

A collector tells me that, obtaining large numbers of objects by digging in sandhills at Warrington, Purakanui, and other places, he finds most of them in the remains of old whares or dwellings. When he has cleared away the drifted sand he finds by the presence of hearth-stones that he has reached the floor. Below the level of this he may expect to find in one spot a small collection of treasure. It looks as if there were a receptacle under the sandy floor, which was probably covered by a flax mat. The site of this receptacle may sometimes be detected by a slight discoloration in the sand. In one he saw opened there were two beautifully-finished objects of greenstone and several odd pieces, also several pieces of *kokotai*, or hæmatite, with the mullers used for crushing it, and several sandstone rubbers. This represents the stock-in-trade and tools of a greenstone-cutter, and also the material and tools with which he made the red paint with which, mixed with shark's oil, he adorned his person. I have several of these mullers, still red with the adhering paint, dug out in this way, and I often find the pieces of soft red stone in the camps.

USES OF GREENSTONE.

As to the uses to which greenstone implements were put, there is evidence that they were used for all kinds of work excepting, perhaps, such rough work as cutting down trees and hoeing ground. I have an adze weighing 5lb., suitable for finishing the great slabs lashed on to the canoes to serve for top-sides. These adzes are called *kapu*. The word for an axe is *toki* or *toki uri*. Large adzes of greenstone are rare. Very long slender axes of the finest stone, formerly fitted with beautiful handles, are also rare. The commonest tools are chisels or small adzes, from 4in. to 8in. long and 2in. wide. These are called *panehe*. Small chisels 3in. long and 1in. wide are not uncommon. Some are as small as 1in. long and $\frac{1}{4}$in. wide. Mr. J. White has numerous very small chisels, while I have a few of these, and many exactly similar implements in other kinds of stone. His come from Murdering Beach; mine from Foveaux Strait, where greenstone is apparently rarer. The Rev. Mr. Stack tells me that when he came to New Zealand forty years ago greenstone implements were still sometimes used in carving wood. He has seen a long narrow *purupuru* or chisel so used in carving the woodwork of the canoe-head. Drills of greenstone are frequently found, and as they have to be of the hardest stone they are generally very beautiful objects. They are not infrequently broken, but I never find them bearing evidence of having been used to bore holes in stone. I think they must have been used generally for working wood and perhaps bone. The point of one kind of implement is often shaped exactly like that of a gouge. Though these are described as drills, they are probably gouges. Another small tool is like a narrow-pointed chisel. In two instances in Mr. White's collection small tools, apparently drills, present the exceptional feature of four facets meeting at a point, like some of the bits used by carpenters. We know from various sources that greenstone drills were used for drilling the holes by means of which the top-sides were lashed on to the great war-canoes.

Mr. White has some very special objects, such as a pendant, needle, or shawl-pin, as thin as a penholder and 7in. long; several fish-hook points, which of course would also serve for eardrops; and a peculiar chisel with a basin-like depression near the edge to accommodate the thumb and finger while the haft end rested on the palm of the hand. Shawl-pins, used for fixing the flax mat formerly the sole garment of the Maori, were more commonly made of bone, but there are several in local collections of this stone. A very curious object in Mr. White's collection is a small fish-shaped spinning-bait or minnow.

Cook, in his first voyage, gives an account of the tools used by the Maoris: "They have adzes, axes, and chisels, which serve them also as augers for the boring of holes. As they have no metal, their adzes and axes are made of a hard black stone, or of a green talc which is not only hard but tough, and their chisels of human bone or small fragments of jasper, which they chip off from a block in sharp angular pieces like gun-flints. Their axes they value above all that they possess, and never would part with one of them for anything that we could give. I once offered one of the best axes I had in the ship, besides a number of other things, for one of them, but the owner would not sell it; from which I conclude that good ones are scarce among them. Their small tools of jasper, which are used in finishing their nicest work, they use till they are blunt, and then, as they have no means of sharpening them, throw them away. We have given the people at Tologa a piece of glass, and in a short time they found means to drill a hole through it, in order to hang it round the neck as an ornament by a thread; and we imagine the tool must have been a piece of this jasper. How they bring their large tools first to an edge, and sharpen the weapon which they call *patoo-patoo*, we could not certainly learn, but probably it is by bruising the same substance to powder and with this grinding two pieces against each other." What he here refers to as jasper is most probably obsidian, or volcanic glass, which is plentiful in the North Island, and splinters of which, such as he describes, are found in Maori camps throughout New Zealand.

Polack speaks of the implements in similar terms; but they were out of date in his time—*i.e.*, in 1832. He says, "Much patience was required to put an edge on the *mere*, which was often managed by pounding the talc to powder, and briskly rubbing the surfaces together." I am not sure whether this is an original observation, as I often find Polack borrowing from Cook. Even in 1806 Savage observed the diminishing value of the greenstone implements in consequence of the introduction of iron.

There are some objects the use of which I have not been able to ascertain, but which may be learned from old Maoris in the North. Sir W. Buller informs me that, in making the deep cuts in carving large figures, the artists burnt out a cavity, and then chiselled out the charcoal. This would require small chisels. He also points to a number of smoothly-polished blocks of greenstone, generally 1in. or 2in. long by about the same breadth, and ½in. thick, in his collection and my own. These had long puzzled me. They are burnishers, used to rub down the surface of wood-carvings. I have similar objects of various shapes made of agate or chalcedony, which probably served similar purposes. Sound pieces of greenstone are used, and in Sir Walter Buller's collection they are of *tangiwai*, *pipiwarauroa*, and *kawakawa*. One of these has two scraping edges, and has evidently served a double purpose.

WEAPONS.

The stone axe, or hatchet, was a weapon of war, and no doubt axes of greenstone, as well as of other stone, were thus used. The *mere*, the most famous weapon of the Maoris, which in ancient times was generally of white whalebone, was in later times—that is, in the last few centuries—often made of greenstone. There are also many in collections made of black trap and similar hard rocks. A greenstone *mere* is an object of great value. It is usually about 13in. to 15in. long, sometimes longer, and is to be found figured in many books—for instance, Sir John Lubbock's "Prehistoric Times;" while Hochstetter figures the famous *mere* of Te Heuheu, shown to him by the chief's successor, cut out of the most beautiful transparent nephrite, an heirloom of his illustrious ancestors, which he kept as a sacred relic. It was taken from a hostile chief in bloody combat, and had five times been buried with its owner's ancestors. A notch on one side denoted the last fatal blow struck at a hard skull. The *mere* was not used like an axe, for a downward hacking stroke: if used thus and parried it might be broken, and thus the labour of years lost. It had a hole through the handle, through which was a strong thong of dogskin, made into a running noose through which the thumb would slip readily. It was carried thrust into the belt. The first contact of the fighting forces was with the *hani*, or *taiaha*, a sort of staff, used, however, ordinarily as a walking-stick. This was not pointed, but was used for striking as a quarterstaff. As the fighting got closer these had to be laid aside, and the *mere* was then taken from the belt and fastened to the right hand. The thumb was thrust through the loop of the thong, and then one turn made round the hand. To have thrust the hand through would have exposed the warrior to the risk of being dragged into danger by any one who could successfully grasp the blade of the weapon—a risk never run. The left hand now grasped the hair of the enemy, the fingers being twined among the long locks. This probably describes a moment when the enemy had already been reduced to inactivity by many blows, or had been thrown down. Then the blow was struck, rather as a stab, if possible, at the side of the head, where the bones are weakest, and it was thus driven into the brain. Whare-kino, a West Coast chief, had a spear run through his arm by Tuhuru, and, being violently pushed, fell upon his face. Before he could rise Tuhuru caught him by the hair, and was just about to smash his head with his *mere-pounamu* when he recognised him as his own cousin, and spared him.

Dr. Shortland describes the *mere-pounamu* to which in the South Island he finds the name *rakau-pounamu* given. This word means timber, or perhaps club, and may be derived from the use of a wooden club in olden times. There is a highly-ornamented wooden *mere*, sometimes shaped like an ordinary *mere*, sometimes like a bill-hook. Tasman, describing in 1642 the attack upon his boat, says that the natives were armed with short thick clubs like clumsy *parangs*. He does not say of what they appeared to be made, but had they been either of white whalebone or of greenstone he would probably have noticed it.

Famous Implements, etc.

It would be impossible in a paper like this to refer even briefly to any considerable number of the famous historical implements and ornaments of New Zealand. A few only can be mentioned. English lawyers are familiar with the case of Pusey *versus* Pusey, in White and Tudor's Leading Cases, decided in 1684, which shows that before the days of title-deeds a material object might be the outward symbol of a title to land, and that in this one case the tenure still exists. There the horn is equivalent to a title-deed, and on it is the inscription in what looks like comparatively modern, or fourteenth-century, English,—

> Kyng Knowd geve Wyllyam Pewse
> This horne to hold by thy lond.

Such cases are not unknown in New Zealand. The title-deed of the famous Heretaunga Block, now worth three-quarters of a million, was a small pendant now worn by a gentleman on his watch-chain. In finally ceding land to the Queen upon a sale by the native owners a *mere* has often been handed over as symbolical of title. It is, of course, handed to the white man who settles the bargain. I am not aware of cases where it has got any further towards the Queen, nor does the colony possess any treasure-house for keeping such objects.

The famous heathen chief Te Heuheu, on the night of the 7th May, 1846, was overwhelmed, with all his people save one man, by a landslip burying the village Te Rapa. It is said that the great warrior was last seen praying to or threatening his *atua*. His *mere* was the most famous in New Zealand, and is mentioned in the lament written by his brother and successor,—

> Sleep on, O chief, in that dark, damp abode,
> And hold within thy grasp that weapon rare,
> Bequeathed to thee by thy renowned ancestor
> Ngahue when he left the world.

I think there must be some confusion in this, as it was the famous eardrop called Kaukaumatua which Tama-te-kapua was said to have brought from Hawaiki, and which had been made from Ngahue's stone, which had come down to his descendant Te Heuheu. This eardrop is often mentioned in Maori history. It was the subject of a fight between two sons of Tama-te-kapua, who was supposed to have brought it from Hawaiki, and was buried by one of them but recovered by his nephew. Some years before Te Heuheu's death it was appealed to in a dispute as to the ownership of Flat Island, in the Bay of Plenty, claimed by his relations. It was agreed that those who could prove relationship to its possessor could establish the best title to lands first occupied by their common ancestor Tama-te-kapua. In later times a hundred men were successfully employed in digging out the famous *mere*, which is still held by the tribe. The bones of its mighty owner were carried high up the mountain Ruapehu, and there left on a ledge of rock; from which cause that mountain remains sacred to this day.

When Sir Donald McLean in 1856 brought to a close the protracted and complicated negotiations by which the Government finally acquired from hostile and conflicting claimants the northern end of the South Island, he had his greatest difficulty with the district about Tory Channel and Queen Charlotte Sound, as from its past associations the natives attached great importance to it as the scene of many hard-fought battles, and of final conquest. When signing the treaty of cession, Ropoama te One, after alluding to these wars in an emphatic harangue, struck into the ground at the feet of the Commissioner a greenstone axe, saying in their usual style of metaphor, "Now that we have for ever launched this land into the sea, we hereby make over to you as lasting evidence of its surrender this adze named Pai-whenua, which we have always highly prized from having re-gained it in battle after it was used by our enemies to kill two of our most celebrated chiefs, Te Pehi and Pokaitara. Money vanishes and disappears; but this greenstone will endure as durable a witness of our act as the land itself which we have now under the shining sun of this day transferred to you for ever."

Mr. Travers mentions several celebrated *meres*—viz.: One with which Te Wherowhero, the father of the chief who afterwards became the Maori King, and is still so called, killed two hundred and fifty prisoners of war at a sitting, smashing the head of each with a single blow. His son still has the *mere*. Another, called Kai-kanohi, now in the posses-sion of the descendants of Matenga te Aupori, with which, as has already been mentioned, Ngaitahu once ransomed Tuhuru, who had been taken prisoner by Rauparaha's branch expedition. I have elsewhere referred to the two beautiful weapons which Te Pehi has left to his descendants. Others are connected with the history of the North Island tribes.

In the early part of this century a splendid *mere* was buried secretly in a swamp in Southland to settle a dispute as to who was to inherit it. Not long since a half-caste, in dig-ging a post-hole for a fence, accidentally dug it up, and re-stored it to the heir, death having settled the dispute. Similarly one now lies hidden in a swamp beyond Riverton. It is well known that in the North Island many have been hidden, and in many instances mortality in the tribe has obliterated all knowledge of the hiding-place. Occasionally lost *meres* are found and recognised, to the great joy of the tribe. On other occasions Europeans have found them buried in the ground or hidden in old hollow trees. Indeed, Polack's prediction, made fifty years ago, has been fully realised—namely, that in future many aboriginal curiosities would be discovered by European colonists, as the New-Zealanders have been in the habit from time immemorial of burying with their dead the favourite axes and implements of stone that were highly prized by the chiefs whilst in existence.

Other Ornaments and Objects.

The *mako*, the beautiful tooth of the tiger-shark, is much prized as a keepsake, and is handed down from generation to generation; but its inferiority to a jewel of *kahurangi* or *pounamu* of the first water is recognised in the ode,—

That is worthless—
That is the bone of a fish ;
But were it the little *pounamu*,
That ancient source of evil
The fame of which reaches
Beyond the limits of the sky—eh !

In the list of ornaments given by White the word "*mako*" occurs, referring evidently to a greenstone imitation of the shark's tooth. Rings are mentioned by some writers. The Maoris keep tame parrots with rings round their feet. In the Christchurch Museum is a prettily-carved parrot-ring of greenstone.

In addition to the *hei-tiki*, fuller reference to which is made hereafter, and those above mentioned, the Maoris had a great variety of greenstone ornaments. Of these, only a few can be described here, thus: (1.) Lobe-shaped ornaments, suspended from the neck when very large, and from the ear when smaller. Some of these are referred to in the description of colours. (2.) Small objects with a slight resemblance to the human form, slighter, and flatter, and more formal in shape than the *hei-tiki*, though perhaps also so called ; others without resemblance to human shape. There is a peculiar fish-shaped *hei-tiki* in the Christchurch Museum. (3.) Ear-pendant, called *kapeu* or *kapehu*, curved at the lower end ; and numerous other forms of ear-pendant. Fish-hook points, also used as pendants. *Kapeu whakapapa* was a genealogical staff with the generations notched upon it. They are more commonly made of wood. (4.) Mat-pins of various sizes and shapes.

TIKIRAU.

Sir W. Buller supplies me with the following :—

"Tikirau, the ancient name of a *kapehu* or *tara* (long pendant with curved extremity), presented by Heni te Rei, daughter of the late chief Matene te Whiwhi, to the Hon. Huia Onslow (the infant son of the Earl of Onslow, Governor of New Zealand), on the occasion of his presentation to the Ngatihuia Tribe, at Otaki, on the 12th September, 1891.

"This *kapehu* is of pale *kawakawa*, and is not of the very best quality ; but the relic is valuable because it was an heirloom in the family of Te Rangihaeata, the fighting chief of the Ngatitoa. The Maoris associate it with the following *karakia* (or incantation) :—

"Ka haere hine, ka haere hine,
Te ara nui no *Tikirau*,
Hoki atu, hoki mai
Ka rarapa ki te rangi,
He uira."

Authorities.

At the risk, perhaps, of becoming tedious, and of being accused of repeating matter, I now give the original answers of my correspondents to the questions which I drew up for Professor Fischer; and I take this opportunity of thanking them for the trouble they have taken. I set out the questions in full, in order that the answers may be fully appreciated, and in the hope that their publication may induce other Maori scholars to send me further information.

Questions asked by Mr. F. R. Chapman, of Dunedin, for Professor Fischer, of Freiburg.

You are requested to return this paper with answers to these questions, giving all possible details, and stating any facts within your knowledge besides those touched upon in these questions.

1. How did the natives make the figures known as *hei-tiki*, and what was their method of working greenstone?

2. In the process did they use chipping-instruments, or was anything done by grinding?

3. Are these objects idols or gods, or the portraits of ancestors, or what do they represent?

4. Are the existing *hei-tiki* the result of the patient labour of modern or comparatively modern people, or are they objects remaining in the hands of the Maoris from a former age, the relics of an earlier vanished culture?

5. Is such a vanished culture to be inferred as well from these highly-worked objects as from the fine wood-carvings of this race? Is it supposed that they came to New Zealand with a knowledge of these advanced arts, or that they have so advanced themselves here?

6. Do the natives continue to make these objects? Do they make them in their ancient fashion or by means of modern appliances?

7. Have the Maoris any traditions or superstitions on the subject of or with reference to these objects? Are individual *hei-tiki* treated with reverence? Are they highly prized by Maoris beyond their money value?

8. Do the Maoris make other objects in greenstone than *hei-tiki*, and articles of actual use, such as axes, chisels, &c.?

9. How many varieties of greenstone do the Maoris recognise? What are their names and description, and what peculiar use or value has each?

10. Where is greenstone found *in sitû* in a virgin state? Whether in more than one place?

11. Is a rusty yellow-coloured nephrite known in New Zealand? Is a peculiar nephrite with thread-like streaks, having a beautiful silky lustre like asbestos, common in New Zealand?

12. Is the true name of the South Island "Te Wai Pounamu," The Water of Greenstone, or "Te Wahi Pounamu," The Place of Greenstone?

13. Have the Maoris any traditions as to when they first found and began to work it?

14. Have the greenstone objects occasionally seen in other oceanic islands been carried from New Zealand, or is the stone native elsewhere?

15. Are the greenstone and other hard-stone axes first chipped to shape and then polished, or are they all ground to shape from water-worn stones?

16. Can you state any special native customs, superstitions, traditions, or other lore relating to greenstone, or objects of greenstone?

17. Was greenstone really the object of Rauparaha's invasion of this Island?

18. Are there any other traditions of wars on this account?

ANSWERS OF JOHN WHITE, AUTHOR OF THE "ANCIENT HISTORY OF THE MAORI."

10. The *pounamu* was found in blocks in the rivers and creeks at the south end of the South Island. Some was also found in the creeks which run into the lakes of that part of New Zealand. Some was also found in the creeks and sounds in that part of the South Island.

13. Tradition says that a chief called Nga-hue was driven out of Hawaiki by Hine-tu-o-hoanga; that Nga-hue, after landing on various islands, at last arrived in New Zealand, and, having found the *pounamu* on the South Island of New Zealand, on his return to Hawaiki he took some *pounamu* with him, and with axes made from that greenstone some of the canoes were made which came over to these Islands with Kupe, Turi, Hotu-roa, Nga-toro-i-rangi, and others.

14. All that can be said on the question is answered in No. 13.

1, 2, and 15. The *pounamu* was broken as best they could break it into pieces when in boulders or large blocks, but it was not chipped—it was bruised to take any angle or point off. It was then rubbed into shape with a stone called *mataihona*, *takiritane*, *hoanga*, *onetai*, *patutane*, and *ureonetea*, with chips of *kiripaka* as a drill. These stones were called by different names in the localities (by the natives of the districts) in which they were obtained. In some instances a piece of *pounamu* would be found of a flat or slab shape. The *mataihona* was then used to cut a line on each side of the slab, and when the cut was sufficiently deep the slab was broken into pieces, thus cut into a rough form of a *mere*. The *ureonetea*, *takiritane*, *patutane*, and *kiripaka* were used as drills to cut holes in the *pounamu* to form a *hei-tiki*, and when the holes were made to form the arms and legs of the Tiki then the *mataihona* was used to form the Tiki. The drill used to make the hole in the *mere* was made with *kiripaka* and *ureonetea*. These were broken into spike-like shapes, and placed in the end of split wood [drill-spindle], and tied tightly, the upper end of this wood being placed in a block of timber placed in position to receive it [mouthpiece, or drill-cap]. Two stones [weights] were tied to the upper end of the drill [to steady it], the *kiripaka* or *ureonetea* being placed on the *mere* where the hole was to be made, and a string was wrapped round the drill above the stones [weights], and next to the block of wood [mouthpiece, or drill-cap]. These strings were pulled first one and then the other [the unwinding of one causing the other to wind round the spindle], thus giving a rotatory motion to the drill. A little of the pounded dust of the *mataikina* and water were put to the point of the drill at various times of the work. [Observe that Mr. White describes a piece of wood by way of a mouthpiece or drill-cap. He does not say whether it was held in the mouth or pressed down with the flat of the chin or the breast of the workman. Compare Mr. Wohlers's interesting description, and Note 3, *post.*]

3 and 7. These objects were not idols or gods, nor were they the portraits of ancestors, but, as the name implies, *hei* (for) -Tiki, or, for, or to be used as, Tiki, or to be like Tiki. The value or sacredness of these was derived from the fact of their having been worn or handled by the dead of past ages.

4 and 6. Some of the *hei-tiki* now seen are many hundred years old, others are of more modern date. The mode of making the *hei-tiki* in ancient times is that now practised.

5. They brought the knowledge with them.

8. Yes; *toki* (axes) and eardrops, as *kurukuru kapeu*, *mako* (of greenstone), *kani* (ring), *porotiti*, and many others.

9. Many sorts of greenstone—namely, *kahurangi*, *inanga*, *tangiwai*,

totoweka, and fourteen others, all of which are grades less in value than the *kahurangi*. [I have never seen a list containing eighteen names, but I have seen some with some of the names I have collected repeated with qualifying adjectives to describe minor variations. There is one word here, *totoweka*, which would mean weka's blood, which does not occur in my other lists. It must be the variety with red streaks or spots.]

11. This is called *totoweka* [weka = the bird *Ocydromus*]. This, or something like it, is called *inangatangiwai*. [The rusty yellow-coloured nephrite for which Herr Fischer inquires is extremely rare. I have seen one piece that would answer this description. The expression *inangatangiwai* evidently indicates one of the numerous grades described in Answer 9, the names of two kinds being combined to describe it.]

12. "Te Wai Pounamu" is the correct name.

16. Yes, but it would fill a book of moderate size to give it. As I am bound to time in writing the Maori History I am compelled to give these answers in this very short way; but all these questions will be fully answered in the history now being compiled. [Mr. White's history had reached the completion of vol. v. when he died, and one volume has appeared since. A mass of MSS. was left, and it is to be hoped that this will some day see light. The published portion does not treat of greenstone save in the chapters incorporated from the Rev. Mr. Stack's writings, the substance of which I have incorporated in this paper.]

17. No; not in the first instance. His invasion was to obtain a home for himself and tribe, as he was being pressed by his enemies the Kahungunu, and being urged on also by his revenge for his relation Pehi.

18. Yes; but in the first instance all the wars undertaken by the natives of the North Island were for conquest of country, and consequent on their being driven out of their homes by fear of stronger enemies; but eventually it became a great point to obtain possession of a land in which the greenstone might be obtained.

Answers of the Rev. J. W. Stack, Missionary to the South Island Maoris.

[Note.—I have thought it best to leave in the signs of quantity placed by Mr. Stack over the vowels to aid pronunciation.]

1 and 2. The tools used in the manufacture of greenstone were—

(a) *Kŭrŭ Pōhătŭ*.—A stone hammer. Nothing more than a conveniently-shaped boulder of greenstone about the size of a human skull. If the piece to be broken off was for a *mere* it was necessary to insure against any cracks. This was done by cutting a deep groove before striking the piece off. [I have made a large and interesting collection of stone hammers, some of which must have had wooden handles, while others were used in the hand. They are of trap, quartz, and various other stones. I have never seen one of greenstone. I have a great many hammers of very small size, evidently for very fine work. Bruising is mentioned by White and others as a mode of reducing angles and points. Two unfinished axes in the Colonial Museum, at Wellington, show admirably that bruising was used to reduce the size of the handle part.—F. R. C.]

(b) *Pārihi pōhătŭ*.—A sharp-edged chip of trap or any other hard stone for cutting grooves. [Called a hard cutter in the text.]

(c) *Hōăngă*.—Sandstone or other gritty kind of stone for rubbing down the rough surface and polishing. [For this I have adopted the word "rubber," as the words "grindstone" and "whetstone" are inapplicable. They are coarse or fine according to the work to be done.—F. R. C.]

(d) *Kŭrŭpăkă*.—A micaceous stone, plentiful on the West Coast, used for rubbing down and polishing. [See references to Brunner and Heaphy's Journal.]

(e) *Mătā.*—Obsidian for pointing the drill, or *pirori.* [I have many of these in flint and quartzite, commonly but erroneously called chert: they are in every stage of wear.—F. R. C.]

Having procured a suitable-sized piece of stone for the article to be made, the workman placed it either on the ground or on a slab of wood cut to fit it. The surface was then rubbed down with a hōăngă, the greenstone being kept constantly moistened with water. The only tools employed in forming the *hei-tiki* were those above mentioned.

3. They are portraits of ancestors, and were highly valued. ["Mementoes of ancestors," used later by Mr. Stack, is a better term.—F. R. C.] It was the custom to bury them with the wearer after death, and then to remove them when the bones were taken up for final sepulture. The nearest of kin employed in the rites connected with the removal of the bones to their final resting-place became the possessor.

4 and 5. The custom of wearing the *hei-tiki* was probably imported from Hawaiki. During a visit to the Thames about twelve years ago, Paraone, a chief residing in Grahamstown, showed me a small ill-formed *hei-tiki* which, he said, had once belonged to Marutuahu, son of Hotunui (*vide* "Polynesian Mythology," by Sir G. Grey, p. 246), one of the original immigrants from Hawaiki. One branch of the family resided near Taranaki; one at the Thames. This *hei-tiki* had passed backwards and forwards from one branch to the other during successive generations, the relatives who performed the ceremony of *hăhŭngă* taking possession of it each time. If this particular *hei-tiki* was a fair specimen of the workmanship of the original settlers, the Maoris in later years had improved in the art of making them. Both the knowledge of carving wood and working in stone must have been imported by the original immigrants from Hawaiki. Most of the *hei-tiki* in existence were made before the beginning of this century, and are of comparatively modern workmanship. As far as I can recollect, the best specimens I have seen were those said to be about a hundred or a hundred and fifty years old.

6. No. Since intercourse with Europeans became constant (say, 1820), the Maoris have ceased to make *hei-tiki.* They were difficult to make, only the most skilful *tohungas*, such as could carve and tattoo, undertaking the manufacture. *Meres*, axes, pendants, &c., required little skill, and their manufacture was the favourite occupation of elderly gentlemen.

7. They are very highly prized as heirlooms for having been actually in contact with the sacred bodies of their revered and noted ancestors.

8. Axes, chisels, adzes, *meres*, ear-pendants, as well as *hei-tiki.*

9. Seven different varieties :—

(a) *Inanga.*—A whitish stone, not much prized, rather opaque. [I cannot quite assent to the expression "not much prized," as I have been informed by many good authorities that it comes next to *kahurangi*, which is the rarest stone.—F. R. C.]

(b) *Kăhōtĕa.*—A dark-green with spots of black through it, rather more opaque than the other varieties. [I presume the expression "spots of black" would include patches and streaks. A large number of chisels, &c., of this description have been found at Murdering Beach. *Vide post*, Dr. Shortland's answers, *tuapaka.*—F. R. C.]

(c) *Kăwăkăwă.*—A very bright green; semi-transparent. [This is the beautiful greenstone of commerce, much used by lapidaries.—F. R. C.]

(d) *Aŭhŭngă.*—Pale-green, between *inanga* and *kawakawa.* Not so transparent as the latter.

(e) *Kăhŭrăngi.*—A darker green, without flaws or spots; semi-transparent.

(f) *Kahurangi.*—Like the former, but with pale streaks of *inanga* through it.

[As *kahurangi* is repeated, I presume that the former is a hard clear stone, and the latter similar but with beautiful fleecy clouds in it of the whitish tint of *inanga*. The most beautiful piece I ever saw is in the possession of Wi Parata, of Waikanae, the grandson of the great Te Pehi.—F. R. C.]

(g) *Kōkōtăngĭwăi.*—A soft and brittle variety found at Piopiotahi or Milford Sound, and in small pieces along the beaches to the northward of that place. Beautifully clear and transparent, with the appearance of water-drops in the texture of the stone. Hardens on exposure to the air. When first taken from the block can be worked with an ordinary knife and file.

All the other varieties of greenstone are extremely hard. When found in the river-beds the surface of the stone resembles that of the surrounding boulders, and only the trained eye can detect its presence among them.

[When free from cracks, flaws, or joints, all the kinds of greenstone save *kokotangiwai* or *tangiwai* (tear-water) are so hard that the steel point of a penknife will not scratch the stone, but will leave a metal trace.—F. R. C.]

10. Up the Arahura River and other streams between Hokitika and Greymouth, and at Milford Sound. As far as I have been able to ascertain, greenstone has only been found in detached blocks, varying in size from pebbles to rocks 20ft. square.

11. I do not know.

12. Wai Pounamu. All greenstone, till the occupation of the country by Europeans, and the consequent clearing of the forests on the West Coast, was found either in river-beds or along the beaches.

13. Vide "Polynesian Mythology," by Sir G. Grey, K.C.B., page 132. [Already narrated.]

14. I heard from the late Tamihana te Rauparaha that when the Rev. Riwai te Ahu returned from a cruise in the Melanesia Mission vessel he brought back from some island a piece of greenstone.

15. The boulders were broken up with hammers into convenient-sized pieces, and then ground down with *hōăngă*.

16. I can recall nothing at present.

17. I have always been told that Rauparaha came for greenstone, Rerewaka's curse giving him a good reason to put forward for his invasion. Rerewaka was a Kaikoura chief, and after his destruction and that of his people there was no reason for Rauparaha going a hundred miles further south, unless he went, as alleged, for greenstone. Just before the European occupation of the country greenstone was fast being recognised as the medium of exchange, and the Maoris, since they became familiar with our money, have often spoken of greenstone as the Maori's money in time past. Rauparaha was shrewd enough to see the advantage of possessing an unlimited supply of the existing medium of exchange.

18. I do not know of any in particular, but I do know that in times past wars occurred from one tribe, or a section of a tribe, desiring to get possession of articles of value as ancestral relics, which were wrongly retained by others. Most of the greenstone worked up in the South Island was carried across the Southern Alps on men's backs in a rough state. The labour of procuring the stone was very great. The tracks across the mountains were most dangerous, and some one skilled in prayers and charms always attended the party of carriers, who led the

way, uttering petitions for safety whenever the party reached any particular difficulty. On reaching the coast the *tohunga* performed certain religious rites, and retired to rest alone, and in his dreams a spirit would come and indicate the spot where a stone would be found. On waking, he would summon his companions, and, spreading themselves along the river-bed, they would proceed up stream till they reached the spot indicated in the vision, when the stone was sure to be found, and received the name of the spirit who revealed its position. This method of discovery is still adopted; and I have a piece of greenstone in my possession that is known by my name, the finder, an old chief at Arahura, having found it in a place indicated to him by my spirit during the visions of the night.

SUPPLEMENTAL ANSWERS BY THE REV. J. W. STACK.

DEAR SIR,— Duvauchelle's Bay, 31st July, 1881.

I have just received from an old Maori chief, Hakopa te Ata o Tu, at Kaiapoi, the following replies to a translation of the questions forwarded to me by Dr. von Haast. I attach great value to them, as the writer is a very intelligent man, who occupied a leading position in the Maori community here at the time of Rauparaha's invasion.

JAMES W. STACK.

1. I never saw the process of making *hei-tiki* being carried on here (South Island) when I was a child. [Hakopa is at least eighty-three years old.—J. W. S.] *Hei-tiki* were all made in the North Island.

2. Obsidian and chips of hard stone, but no chisels, were used in making *hei-tiki*. Very hard stone, obsidian, and a grindstone were the tools used in shaping greenstone.

3. People never prayed to *hei-tiki*. They were mementoes of deceased ancestors, to remind their posterity.

9. (*a*) *Hauhunga* [*hauhunga* = frost, cool.—F. R. C.]; (*b*) *kawakawa*; (*c*) *inanga*; (*d*) *kahurangi*; (*e*) *tangiwai*; (*f*) *matakirikiri*—greenstone pebbles; (*g*) *aotea*—a counterfeit greenstone, opaque; often mistaken when in the river-beds by the unskilful.

10. Arahura, Waininihi, Hohonu (Taramakau), Piopiotahi, were the streams in which greenstone was formerly found.

14. When I see you I will tell you of the discovery of greenstone [Already related above.]

15. Some greenstone could not be broken by any other stone but greenstone.

ANSWERS OF DR. SHORTLAND, FORMERLY NATIVE SECRETARY.

1. The method of working is described in Shortland's "Southern Districts of New Zealand" (London, Longmans, 1851). Holes are drilled by a drill of native invention, the grinding apparatus being a sharp-pointed stick of soft wood, sand (fine, and of a biting quality). The *patu*, axe, implements, &c., were rubbed into form on slabs of sandstone. The supply of water for such operations dripped through a small orifice in some vessel conveniently placed. The *hei-tiki* was similarly fashioned by rubbing with a pointed stick, sand, and water. [The above work by my correspondent, Edward Shortland, M.A. Cantab. (a physician, who was formerly Native Secretary, and is the author of several works on New Zealand), is an admirable account of the state of the Maoris in the South Island in 1842–43, before there was a single inhabitant where the cities of Dunedin and Christchurch now stand. Visiting Waikouaiti, Dr. Shortland says, "Here I saw for the first time on a large scale the native method of grinding *pounamu*, or greenstone, from the rough block into the desired shape. The house belonging to the chief Koroko was like a stonecutter's shop. He and another old man were

constantly to be seen there seated by a large slab of sandstone, on which they by turns rubbed backwards and forwards a misshapen block of *pounamu*, while it was kept moist by water which dropped on it from a wooden vessel. While one rubbed the other smoked. They made, however, so little progress on it during my stay that it seemed probable that it would be left for some one of the next generation to finish the work. It is not, therefore, to be wondered that what has cost so much labour should be regarded as the greatest treasure of the country." Elsewhere he says, "When procured it is fashioned and polished by rubbing it on flat blocks of sandstone. This is a work of so much labour that to finish such a weapon as that of Te Heuheu often requires two generations." Mr. John Richard Jones, who as a boy knew Dr. Shortland at Waikouaiti, tells me that he never saw the Maoris working greenstone or making stone implements, but saw them using stone implements of black trap in building canoes.]

2. No chipping instruments were used—simply sandstone, fine sand, and water, and a stick for drilling or groove-work. Stones were reduced in size by rubbing them with laminæ of sandstone used like a saw. I have specimens of incomplete work done in this way: one where it was intended to make a pair of axes, the faces of two axes being partially complete, and the stone to be divided in twain about one-third completed.

3. They are merely grotesque representations of the human form. The name is derived from *hei*, which seems to mean a necklace, and Tiki, the progenitor of the human race, the Epimetheus of the Greeks. Any image of a man is known as Tiki. Their value greatly depends on their antiquity. It is the practice to bury such and other valued articles with the dead. After a time they are removed, and then are specially valued. I remember a chief excusing himself from giving me an eardrop because it was a *pirau-tupapaku—i.e.*, a thing with a dead taint.

4. The art is of ancient times, and endured till recently.

5. The wood-carving skill was in full force when the colony was formed. They came to New Zealand with the art, and practised it continually here.

6. Our grindstone has been used for making *patus*, and a cross-cut saw and sand and water for sawing blocks into slabs, after the manner of stone-cutters.

7. A celebrated eardrop (Kaukaumatea) is reported to have been brought from Hawaiki by Tama te Kapua, a chief of the Arawa Tribe, and was in the possession of the chief Te Heuheu, with whom I have conversed, but was buried with him and others in a landslip at Taupo, and has never since been recovered.

8. This is answered in No. 2.

9. I have recorded six varieties,—

(a) *Kahurangi.*—Bright green, translucent, the most prized; used for eardrops and other valued objects.

(b) *Pipiwahairoa* [*Pipiwararauroa:* Buller].—White and green. So named from a bird resembling it in plumage [the shining cuckoo—*Chrysococcyx lucidus*].

(c) *Inanga.*—Whitish.

(d) *Kawakawa.*—Bay-green. From resemblance to leaves of a shrub of same name [*Piper excelsum*].

(e) *Kawakawa tangiwai.*—Resembles the colour of greenish glass. [This name is probably a mistake for *kokotangiwai.*—F. R. C.]

(f) *Tuapaka.*—Inferior stone; green and black intermixed. [A large number of pieces in Mr. White's collection correspond to this. It seems to have been used up for chisels and small tools. See Mr. Stack's answers—*kahotea.*—F. R. C.]

10. In the South Island, on the west coast, in several mountain-streams. [Dr. Shortland, in his "Southern Districts of New Zealand," says, "Specimens of stone are found in detached blocks or pebbles. . . The places most renowned near which it is sought are Arahura and Ohonu [Taramakau], on the north-west coast; Wakatipu, a lake in the interior, one of the sources of the River Matau (the modern Clutha, or Molyneux); and Piopiotahi, a torrent on the south-west coast." No white man had then seen Lake Wakatipu. The errors in this statement are elsewhere explained.—F. R. C.]

11. A dirty-yellow colour I have seen, but understood that it resulted from the action of fire. The sort with a silky lustre like asbestos is found on the west coast of the South Island. It is said to be found on the beach after heavy gales—possibly derived from some reef seaward.

12. I do not think the name Wai Pounamu was applied to the whole Island. [See on this subject a reference to Dr. Shortland's memorandum elsewhere.—F. R. C.]

13. *Vide* Sir George Grey's "Mythology and Traditions." [Referred to fully *ante*.—F. R. C.]

14. *Vide idem.*

15. Made by rubbing on sandstone or otherwise, as described above.

16. *Vide* Sir George Grey's "Mythology and Traditions."

17. *Vide* Shortland's "Traditions and Superstitions of New-Zealanders," p. 253, ed. 2; the account of the wars being translated from a narrative by his son. The cause was a curse by Rerewaka, a chief of Kaikoura (called the Looker-on Mountains by Captain Cook), as stated to me by his son. The following-up of the war to Kaiapoi was caused by a chief or relative of Rauparaha named Te Pehi going into a large *pa* there in a peaceable manner with the object of obtaining a *patu-pounamu* as a present. He and his party were murdered. This led to the continuation of the war, and a great distrust of all natives as far as Taumutu.

OTHER AUTHORITIES.

Major Heaphy, already quoted, gave, in 1862, a brief description of the qualities of greenstone:—

Of *pounamu* there are the following kinds, namely:—

1. *The Inanga.*—This is the most valued by the Maoris. It is rather opaque in appearance, and is traversed with creamy-coloured veins. The best *meres* are usually made of this stone.

2. *The Kauairangi* [*Kahurangi*].—This is of bright-green colour, with darker shades or mottled, and is the most translucent. It is a brittle material and not easily worked. Ear-pendants are frequently made of it.

3. *The Kawakawa.*—This is of a dark olive-green, and has rather a dull and opaque appearance. *Hei-tiki* and ear-pendants are composed of it.

4. *Makatangiwai* [= *Kokotangiwai*].—This is the least esteemed by the Maoris, but by far the most beautiful of all. It is a clear pale-green, and is very translucent. The natives will drill a hole through a pebble of it and hang it to a child's ear, but do not care to fashion it into any shape. It is the only kind of *pounamu* that would be esteemed for the purposes of ornament by Europeans.

[NOTE.—*Kawakawa* is now largely used for jewellery in the colony.]

Other Varieties.

I have collected from various sources other words describing varieties and subvarieties, or perhaps local words.

1. *Raukaraka.*—A term much used about Cook Strait to describe the olive-coloured streaked variety of *kawakawa.* [*Rau*=leaf; *karaka*= *Corynocarpus lævigata.*]

2. *Kuru-tongarewa* [*Kuru* = an ear-ornament; *tongarewa* = a precious jewel].—It is sometimes, apparently, connected with greenstone thus :—

3. *Kawakawa-tongarewa.*

4. *Kuru-pounamu.*

5. *Tutaekoka* (a stain in greenstone explained in a story already narrated).—I am unable to obtain a satisfactory meaning for *koka.* Mr. Tregear suggests *koko* [= the bird *tui* = *Prosthemadera*], which seems probable.

6. *Kawakawa-aumoana.*—*Kawa* = the plant *Piper excelsum* ; *moana* = the ocean ; *au* = cloud or fog. Perhaps the whole suggests sea-foam.

7. *Kawakawa-rewa.*—*Rewa*=to melt. Explained to me by a chief as like whales' blubber.

ANSWERS OF THE REV. J. F. H. WOHLERS, MISSIONARY AT RUAPUKE, FOVEAUX STRAIT.

DEAR SIR,— Ruapuke, Southland, 15th November, 1881.

Yours of 20th October, asking for information about the art of working in *pounamu* or greenstone among the Maoris, has come to hand. I will try and write you about my observations as far as they go. I will also enclose a paper on the same subject in German, which I think you might like to send to Professor Fischer at Freiburg.

I think that the ancestors of the Maoris long ago were in the possession of some culture, which they had lost during their migrations to the South Sea islands, where they sank down to what is called the period of stone implements [This, of course, must be regarded as impossible—F. R. C.] ; and that the noble bearing among the chiefs' families and the sense of art are remains of that culture. But the greenstone ornaments, weapons, and figures are the results of long persevering labour with stone tools. Many of the old Maoris could make simple ornaments, but only a few could produce the high and peculiar works of art. The figures or images were never worshipped. The Maoris as long as they have resided in New Zealand never worshipped idols, as their mythology and traditions show. Neither were their *hei-tikis* representatives of ancestors. They were simply works of art, and as such were highly prized. They went as heirlooms from generation to generation in the families in whose possession they were, and on this account only were they considered as sacred family treasures. It has happened that when families were dying out the last possessors of such works of art buried them secretly in the earth, so that they should not come into other hands.

There is an old tale of a mad Maori woman who long ago wandered from the West Coast, where greenstone is found, into the high mountains, carrying a greenstone axe with her. By good luck she found a passage over and through the mountains, and wandered on to the East Coast, where, south of Banks Peninsula, near one of the large rivers, she came upon Maoris who were chipping with axes made of inferior stones. She said to them, "Your axes are not good: try mine." Then the woman was questioned about the greenstone place (*wahi pounamu*) ; and, having listened to her description about the road thereto, it was resolved to visit that place. Two large parties were formed for that purpose. One party perished in the snow and ice on the high mountains ; the other reached the West Coast, and returned with greenstone.

My observations are limited to the Maoris on the shores and islands of Foveaux Strait. The pieces of greenstone in the raw state came, and still sometimes come, from the West Coast, where it is broken out of the rocks; but how it is imbedded there I cannot tell. When, forty or fifty years ago, the South Island was frequented by European whalers and sealers, some young Maori men went with them in their vessels to the West Coast, and brought pieces of raw greenstone back. A Captain Anglem, of that time, who lived in retirement on Stewart Island, told me that he had blasted greenstone rocks with gunpowder on the West Coast. But before that greenstone had been brought here, very likely, both overland and by sea, in canoes.

When I came among the Maoris here in 1844 there were still some real *tohungas* (wise men) living among them. Some men were learned in old tales; some were skilful in works of art: but such very high art as has been found in the North was never produced here in the South. Let us now look at one of those old artists such as I observed thirty-seven years ago. He is advanced in years, and hard labour no longer agrees with him. Sitting and doing nothing, his nerves will not be quiet; so he takes in hand a piece of raw greenstone, looks at it, and thinks what can be made of it. By-and-by he begins to rub it on a suitable stone. It takes a long time before a bright smoothness appears; but even a very slow progress cheers his mind, and the monotonous rubbing quietens his nerves. When he feels tired he ceases rubbing and enjoys rest. So it goes on through, perhaps, many years. By-and-by the idea which had been conceived in his mind begins to gain shape in the greenstone. Then fresh ideas about detail come into his mind, and he has to work with different stone tools—large and small, thin, and pointed. To bore a hole or to make fine depressions he has a wooden staff about 18in. or 2ft. long; at the lower end is fastened a sharp splinter of a hard stone; in the middle of the staff is fastened a small fly-wheel; round the upper end he winds a cord, and holds the two ends of the same one in each hand. Now, while comfortably sitting, and the greenstone being fastened below him with the sharp end of the bore upon it, he skilfully balances the latter in an upright position, and as he draws alternately with his hands the tool revolves in fast motions forwards and backwards. Formerly time was not considered among the Maoris—no one knew how old he was. Many old Maoris were engaged in similar hobbies, which, as they had no literature, were blessings to them.

The old Maoris were good judges of the quality of greenstone. They also showed and explained to me the goodness and defects thereof; but I did not learn enough of that science to be able to give a description of the same. All those old Maoris are now dead, and the present generation has adopted the ideas and fashions of the Europeans. They therefore leave the polishing of beautiful stones to European artificers. Some raw greenstone may still be in the possession of Maoris here, but I think very little is left of works of art.

You ask, "Was greenstone really the object of Te Rauparaha's invasion?" My answer is that very likely Te Rauparaha may have boasted that he would conquer the Wahi Pounamu, but I think he and his people were only continuing the savage history of the South Island. Long ago there came from the North a tribe called Ngatimamoe. They killed and ate of the Maoris found by them in the South. After them came the Ngatitahu Tribe from the North Island, and began to kill and eat the Ngatimamoe on the South Island. They had nearly finished them when Te Rauparaha and his people came to kill and eat the Ngatitahu, but were stopped by Christianity and by European immigration and civilised government.

Yours, &c.,

F. R. Chapman, Esq., Dunedin. J. F. H. WOHLERS.

Observations on the Authorities.

Several points in the matters touched upon in the foregoing answers appear to call for observation, though I feel much diffidence in venturing to criticize anything coming from gentlemen of the standard of knowledge of my correspondents. Certain obscurities and apparent differences are, however, in a large measure capable of being explained and reconciled.

1. *The* Hei-tiki: *its Significance.*

White's derivation is overruled by all other authorities. *Hei* is a neck-ornament. This name is given to me by competent Maori scholars to represent several forms of bone ornaments hung from a string round the neck. *Tiki* is the name given to the large carved figures on the gables of houses or set up near houses. This, then, is a small copy—a neck-*tiki*. The *tiki* represents, and the word is derived from, the name of the god Tiki. He is sometimes spoken of as the progenitor of mankind, and enters into numerous mythical tales. According to some authorities there were several gods Tiki. It seems certain that these objects were not gods or idols, nor were they in any way worshipped. Messrs. White, Stack, Shortland (second paper), and Wohlers, beside other authorities, are substantially in agreement as to their true import. Though Dr. Savage, who visited New Zealand in 1806, thought they were protecting deities, for some unexplained reason he uses the expression "the man in the moon" in describing them.

Mr. Wohlers's account of the *hei-tiki* offers in all probability the true solution of the apparently conflicting views. They were not portraits of ancestors, but they were, as Mr. Stack says, mementoes of ancestors. They became sacred and ever more sacred from the touch of the sacred dead, and so became indissolubly connected with the memory of ancestors. Why they were named after Tiki, or Adam, is a matter now lost in the mist of time. The old missionaries, who had an ignorant aversion for everything connected with heathen worship, had none for this object or its uses. The Rev. William Tate, who lived in New Zealand in 1828–35, says that the idea that it was connected with superstitions arose from the fact that the *hei-tiki* was taken off the neck, laid down on a tuft of grass or a clean leaf in the presence of a few friends meeting together, and then wept and sung over, in order to bring more vividly to the recollection of those present the person recently slain, whose body they will never see again, to whom the *hei-tiki* belonged. In this way it is used as a remembrance of all those who have worn it, and is called by the name of the individual whom it for the moment represents. It is wept over and caressed with much affection, and those present cut themselves severely in token of their regard for the deceased. These amongst other *manatungas* (keepsakes or heirlooms) are much valued. When not received from friends, similar objects may be purchased for a trifle. Similarly, Thomson, describing it as the most valued of all their ornaments, varying in size from a shilling to a plate, says, "When a long-absent relative arrives at a village the *hei-tiki* is taken from his neck and wept over for the sake of those who formerly wore it. There is no doubt they are handed down from father to son for generations—indeed, for centuries. They were deposited with the bones of the dead until they were removed to their final resting-place." The practice of burying them when the last of a family dies continues to this day, and is doubtless the reason why so many of them and other valuable objects are found buried.

Dieffenbach refers in somewhat similar terms to the practice of wearing them by Maoris of both sexes, and connects them with the grotesque colossal busts at Easter Island and elsewhere. Thomson shows the reverence in which they were held as representing the dead, narrating a story of an English sailor travelling with him who dared to remove one from a monument by the roadside, and only saved his life by hastily restoring it.

The *hei-tiki* is best described as a grotesque squat figure with a big head and attenuated legs, resembling some kinds of Hindoo idols. Its arms are bent, and its feet meet below. The hands, as on the great *tikis* of wood, and, indeed, in all Maori carvings, have only three fingers. Mr. Tylor, in his "Early History of Mankind," quoted with approval on this head by Mr. Travers, says, "Some New-Zealanders lately in London were asked why these *tikis* usually, if not always, have but three fingers on their hands ; and they replied that if an image is made of a man and any one should insult it the affront would have to be revenged, and to avoid such a contingency the *tikis* were made with only three fingers, so that, not being any one's image, no one was bound to notice what happened to them."

It is worthy of note that Parkinson, who went out with Cook on his first voyage, never figures a really good *hei-tiki*, though several flat ill-finished specimens appear in his book. It may be that the highly-worked specimens were rarer then than fifty or sixty years later, when the missionaries began to describe them.

Writing to me on the subject of the manufacture of *hei-tikis*, Mr. Helms says, "I was told by a Maori at Blenheim that as many as eight or nine slaves were given for one. Have you heard anything like this? I tried also to find out how they were made, but all my informant could tell me was that it took a long time, and that the old men would sit in the sun and grind away, humming at it all the time. He put the action to the word, and described circles round the eyes of a *hei-tiki* I had, at the same time doing a hissing hum. The description seemed to me very natural, because the humming would counteract, so to say, the monotonous grating of the operation."

Though the best authorities agree that the *hei-tiki* was not made in this Island, this must be taken subject to an exception. Major Heaphy, in his account of his visit to Arahura in 1846, says that he there saw *hei-tikis* receiving their last polish. The inhabitants of that place consisted largely of Ngatitoa and Ngatiraukawa conquerors, who had formed a part of Rauparaha's West Coast expedition, and it was probably some of these North Island people who had recently introduced this art.

2. *Te Wai Pounamu.*

The weight of authority is against Mr. Wohlers on the subject of the name of this (South) Island, though Major Heaphy and a few others take the same view. Wahi Pounamu would mean "place of greenstone," though a Maori has told me that it is an inadmissible form of expression. Wai Pounamu means "water of greenstone." He suggests that the former is correct, and that it applied to the district where the stone was found. The pronunciation of the two words is very different. Captain Cook, in his way of spelling, wrote "Tovy Poenammoo." He treats "Te Wai" as one word, in which case the short vowel might without great inaccuracy be written "o," and was so written by other writers of later date, until the missionaries reformed and settled the Maori orthography. He fancied, probably with truth, that the "w" was there a "v," as he often writes it so; and he gave "y" as the English equivalent for the long vowel-sound which we now write "ai." By no process can "Te Wahi" be got out of his word. Had he heard it he would have written it "Vahee" or "Wahee." Cook got the name from an old man at Queen Charlotte Sound. Speaking of the land south of Cook Strait, he says, "This land, he [the old man] says, consisted of two *whennuas*, or islands, which may be circumnavigated in a few days, and which he called 'Tovy Poennammoo.' The literal meaning of this word is 'the water of green talc;' and probably if we had understood him better we should have found that 'Tovy Poennammoo' was the name of some particular place where they got the green talc of which they make their ornaments and tools, and not a general name for the whole southern district."

In his narrative of the third voyage the geographical question is more explicitly dealt with. He concluded from the statements of natives that the stone was obtained near the head of Queen Charlotte Sound, and not above one or two days' journey from his ships—an error arising from an imperfect knowledge of the language, the distance being probably two hundred miles by any available road. His account of the fabulous tales of the natives has already been given. He adds, "As they all agree that it is fished out of a large lake or collection of waters, the most probable conjecture is that it is brought from the mountain and deposited in the water by the torrents. This lake is called by the natives Tavai Poennammoo—that is, 'The Water of Green Talc;' and it is only the adjoining part of the country, not the whole southern island of New Zealand, that is known to them by the name which hath been given to it on my chart."

This notion of a lake in which the stone was obtained was a source of great confusion to geographers, who before the interior was known placed it on the maps at random, generally about the site of the shallow Taieri Lake, fully three hundred miles' journey from the true spot. The fables Cook heard are to some extent collected in this paper; but probably most of them are lost. Cook was probably right in his notion as to the name of the country—so far, at least, that it was not originally general—and Dr. Shortland bears him out in this; but in speaking of it in the North Island the term got to be general, and that is now undoubtedly the name of the Island. It was doubtless so called because the greenstone was always got in or about water, either in a river or on the seashore —not, as Dr. Shortland thought in 1844, about Lake Wakatipu.

Major Heaphy describes the mode of searching for it. The River Arahura appears to cut through some veins of this stone, and to bring down fragments of it in the floods. On the subsidence of the water the natives wade about searching for it in the bed of the river, and the heightened colour of the stone in the water soon reveals it to them.

Parties from distant places travelled to Wai Pounamu, the water where the greenstone was found, and this term gradually became the name used by the North Island people to apply to the South Island. Rauparaha, early in this century, pointing to the south, said, as he abandoned his home to begin his famous march, "The people of Kawhia are going to Kapiti, to Wai Pounamu."

Dr. Shortland insists that neither Island ever really had a name, and that in the case of the North Island Cook picked up a Maori phrase descriptive of it. White gives an earlier name for the South Island as "The Food-abounding Island." The truth is that, as in the case of Europe and America, and even our own Province of Otago, a local name, or the name of a limited territory, has gradually spread to a very large area, and, looking out from the North Island, men point to the mountains of Wai Pounamu as if that name applied to the whole country. Cook must have misunderstood his first informant in one way, as he spoke of circumnavigating the two southern islands in a few days, while it required many months to circumnavigate the North Island, both statements being exaggerated.

Closely connected with this subject is that of Piopiotahi. In the deed of sale by Ngaitahu to the New Zealand Company, dated 12th June, 1848, Milford Sound is called Whakatipu Waitai, and on the attached map it is called Wakatipa Waitai. This mistake is rectified by the purchase-deed of Murihiku or Southland, which gives the true name Piopiotahi for this mighty fjord. As the Maoris gave Sir James Hector the name Wakatipu for the lake now called Kakapo or McKerrow, in the next valley to the north at Martin's Bay, that must be the true Wakatipu Waitai, or tidal Wakatipu. Some years earlier Dr. Shortland had constructed a map from information supplied by Maoris, in which Lake Wakatipu appears as "Wakatipua;" while the range of mountains which separates that lake from Milford Sound is marked, "Wakatipua Range: in this place rises the torrent Piopiotahi." He gives a more detailed map of the lake district, drawn by a Maori named Huruhuru, in which the lake appears as "Wakatipua, the famed Waipounamu." In the text he says that Wakatipua "is celebrated for the *pounamu* found on its shores and in the mountain-torrents which supply it," and conjectures that it may be the Waipounamu of Cook. This conclusion is manifestly incorrect. Modern references to Piopiotahi always connect it with Milford Sound; and, as the shores of Wakatipu are now inhabited, we know that no greenstone is found there. Doubtless the confusion has arisen out of the fact that two waters bear similar names—one being the salt-sea (tide-water) Wakatipu, and the other having been sometimes called the fresh-water sea; while colonists erroneously applied the reference to a sea-coast Wakatipu to Milford Sound, which they knew, rather than to the lake some miles inland, which was unknown.

On the other hand, *tangiwai* in plenty lies on the beach at Anita Bay, in Milford Sound, where, however, the only apology for a torrent is a watercourse, generally dry, coming down the mountain. Sir James Hector, in his admirable report to the Provincial Government of Otago on the geology of the sounds, in 1863, refers to this beach as the place where the Maoris obtained the greenstone. He failed to find the dyke, which was my experience thirteen years later; but I am now informed that it is higher up the spur. Some greenstone is said to be found on a stream in the opposite side of the sound. Shortland gives, in addition to Arahura, both places—" Wakatipu, a lake in the interior, one of the sources of the Matau; and Piopiotahi, a torrent on the south-west coast;" and mentions that at the latter place a block some tons in weight lay in the stream. A whaler, finding this, got up a company in Sydney to work it for the China market. After much labour and destruction of tools they found that it was spotted and would not take the China market. It sold in Wellington for one shilling per pound.

3. *The Drill.*

The description of the drill is singularly interesting. The fly-wheel was originally a couple of very heavy stones, of which I have several in my collection. Mr. White's description suggests the top of the drill-spindle working in a drill-head or mouthpiece. Mr. Wohlers makes it work without this support. Whether the primitive Maoris ever had a mouthpiece is doubtful: to any one who has used a drill it would seem incredible that a man who had once used one should ever try and work a drill without one. The late Mr. I. N. Watt, Sheriff of Otago, who was a very clever mechanician, told me that when he first went to Taranaki, of which province he was Superintendent, the Maoris had a very primitive drill. He taught them to make and use the bird-cage drill, and they at once abandoned their own. The primitive drill was identical with the balanced drill described by Mr. Wohlers. Mr. Watt informed me that the first he saw was steadily and accurately worked, boring a piece of greenstone, by a blind old man. The statement as to the character of the drill is confirmed by my brother-in-law, Mr. M. Cook, of this city, who tells me that in 1888 he saw an old Maori at Rotorua, in the North Island, sitting on the ground, holding down a *hei-tiki* by means of his two great toes, and drilling a hole through it, using such a drill as is above described, supporting it by merely balancing it.

This is the answer to Mr. Tylor's remark upon an apparent omission in Thomson's description of this drill (" Story of New Zealand," vol. i., p. 203): " There must, of course, be some means of keeping the spindle upright " (Tylor's " Early History of Mankind," p. 242). " Captain Cook could not ascertain how holes were bored in the handles of greenstone *meres*, as he saw no instrument sufficiently hard for that purpose. It is now known that these holes are drilled with a sharp wooden stick 10in. long, to the centre of which two stones are attached so as to exert pressure and perform the office of a fly-wheel. The requisite rotatory motion is given to the stick by two strings pulled alternately."

Thomson, in his account of the drill, obviously draws upon Dr. Shortland, who, describing his visit to Waikouaiti, the whaling-station of the late Mr. John Jones, says, "Here, also, I saw the drill with which holes are bored through this stone. It is formed by means of a straight stick 10in. or 12in. long, and two stones of equal weight, which are fastened about its central point, one on either side, opposite each other, so as to perform the office of the fly-wheel in machinery, and to exert the required pressure. One end of the stick, or, as we may call it, shaft, of the instrument is applied to the *pounamu* where the hole is to be bored. Near the other end are tied two strings of moderate length. One of these is wound round the shaft, close to the point of its attachment, and its extremity is held in one hand while the extremity of the other string is held in the other hand. A motion is now given by pulling on the former string, which, as it unwinds, causes the instrument to revolve, and the other string becomes coiled round the shaft. This is then pulled on with a similar result, and so the motion is kept up by alternately pulling on either string. The point of the instrument can thus be made to twirl round backwards and forwards as rapidly as the point of a drill moved by a bow, and merely requires to be constantly supplied with a little fine hard sand and water in order to eat its way through the *pounamu* or other stone, on which steel would make no impression." (Pl. XXXVIII.)

It is noteworthy that Dr. Shortland is the only authority I have quoted who describes the drill without a stone point, the grinding being done by sand alone.

Brunner, in his journey down the West Coast in 1846, found at Pahutani limestone rock containing pure flints, which he erroneously thought occurred nowhere else in New Zealand, and ascertained that presents of this stone were carried by the natives to all parts of New Zealand as material for boring greenstone. His companion Major Heaphy's account of the drill then used has already been quoted.

The Rev. R. Taylor, in his celebrated work, "Te Ika a Maui," says that to drill a hole the Maori ties a small piece of basalt or obsidian firmly to the end of a stick the sides of which are weighted with two heavy stones. Attached to the other end of the stick is a string, by which it is made to revolve; and, to keep the point of the instrument constantly on the same spot, a piece of perforated wood is placed over it. Thus ornaments in the shape of human figures are formed. It appears to me evident, however, that the piece of perforated wood is by no means always used; hence the clumsiness of many holes.

COLOURS.

An examination of the colours of greenstone with reference to their names and qualities, in which I desire to acknowledge the invaluable assistance of Professor Scott, of the Otago University, shows that with many shades they are mainly grass-green (grasgrün of Radde's Internationale Farben-Scala), or green-grey or pea-green (blaugrün-grau, Radde). Exceptional pieces are found to be shades of vermilion-grey (zinnober-grau, Radde). In each of these three colours or combinations I find that between my own collection and that of Mr. White the extreme points of the gamut of twenty shades are reached. In the grass-greens and pea-greens the foot of the gamut is a creamy piece with a faint-green tinge, while the head of the gamut is difficult to distinguish from black. In the vermilion-grey, or brown, the same thing occurs—namely, the foot of the gamut is a beautiful cream-colour faintly tinged with chocolate, while the head is so dark that its colour would scarcely be made out but for the assistance of lighter pieces occurring in places. In the case of certain of the green colours transparency considerably modifies the apparent colour, while numerous pieces of stone vary so much over their surface that the standard colour must be differently expressed for each square half-inch. In the appended scale I have endeavoured to express, in terms of Radde's standard, the colours of typical pieces of the most marked varieties, but, not being in a position first to submit my specimens to a first-class Maori expert, I cannot profess to present the tables as free from error. Radde's classification of colours is based upon twenty-two cardinal colours, with twenty intermediate colours, making forty-two gamuts or scales, which are expressed on cards. Each gamut exhibits twenty tints, produced by modifying the colour by lightening it or making it darker; so that each gamut runs up from nearly white, showing a trace of the colour, to nearly black, still showing a trace of the colour. They are shaded from dark at the head to light at the foot, and these shades are distinguished, in the annexed table describing the various objects, by letters from *a* to *v*.

DESCRIPTION OF OBJECTS FASHIONED FROM GREENSTONE.

No.	Object.	Colour.	Tint.	Maori Name.	Characteristic Qualities.	Remarks.
1	Pendant of modern workmanship (Chapman)	14, grasgrün	(*e*) ..	Kawakawa ..	Moderately transparent	This may be taken as about typical of the greenstone generally used by lapidaries in New Zealand. It is the most effective for general purposes, except *kahurangi*, which is rarely seen. It ranges in colour 14 from (*d*) to (*k*).
2	Highly-polished pendant, lapidary's work (Chapman)	" "	(*g*) to (*k*) ..	Kawakawa, approaching Kahurangi	More transparent, with dense clouds	
3	Magnificent axe, 16in. long and highly polished, with a small hole drilled at haft end; found at Sandymount (White)	14, grasgrün, 1st stage; and 15, grasgrün, 2nd stage, passing to blaugrün	(*p*) and (*q*) (*n*) and (*o*)	Kawakawa ..	Transparent in varying degrees in different parts	I have classed this beautiful object as *kawakawa*, but it must nearly approach *kahurangi*. The range of colours and varying tints greatly enhance its beauty.
4	Long implement in the shape of a narrow chisel, with a hole drilled in haft end; from Centre Island, Foveaux Strait (Chapman)	15, grasgrün, 2nd stage, passing to blaugrün	(*r*) ..	Inanga ..	Opaque ..	This probably fairly represents the stone known as *inanga*. It is placed here in order to give point to the characters of the next class. It ranges from (*q*) to (*t*), and lightens at joints to (*v*), the faintest tint in the scale. Being a dense stone, a large proportion of the implements made of it are very good.
5	Small hatchet from Otaki (Chapman)	38, blaugrün-grau	(*m*) to (*u*)	Inanga ..	Opaque ..	A specimen with more grey.
6	Great adze, weighing 5lb.; from Kartigi (Chapman)	38, blaugrün-grau	(*h*) to (*l*) ..	Auhunga ..	Slightly transparent	This is a stone very largely used by Maoris, and somewhat difficult systematically to distinguish from the two former. It is, however, in colour most like *kawakawa*, but in opacity it falls into *inanga*.

7	Implement (White)	15, grasgrün, 2nd stage, passing to blaugrün	(*m*) to (*o*) . .	Auhunga . .	Slightly opaque	The absence of grey, though not very apparent without comparison, carries this into a different gamut.
8	*Hei-tiki*, from Murdering Beach (Chapman)	38, blaugrün-grau	(*k*) to (*m*)	Auhunga . .	Slightly opaque	A slightly-decreased opacity makes this approach *kawakawa*.
9	Remarkable lobe-shaped pendant, 5in. long, weight 12oz.; from Fortrose (White)	38, blaugrün-grau	(*c*) to (*g*), flecked with (*m*)	Auhunga, flecked with Inanga	Opaque . .	This remarkable specimen is flecked with specks of *inanga* of very small size, which appear to run in from the surface at an angle, giving it a beautiful appearance.
10	Pendant, of very clear transparent stone (Chapman)	15, grasgrün, 2nd stage, passing to blaugrün by transmitted light;	(*d*) to (*e*) . .	Koko-tangiwai	Very transparent	This is a very beautiful specimen of *tangiwai* without the "water-drops." It is like the transparent green sometimes seen in bottles of coloured water in druggists' windows.
		14, grasgrün, 1st stage, passing to blaugrün by reflected light	(*p*) to (*q*)			
11	Flat worked piece (Chapman)	12, gelbgrün, 2nd stage, passing to grasgrün by transmitted light;	(*r*) to (*s*) . .	Koko-tangiwai	Very transparent	This is similar, but less clear, and has a characteristic yellow tinge.
		13, grasgrün by reflected light	(*b*) to (*c*)			

Description of Objects fashioned from Greenstone—*continued.*

No.	Object.	Colour.	Tint.	Maori Name.	Characteristic Qualities.	Remarks
12	Pendant (White) ..	15, grasgrün, passing to blaugrün	(*c*) ..	Koko-tangiwai	Transparent, with water-drops	This has a bluer tinge, and is typical of the stone possessing globular bodies which look like drops of water. (*Tangiwai* = tear-water.)
13	*Hei-tiki*, from Centre Island, or Raro-toka (Chapman)	15, grasgrün, 2nd stage, passing to blaugrün and tending to 31, neutral grau, on the back	(*a*) .. (*a*)	..	No trace of transparency except a faint trace on the back	This is a most remarkable object, and would be called black but that a few patches on the back indicate a slight green colour. In any case it is right at the top of the gamut. It is extremely dense and hard.
14	Very pale axe, from Warrington (White)	13, grasgrün, and 15	(*v*) .. (*b*)	Unknown ..	Opaque ..	This beautiful implement is in the palest shade of grasgrün, and may be described as so near white that it is immaterial whether it is classed in scale 13, 14, or 15, as the tint (*v*) in each of them is similar. It is almost impossible to describe the way in which it is picked out with much deeper patches of grasgrün (15, *b*), and in which in places these deeper shades, being overlain with the white stone, show through the latter in variegated wisps, where the white stone has been ground thin.

15	Remarkable spindle-shaped chisel of an exceptional shape, 6in. long, $\frac{3}{4}$in. in diameter (White)	As above, with spots of 38, blaugrün-grau	As above . .	Inanga . .	Opaque, and same as above, but with more frequent green spots, streaks, and patches, and these bluer.	
16	Another specimen (White)	As above . .	As above . .	As above.		
17	Reddish or brownish axe, from Warrington (White)	32, zinnober-grau (brown)	(*o*) to (*t*) . .	Doubtful, possibly Totoweka	Opaque . .	This is an extremely rare stone. Very pale, with a reddish or brownish tinge.
18	Dark-red axe, from Murdering Beach (White)	32, zinnober-grau	(*b*) to (*l*) . .	Doubtful, possibly Totoweka	Opaque . .	This is a very dark and very hard stone, with light patches which show its affinity with the last, though nothing could well be greater than the contrast between them.
19	Small gouge-shaped drill (White)	33, brown, less red than 32	All tints, except the highest and lowest	Unknown . .	. .	This, though placed in 33, as being less red than the two preceding, is otherwise a stone, only $2\frac{1}{2}$in. long, in which all the intermediate shades are beautifully blended. It might be described as cream-colour and chocolate in all stages of blending. This is probably saussurite.
20	Singularly-streaked axe (White)	38, blaugrün-grau	Various . .	Doubtful, but perhaps the spurious greenstone known as Kapotea	Mottled . .	A singular piece, more like serpentine than greenstone, and probably a different rock.

DESCRIPTION OF OBJECTS FASHIONED FROM GREENSTONE—*continued.*

No.	Object.	Colour.	Tint.	Maori Name.	Characteristic Qualities.	Remarks.
21	Axe of a greenish stone, found at Paremata, Porirua Harbour (Chapman)	38, blaugrün-grau	(*l*) to (*m*) ..	Possibly Kapotea, certainly not greenstone	..	I have found several objects of this or a similar stone near Paikakariki, in the North Island, and have placed it in this list as possibly corresponding with the "spurious greenstone." It is a beautiful stone, probably a green porphyry.
22	Pendant, lobe-shaped, from Murdering Beach (White)	32, zinnober-grau, banded with 38, blau-grün-grau	Various ..	Tangiwai, and possibly Totoweka	Banded colours	In this piece, 4in. long, a piece of *tangiwai* is banded with about 25 transverse streaks of opaque reddish stone. This is due, no doubt, to the infiltration of iron impurities into a much-jointed piece of stone.
23	Axe, from Boatman's (Chapman)	12, gelbgrün, passing to grasgrün	(*d*) to (*e*) ..	Raukaraka ..	..	The prevalence of yellow, especially in the lighter parts, is a marked feature.
24	*Mere* (Sir R. Stout)	14, grasgrün	(*e*) ..	Kawakawa ..	Moderately transparent	This is a beautiful *mere*, 13in. long, of typical *kawakawa*. It is also typical in shape—*i.e.*, 13in. long and 4in. broad, narrowing to 2in. where the hole is bored. The handle is finely carved, and is rather gelbgrün. It was the favourite *mere* of Titokowaru, and was given by him to the Native Minister in token of his return to fealty to the Queen.

CONCLUSION.

I cannot but feel sensible that this long paper is diffuse and somewhat rambling. It is, however, intended as a comprehensive collection of data connected with this subject, and I have made it my chief endeavour that it shall be as complete as possible, at the risk of rendering it interesting only for purposes of reference. No doubt there is a great deal of repetition; but my excuse for this is that I thought it most desirable that these Transactions should be made the receptacle for authentic original matter rather than matter made readable. I am fully aware that in some departments it must prove very defective. The history and traditions concerning objects of greenstone in the North Island ought to form the subject of a paper of a more poetical description than this, and ought to be collated with closer regard for chronology. Let me hope that I may have succeeded in inciting some North Island scholar to write it. My paper is rather a work of South Island research and observation. All this kind of work must be done soon, before the material dies with the dying generation of "authentic fellows." Let me express a hope, too, that I may excite such friendly criticism as will lead to the correction of errors and the procuring of additional information. I shall be only too pleased to receive communications on this subject from any quarter. This applies to Europe as well as the Pacific, for I am almost wholly unacquainted with the literature which the "Encyclopædia Britannica" tells me exists on this subject. It is of too special a character to be found either in my native island, Aotearoa, or in Wai Pounamu, where my home now is, civilised as they both are.

ADDENDA.

Since the foregoing paper was read I have had an opportunity of examining the collections in the Colonial Museum at Wellington, and the Christchurch Museum. The Hon. W. B. D. Mantell and Sir Walter Buller have also afforded me ample opportunities of examining their collections, and I have also inspected several smaller collections: I append a few notes of these. I also append an extract of a letter from Mr. S. Percy Smith, the Surveyor-General of New Zealand, on greenstone in Polynesia; and a comparative set of analyses compiled by Professor Ulrich.

SIR WALTER BULLER'S COLLECTION.

1. *Mere*, 13in. by 4¼in. Broad-leaved. Opaque. *Raukaraka* that is like *kawakawa*, but tinged with yellow (gelbgrün), like the karaka-leaf. The handle is, as is commonly the case, much more yellow. This *mere* belonged to the Waikato-proper Tribe, and came into litigation in connection with a block of land.

2. Famous *mere*, 12in. by 3¾in. *Kawakawa-rewa.* Slightly speckled with black. Name, Te Inu-toto (The Blood-drinker). This greenstone *mere* was the peace-offering of the Uriwera Tribe when Nga Korau and Te Kereru, with two hundred of their followers, came to Ruatoke in 1869 and made their submission to Major Mair, R.M., as representing the Government. The Major handed to one of the chiefs his gold watch, and placed a gold ring on the finger of the other in token of reconciliation. This peace-making was always referred to afterwards as the *marenatanga* or the marriage. It had been in the possession of the tribe for many generations, and had figured in many bloody affairs. Hence the name.

3. *Mere*, named Tuhiwai. Is a portion of a large *mere* broken and worked into shape again. Length, 10in. Has no neck. The handle must have been broken off. This was the tribal property of Ngatiapa from time immemorial. They were originally in the Taupo country, and migrated to Rangitikei, on the West Coast, perhaps one hundred and fifty years ago. It is sometimes called Tuhiwai-iti, or the Lesser Tuhiwai, in contradistinction from another Tuhiwai, the property of Ngatiapa, which was lost during a fight on the West Coast early in this century about 1812. The large *mere* was discovered ten years ago accidentally, in a forest near Porotawhau (Rangihaeata's old retreat, or stronghold). An old woman was collecting fungus in the forest when a mob of cattle was driven through. She ran away, and saw some of the cattle stumble over an old tree-trunk which lay on the ground. When she came back she found the tree partly broken, and the long-lost *mere* exposed. Ngatiapa redeemed it by paying this woman's tribe £200 in notes, five or six horses, and a lot of mats. The story of the losing of Tuhiwai is referred to in the following lament, composed by Puhara, a Rangitane woman of high rank, after the death of her husband. Sent to me by Sir Walter Buller:—

E hara te makau i te wai
Kawakawa koe
Wai kahurangi, e,
No te wai ano i tene ai
Whakare uta
I moe ai Tuhiwai, e,
E pa hiwi mai ra
I ara te tungaane
Kei te po tau au, e!

The Smaller Tuhiwai is *inanga* of a very green tint. It was presented to Sir W. Buller in 1865, in connection with the sale of the Rangitikei-Manawatu Block, amid the firing of guns and the wailing of women. A curious discoloration on the edge is attributed to the oil of the decaying corpse when buried with it. A similar discoloration is seen on a *mere* in the possession of Mr. Kohn, of Wellington, which was found imbedded in the skull with which it was buried.

4. Remarkable *mere*, 12½in. by 3½in. It is a grey stone (graugrün) unlike any I have seen, known as Tuwhai Kowha's *mere*. A dull dense *inanga*, with curious green spots or blotches. It is not carved on the handle, and is bored with two crater mouths. It is most singularly flawed with two silky asbestos-like joints of considerable breadth and most beautiful lustre. This was one of the tribal weapons of the Uriwera, having been in possession of that people for many generations, possessing an individual history known to them, but not yet ascertained by the present owner. It is especially interesting as having been used by the chief Tamaikoha at the killing of Mr. Bennett White at Opotiki, in 1865, as a declaration of war against the Europeans. His servant was killed with him. The act was a formal one, implying no ill-will against the victims.

5. Portion of a very small, narrow *mere*. Dark *kawakawa*. Dug up at Waitemata. Very ancient.

6. Beautiful handle-end of a very ancient *mere* of the Ngatiawa. Tradition says that it was broken in an action. The blade portion is in possession of Ngatiawa. It is a beautiful object, one side being *pipiwahairoa*. A marked feature is the irregular crater-like countersunk holes.

7. Very large *mere*, 14½in. by 4¾in. Very wide and heavy. Named Te Maungarongo (The Peace-making), from some historical incident. *Kawakawa*, more spotted than usual, having a peculiar transverse vein of pure *inanga* and an oblique vein of *raukaraka*. It is from the Uriwera (East Coast) country.

8. *Hei-tiki.* This remarkable object is of great antiquity, and was formerly in the possession of Ngapuhi, from one of whose burial-places at the Bay of Islands it was taken. It is of *totoweka*, of a singular colour. Its great singularity is that it represents a blind ancestor. All that the natives can say of it is that it is very ancient, as they have preserved no tradition respecting it. It has a hole in each corner of the mouth, which are drilled from the back, with craters behind. In style it is quite different from the ordinary form, having a long nose.

9. Very beautiful pale-coloured *hei-tiki* of the purest *inanga*, approaching white in colour. The hole in the back is drilled in a remarkable way in a long slant, and shows the marks of the stone drill in the form of circular grooves or rings. It is said to be very ancient, and has been in the possession of the Ngatikawhata Hapu of the Ngatiraukawa Tribe from time immemorial.

10. Large *hei-tiki.* Pure *kawakawa* of the finest quality, without flaw. Very highly polished by attrition against the skin.

11. *Hei-tiki*, said to be characteristic of some tribes, which in carving a *hei-tiki* put a crest, perhaps representing a frown, on the forehead.

12. Pendant of clear *tangiwai*, perfectly translucent. Belonged to Aperahama Tipae, hereditary chief of Ngahapa, a man well known throughout the North Island. The name of this pendant is Te Kahura-a-rongotea. It was handed over by that chief when he affixed his mark to the deed of cession of the Manawatu-Rangitikei Block. A very beautiful object.

13. A mat-pin, presented by the same chief to the late Lady Buller. Valued as a most perfect specimen of translucent *tangiwai;* delicately barred with varying shades.

14. A pendant. A perfect piece of *ruakaraka* (gelbgrün), given to Sir W. Buller by the Ngatituwharetoa of Taupo. They think this the most perfect stone.

15. A small eardrop of stone of the colour known as *inanga*, but transparent. Mr. Mantell has a pendant of similar stone. This is said by Ngatiwhiti to be the true *kahurangi*.

16. Very small hand-chisel or graving-tool for fine carving, used without a handle. *Kawakawa*. Two similar but smaller chisels to be struck with a hammer, broken at the haft-end.

17. Beautiful pendant of *tangiwai*, with the tear-drops in it. They are like globules of water in suspension.

18. Small ornament in the shape of a miniature axe, cut out of greenstone after the manner adopted by the Bosnians (Boyd Dawkins's "Early Man in Britain," p. 336).

19. Ear-pendant of blue *tangiwai*. This contains spots or stains, which are referred to by the Maoris as representing the blood of ancestors.

20. A small block of *tangiwai*, smooth all over. This is a burnisher for polishing wood-carving. This fact explains the existence of many

highly-polished stones of no apparent use found in Maori camps. A piece of *pipiwarauroa*, nearly square, ½in. thick, used for the same purpose. A small burnisher for the same purpose, with two scraping-edges. A long, thin burnisher for the same purpose.

21. Small chisel or axe, with a curved edge. A earving *toki* for digging the deep holes in totara slabs when executing carvings. The artist burned little holes in the slab, and chiselled out the charcoal. This instrument has a depression for the thumb.

22. Large axe. Length, 13in.; width, 3¾in.; thickness, 1in. As it was found to be too broad, there is a cut on each side to remove a strip. *Kawakawarewa* or melting *kawakawa*.

Greenstone in the Polynesian Islands.

41, Tinakori Road, Wellington,
6th November, 1891.

My dear Mr. Chapman,—

In accordance with my promise of this afternoon, I send by book-post "La Nouvelle-Calédonie," by Jules Garnier. See page 81 for the description of the greenstone, which is probably worth quoting as a note to your paper.

I also give you the following notes from my own note-book. They were jotted down at a time when I was—and still am—in search of anything bearing on the question as to whether the Polynesians knew of the *pounamu*:—

1. Taylor, in "Te Ika a Maui," page 29, says, quoting from the "Voyage of the 'Flores,'" "Green jade is found in New Caledonia (Kanala)." What is its native name?

2. It is also found in the Louisiade Archipelago.

3. Dr. Lesson, in his "Les Polynésiens," vol. i., p. 59, says, "Le jade vert, à l'exception de la Nouvelle-Zélande, n'existe que dans les Îles Hébrides et la Nouvelle-Calédonie."

4. He also says (vol. iii., p. 171), "Il paraît certain aujourd'hui que le jade vert ne se trouve sur aucune des îles Polynésiennes proprement dites. Cependant tous les anciens navigateurs ont signalé son existence sous des formes différentes, dans les divers îles qu'ils ont visitées; tous ont fait remarquer le prix qu'y attachaient les indigènes, preuve convainçante de sa rareté. On y tenait tant, lors des premiers voyages, qu'il etait presque impossible d'en rencontre dans les îles Polynésiennes qui ont été frequemment visitées."

5. *Pounamu* was known by name to the Moriori, and there was formerly a *toki* belonging to their ancestor Moe, of the Orepuke canoe, named Toki-a-ra-mei-tei, which is buried at Owhata, near the east point of Chatham Island, in the *tuahu*, or burial-ground. Tapu says, from the description of it, that it was made of *pounamu*.—A. Shand, 1890.

7. M. A. de Quatrefages, in his "Hommes Fossiles et Hommes Sauvages," page 136, in speaking of the human and other remains found in southern France of the quaternary period, refers to the jade, or greenstone, found amongst the implements, as follows: "Mais toutes les haches recueillies dans la vallée du Petit Morin n'étaient pas en silex. Vingt ont été fabriquées avec des roches étrangères à la contrée, et parmi elles il en est en *jadite*, en *chloroménalite*. Or, la première de ces matières semble n'exister qu'en Chine, et peut-être en Amérique, et notre éminent minéralogiste, M. Dumour, n'a pu encore découvrir la patrie de la seconde."

9. Julian Thomas ("Cannibals and Convicts," page 284) says, when in Tanna, of the New Hebrides, "I found specimens of a rock which I took to be the same as the New Zealand greenstone. The natives made charms of it, as in Maoriland."

10. Basil H. Thompson, in his account of explorations in the Louisiade Archipelago, given in Proceedings Royal Geographical Society,

1889, p. 540, says, "We could not ascertain the actual spot whence the 'greenstone' from which the stone adzes were made is brought; but, as the natives of Goodenough Island pointed westward, it is probably to be found in Huon Gulf. In New Zealand the greenstone is generally found associated with gold."

I have read most of the books relating to Polynesia, both in French and English, but so far have failed to find any reference to greenstone; and this is peculiar in face of Dr. Lesson's statement given in Note 4. I mean, I have failed to find any reference besides those given above. At the same time I feel little doubt that the *pounamu* has played an important part in inducing the early voyagers to direct their paddles towards New Zealand. I remain, &c.,

S. PERCY SMITH.

The following is abbreviated from "Océanie. Par Jules Garnier. Paris, 1871":—

The geology of Ouen Island is extremely interesting. I recommenced my examination of the west coast. From Koatouré Bay I went up to the rugged summit of Nougougueto, which rose to my left. My attention was suddenly attracted to some rocks of peculiar appearance, which, besides presenting the features of novelty, exhibited that of beauty. They were somewhat translucent, of a very pure white, among which ran veins of a delicate green. Their physical character recalled tropical jade. It is of this stone that the New-Caledonians formerly made their finest axes, the *situs* of which I had until now sought in vain. There was ample evidence that this was one of their ancient quarries in the fact that the soil was scattered over with *débris*, and with splinters which the hand of man alone could have produced. Nevertheless the dull fractures indicated that a long time had elapsed since these heaps had been made; and the young men of Ouen Island, who accompanied me, regarded with as much astonishment as I did these traces of an ancient work of their ancestors. The reef of this beautiful stone is extensive. It crops out on the surface for a considerable distance, and its association with veins of *euphotide*, in which it appears to lose itself, seems to indicate that it is only a form of that rock. This fact is interesting, because hitherto the jades have been classed somewhat at random, not having been found *in situ*.

On showing my specimens to Zachario he said, "That is the stone which was used for making axes. Formerly people came from as far as the Loyalty Islands to search for pieces. What sanguinary battles my ancestors have fought against strangers who have sought to invade the territory in search of that precious stone! In those days we had neither axes nor knives of iron or other metal. Nevertheless, we had to hollow out our canoes, cut up fish and the bodies of our enemies. For this purpose my ancestors sought out the hardest and toughest stones, polished and sharpened them. If all kinds became sharp, all did not take on a fine polish and a good appearance. Some remained black and dull, others were of a more or less bright green; but for richness of colour and transparency none approached the stone you have found to-day. Instead of being satisfied with making small hatchets of it, they turned to account the facility offered by that stone of breaking off thin slabs of large size at a blow. They chose one of those slabs, rounded its edges regularly, then polished its surface with coarse and fine sand until it became smooth and uniform. The thinner such an axe became the more it was prized, as the light of the sun could pass through it. By means of very hard, sharp pebbles several holes were then bored close together near the edge. By this means the handle was fixed to it. But what time was consumed in completing such a work! The lifetime of a man was not always sufficient to finish one. Thus such an axe was the most valuable possession of a chief. For one of these peace could be purchased, an alliance secured, great canoes bought—in short, it was as gold is with you. Each chief owned axes such as that, and with them the bodies of the vanquished were cut up after a victory. The use of that stone did not stop there. Small fragments were rounded and pierced as beads, with which were made the necklaces you have noticed round the necks of the ladies of chiefs' families. But since your arrival your axes so sharp, and your brilliant necklaces, have caused us to forget our ancient arts, and that stone, once so precious, remains unused."

M. Garnier with difficulty blasted out some large blocks, finding generally that his shots went off like guns instead of shattering the rock. He found it impossible to purchase even the small beads from the natives.

The axe described by Zachario must be similar to that in the Colonial Museum, at Wellington. It is a disc of greenstone, 8in. long by 6in. wide, very thin and highly polished. By means of two holes near the edge it has affixed to it a handle 20in. long, covered with tappa cloth tied on with a band of sinnet. It forms a most formidable *casse-tête*, but not a useful tool. It is a dark green, of several shades intermixed, and with a brownish tinge. It is undoubtedly nephrite, and in New Zealand would be regarded as of a rare but not unknown colour.

At page 312 of M. Garnier's work, from which the above quotation is taken, in speaking of the people of Uvea, one of the Loyalty Islands, he says, "Most of them had ornamented their throats with necklaces of the *green jade* of Ouen Island. We essayed in vain to purchase some of these; our most brilliant offers failed to obtain a single one of the ornaments. It is always thus among the tribes of New Caledonia: if one wishes to possess one of these necklaces, one must purchase them bead by bead."

New Hebrides Jade.

In the Colonial Museum there is also a small yellowish-green adze, possibly of jade, from the New Hebrides, and a very dark stone adze, similar in shape, from the same country. Besides these, however, there is from the same islands a pale greenstone axe with five transverse seams of black. This is unlike New Zealand stone; it is more like some I have seen from China. Its shape is characteristic of the New Hebrides, not of New Zealand. It is manifestly a jade of a different character from that found in New Zealand.

New Guinea.

The Colonial Museum also contains specimens of the very dark greenstone of which there are several fine specimens in the Technological Museum in Melbourne. I am unable to say whether it is an allied stone.

ANALYSES OF GREENSTONES.

Localities.	Sp. Gr.	Silica.	Alumina.	Iron-protoxide	Manganese-protoxide.	Magnesia.	Lime.	Potash.	Soda.	Water.	Oxide of Zinc.	Total.
				Nephrite (Jade).								
Rammelsberg—												
China	2·96	54·68	..	2·15	1·39	26·01	16·06	..	..	0·68	..	100·97
"	..	58·91	1·32	2·43	0·82	22·42	12·28	0·80	..	0·25	..	99·23
"	..	58·88	1·56	2·53	0·80	22·39	12·15	0·80	..	0·27	..	99·74
Damour—												
China	2·97	58·46	..	1·15	..	27·09	12·06	..	..	..	..	98·76
"	2·97	58·02	..	1·12	..	27·19	11·82	..	..	..	..	98·15
Scheerer—												
China	..	57·28	0·68	1·37	..	25·91	12·39	..	..	2·55	..	100·18
New Zealand	..	57·10	0·72	3·39	..	23·29	13·48	..	..	2·50	..	100·48
Fell—												
Swiss lake-habitations ..	..	56·83	..	6·70	0·58	20·35	13·02	..	..	3·18	..	100·66
" ..	..	56·14	0·48	4·66	1·13	22·68	11·12	..	..	3·72	..	99·93
				Jadeite (Jade, Nephrite).								
Fell—												
Swiss lake-dwellings ..	3·32	58·89	22·40	1·66	..	1·28	3·12	0·49	12·86	0·20	3·73	101·03
Damour—												
*China	3·32	59·17	22·58	1·56	..	1·15	2·68	Trace	12·93	..	..	100·07
Kastner—				Iron-sesquioxide.								
China	..	50·50	10·00	5·50	..	31·00	..	..	..	2·75	..	..
Melchior and Meyer—												
New Zealand (*tangiwai*)	2·61	53·01	10·83	7·18	..	14·50	12·40	0·97	..	1·11	..	100·00
"	2·61	55·01	13·66	3·52	..	21·62	..	1·42	..	5·64	..	100·27
				Bowenite (Nephrite).								
Smith and Brush—												
†Smithfield, North America	2·594 to 2·757	42·29	Trace	FeO 01·21	..	42·29	0·63	..	..	12·96	..	99·38

* This stone is highly prized by the Chinese, and called "teitsui." The greenstone called "chalchihuitl" by the old Mexicans is supposed to be the same as the "teitsui" of the Chinese.

† This is a true serpentine.

Art. LI.—*On the Native Dog of New Zealand.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 8th June, 1891.*]

During the last twelve months I have collected further information regarding the kuri, or Maori dog, through the "Notes and Queries" column of the *Otago Witness*, and by private correspondence, and now bring to your notice the answers received. It is noteworthy that the name "kuri," which some persons say is equivalent to "animal," and does not refer to the dog alone, should seem to be closely connected with European or Aryan names for dog; and, as Mr. Edward Tregear informs me by letter, a somewhat similar name is used among the Pacific islands, as follows: "Tongan, *kuli;* Fijian, *koli;* Baki, *kuli;* Api, *kuli;* &c. Skeat, our great authority on etymology, says that 'colley' is related to the Celtic *cu,* a dog, and gives from an old glossary '*Coley,* a cur-dog.' I do not think you are right about your derivation of 'cur,' as a dog which has been curtailed or cut in any way. Skeat says, '*Cur,* a small dog: Middle English, *kur* and *kurre;* Swedish, *kurre,* a dog; Old Dutch, *korre,* a watch-dog, giving as probable origin a sound as of growling or barking.' I do not hold with this. I think that the root is *kur,* to run, as found in French *courir* and Latin *curro.* *Cur* is 'a dog which runs away,' and *ku*—as seen in the Greek *κύων*, a dog; the Celtic *cu,* a dog; &c.—is evidently the same root, the original *kur, kuri, kuli,* or *colley* meaning 'the swift animal.' Years ago I said in 'The Aryan Maori' that I believed the Maori dog was the degraded descendant of the dogs which once guarded the herds of the Maori people in Central Asia. Remembering this, do not the constant comparisons to a shepherd's dog made by those who saw the old kuri seem remarkable? And note the European and the native names."* *Cu* is also Irish for dog; *ci,* Welsh: *cú,* a dog, Gaelic: Russ, *suka,* a slut: Sanskrit, *çvan,* a dog; *çara,* variegated in colour, also used of hair mixed with grey and white: *canis,* Latin, a dog; *canus,* grey, hoary: *chien,* French, a dog (Old French, *chen,* a dog); *chenu,* grey hairs: *grey,* Icelandic, a dog; as also *greyhunde,*

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* The foregoing is quoted from Mr. Tregear's letter, but I take exception to Mr. Tregear speaking of the kuri as "the degraded descendant," holding that, although the kuri might be greatly altered in habits, there is no proof of degradation as far as size is concerned. We have ample proof that the word "cur," used by Captain Cook, was then the correct term for dog; and, in place of "runs away," read "the chaser," or, more correctly, "courser."

a greyhound; *grey-baka*, a slut (Skeat says not allied to "gray," which is *grar* in Icelandic). In this I think he is wrong, for we have both "grey" and "gray" in English. From the apparent connection of these words we may safely infer that the old-time dog was of a grey colour, and that English stag-hounds and the greyhound are the least modified from the original old-time dog—as also is proved by Assyrian bas-reliefs or sculptures. Take the word "grin," to snarl, grimace: Middle English, *grennen;* Anglo-Saxon, *grennian*, to grin; Dutch, *grinjen*, to weep, fret; Icelandic, *grenja*, to howl; Danish, *grine*, to grin, simper; Swedish, *grina;* German, *greinen;* and English, *grimace*, *grind*, *gripe* (to seize), *grip*, *grizzly*, *grizzled*, *grab*, *grasp*, *grope*. These words all refer to the characteristics of a grey animal, presumably the dog. The English word "*grim*, fierce—Anglo-Saxon *grim*, allied to *gram*, fierce, angry, furious: Icelandic, *grimmr*, grim; *gramr*, angry: Danish, *grim*, grim; *gram*, angry: German, *grimm*, fury; *gram*, hostile:" &c. (Skeat)—shows parallel changes = *grey* and *gray*, and is another dog word.

The Maori also uses *moi* and *pĕropĕro* in connection with the dog. It is remarkable that *perro* is Spanish for dog. Mr. W. H. Skinner says "*Peropero*" is used by the Maoris to their dogs, as we call "Puss, puss," or "Chuck, chuck," to cats and poultry. *Moi* is, I believe, connected with a Maori story of a person of that name who was changed by witchcraft into the form of a dog, which was proved by the strange dog answering to the name when called by the lost one's sister.

The Maoris name a plant "poroporo" (*Solanum aviculare*), which is allied to the potato and tomato, and bears large oval berries or drupes, the size of a pigeon's egg, of a bright-orange colour. The colour of these fruits gives a fair definition of what I described as gamboge-yellow in a former paper—a white dog with patches of gamboge-yellow, meaning thereby a light-orange colour. This will give a better idea of the colour meant, and might be one reason for the coupling-together of "peropero" and "poroporo;" still, I have no evidence of the white-orange-coloured dog occurring in the North, where "Peropero" is used as a call for dogs. This plant, also, I have not seen in the South Island, and the name discussed is strictly confined to the North.

In Mr. Tregear's paper I was much taken by the sketch or figure showing an old form of tattoo formerly used by the Maoris, called *mokokuri*. This was a marking of the face by sections of three short parallel lines, and at once reminded me of the black markings on dogs which were described as freckled with black—that is, a few black hairs close together here and there on a pure-white ground, but not in sufficient numbers to constitute spots. I consulted Mr. Colenso on this matter, and he replied, "It means an inferior, or common, or less-esteemed kind of face-tattoo. '*Kuri*' is added adjectively to several words in Maori, generally meaning as above (having nothing to do with their *kuri*=dog)—much, indeed, like our English use of the term 'horse' as in 'horse-chestnut,' 'horse-mint,' 'horse-mackerel,' 'horse-laugh,' &c." Mr. Colenso is not with me; but there is yet no certain proof that the tattoo was not copied from the dog's markings. A horse-trough and horse-cloth are certainly connected with the horse. And it is rather remarkable, in taking the skin from a wild pig, I noticed that the arrangement of the hair-follicles, as seen on the under-side, were almost invariably in threes, and closely resembled the *mokokuri* tattoo, and showing as parallel lines. Most of the Pacific islands were supplied with pigs when the first European ships arrived, so that, if "kuri" included pigs, the skin of the pig might originate the markings of *mokokuri*. But this is hardly probable, for the natives seldom remove the skin: still, the incident is worth recording. To return to the word "curtail," mentioned above, I had not then seen a copy of Skeat, but I will now quote his definition, and leave you to judge between us as to whether it is a dog-word or no: "'Curtail,' a French word derived from Latin. It has nothing to do with 'tail,' but is a corruption of the older form *curtal*, verb, to dock, from the adjective *curtal*, having a docked tail ('All's Well,' ii., 3, 65); old French, *courtault;* later, *courtaut*, 'curtal, being curtalled' (Cot.). The same as Italian *cortaldo*, 'a curtall, a horse sans taile' (Florio). Formed with suffix *ault* (=Italian, *aldo;* Low Latin, *aldus;* from German *wald*, power), from old French *court*, short, from Latin *curtus*, short."* I would have you notice that the word "tail" occurs four times in this paragraph. In fact, it seems all about the tail and the shortening thereof. Possibly the word is "curt-tail"= short tail; but why not "cur-tail," or dog-tailed? Most of us know that a breed of dogs are born with little or no tail, as also are Manx cats; therefore "curtail" came to mean docked or shortened tail. We do not say "curt-ail" or "curt-al," but "cur-tail" and "cur-tal." If not allowed either the cur or the tail, the whole word seems lost.

I hope it may not seem irrelevant to the subject of this paper if further remarks are made on the European dog. It

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* Again, Skeat says, "'Dock,' to curtail (Celtic ?). Perhaps from Welsh *tocio*, to clip, dock; chief form, *tocyn*, a short piece." Here we find *ci* and *cy*, Welsh for dog. "'Dock,' a basin for ships; Danish, *dokke;* Swedish, *docka;* Low Latin, *doga*, a ditch, also a cup." Compare M.E. *dogge*, A.S. *docka*, a dog.

is evident that chains were first made for the special purpose of controlling the dog. Most people are acquainted with the result of tying a dog to his kennel by a rope or piece of hide—how he will with the greatest ease cut them with his teeth as if with a knife. Now, *chien*, French, a dog; *chenil*, a kennel; *chenu*, hoary, grey-headed; *chaine*, a chain: and in Latin, *canis*, a dog; *canities*, a grey or greyish-white colour; *canicula*, a small dog or slut. *Cuniculus*, a rabbit; and *kaninchen*, German, a rabbit—the ending of these two words means "little" or "small;" so the whole is "the little grey fellow," and seems to show that the rabbit was not indigenous to Germany.* Latin, *catella*, a little chain; *catellus*, a little dog, puppy, or whelp, also a small chain; *catena*, a chain; *catillo*, to lick a plate; *catulus*, a young dog—point to the dog being of a grey colour, and to his being fastened by a chain when not in use.

"The Gauls used dogs in war. Appian relates that a Celtic ambassador's body-guard was composed of these trusty animals. The Allobroges also kept numbers of them for this service. The Cimbrians having left their baggage in the charge of their dogs, they successfully defended it after the defeat of the army. (Pliny, viii., 40.)

"Those of Britain were particularly esteemed, and great numbers were sent to Gaul to be used in war, being much superior to the continental breed. The Caledonians kept them for the purpose of giving notice of the approach of an enemy. (Smith's Gall. Ant.) The Romans imported great numbers from Britain for use in hunting.

"The *Lupus cervarius*, a hart- or hind-wolf, called by the Gauls *raphium*, was found in their extensive forests, and several were exhibited in Rome by Pompey as natural curiosities. They were not the only remarkable animals of the kind; there were a sort of very large and fierce creatures, called wolf-dogs, being a cross from the two animals. Great herds of these roamed in the woods, and, what was most singular, a particular dog acted as leader, all the others following and submitting to his direction, the whole pack observing an appearance of order." (Pliny, vii., c. 40.) "They seem to have resembled the Irish wolf-dog."

"The present name of a wolf in the Highlands is *mada*, a dog, and *alluidh*, ferocious: and foxes are *madadh ruadh* (red dogs) or *sionach*." It would seem probable that the idea that these wild dogs were hybrids is fallacious: their evident numbers and the fact of their congregating together are against

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* It might be said that Lat. *cuniculus* means "little cave-maker;" but I prefer to take advantage of the change of the vowel "u" to "a," as shown in the German *kaninchen*.

it. They must have been the original of the domestic dog, or the descendants of stray dogs gone wild.

It is not very clear if the crossing of *Lupus cervarius* and the wolf, or of the dog and wolf, is meant. I am much inclined to think *Lupus cervarius* was the badger. It is said that the wolf and the dog are fertile together. The jackal must have been extinct in Europe long before the time of the Romans, although remains of an extinct species have been found in Britain, together with those of the cave-bear, sabre-toothed lion, and other curious animals.

Mr. W. H. Skinner, surveyor, New Plymouth, Taranaki, has kindly furnished me with the following account of a dogskin mat which is in his possession at the present time:—

"New Plymouth, 14th February, 1891.

"Mr. Taylor White: Dear Sir,—I am sending under separate cover a rough sketch of dogskin mat. I find it a most difficult matter to hit off the colouring, and nothing short of seeing the mat itself would be satisfactory. The mat was bought by myself from Whakatau, a chief of the Taranaki Tribe. This man's age, I should think, would be from seventy-five to eighty years. The mat was made by his father, Rawahotane. The skins were obtained and cured by this man's father, or the grandfather of Whakatau; so that these dogs must have been killed at least eighty years ago. This would accord with Te Whiti's statement that the mat was at least eighty years old. Such being the case, these skins cannot possibly be other than those from the native dog, as explained in my first letter.

"I am surprised that Mr. Colenso takes up the line that the native dog was a small miserable cur. From conversations held with intelligent natives I gather that the old Maori dog was by no means a small animal, but a very fine animal indeed, and good-looking withal; but in one respect they differed greatly from our European dogs, and that was, they had no bark such as our dogs, and they never offered to bite any one, or, as the Maori explained, never got into a rage.

"Some twenty years ago Captain Good, then living at Urenui, in this district, found the skeleton of a Maori dog which had evidently been buried with some show of respect. The bones were found in a small cave, and the remains of a mat—a few fragments only—in which the dog had evidently been wrapped, were lying around. This skeleton is either in the Wellington Museum or was sent to Copenhagen. Mr. Good's address is Oeo, near Opunake. He, no doubt, could tell you if the dog was a small or a large one. Some nine years ago, whilst surveying well up on the slopes of Mount

Egmont, a small pack (four or five) of wild dogs passed within 20 yards of me. One of them I was particularly struck with. It was jet-black, with long hair, prick ears, long tail, and to me looked as if it might have been a well-conditioned black fox—in fact, it might answer to skin No. 8 on the sketch. They were following up a cow with a young calf at foot. They did not bark, but made a most uncanny noise—a strange sort of howl. Often we have been awakened in camp by this strangely human—or unhuman—sound, and have turned out to answer, as we thought, the 'cooee' of some unfortunate lost in the bush; but as we listened more attentively we found that it was the cry of the wild dogs. The camp dogs always got into a restless, uneasy state whenever they heard this sound.—Yours, &c., "W. H. SKINNER."

In a previous letter:—

"The mat was purchased by myself at Parihaka in June, 1889. The fact of my having purchased the mat caused quite a small sensation at Parihaka, and a friend of mine, being in the village the following day, overheard Te Whiti and several of the older men discussing the affair and the history of the mat. Te Whiti remarked that it was *at least* eighty years old, and was the only one to his knowledge anywhere in the district. In conversation with a native of the same hapu he gives its age as ninety or a hundred years, proving beyond doubt in my mind that they are genuine old dogskins. This part of New Zealand—Cape Egmont—was quite unvisited by the very early whalers and traders up to about the years 1825 to 1830, and only then very occasionally, so there can by no possibility be any chance of these skins being crossed with the European dog; and I have yet to learn that the very early traders brought dogs with them as an article of trade. Whakatau's father, Kiore, was the *ariki* of his tribe, and Whakatau's elder brother, Paora Kukutae, led the tribe at the battle of Waireka, in March, 1860, where he was killed; so they are a family of rank in these parts.

"Description of dogskin mat Hurukuri (history as given by Whauhoka: Rawahotana tamaiti, ko Whakatau, potiki no Rawaho te Hurukuri):—

"No. 1.—Dark brown on back, shading off to brown underneath and on head: prick ears: length, 3ft. 6in.; width, 1ft. 3in.: hair about ¾in. to 1in. in length; longer, of course, on tail: the tail at present is stumpy, but I am inclined to think it has been trimmed back to this.

"No. 2 is a most difficult one to describe: A light tan underneath; a darker shade of tan, freely intermixed with black, along back and top sides; very light tan under-side hams and under tail (this is the skin of a very large dog):

hair close and stiff: the ears have been trimmed, so cannot say if prick or not; inclined to think they were originally prick: long tail, with short hair: length, 3ft. 8in. by 1ft. 6in.

"No. 3.—Black: long soft hair: long tail, with long hair (I have sometimes seen this long black hair in the decorations used for the *taiaha* spears): prick ears: length, 2ft. 10in. by 10in.

"No. 4.—Slut: creamy white: short, stumpy tail: prick ears: hair about 1in. long, a little longer on hind-quarters: bare underneath the loins: smallest skin in the mat—length, 2ft. 7in. by 9in.

"No. 5.—Black: long soft hair: long tail: prick ears: length, . . . by 1ft. 3in.

"No. 6.—White: long hair, especially on tail (this is the kind of dog from which the long white hair used in decorating spears, &c., was obtained): length, 2ft. 8in. by 1ft.

"No. 7.—Tawny-yellow: long shaggy hair: very small prick ears: narrow head: much the colour and appearance of Australian dingo: length, 3ft. by 1ft.

"No. 8.—All black, except, under tail, a light-tan spot: long soft hair: long tail: large prick ears: length, 3ft. 6in. by 1ft.

"Nos. 5 and 8 are slightly freckled with white hairs.

"The skins have been trimmed slightly, I think—so as to make them of one width with the skin of the head. I do not find any spots or marks of any kind whatever over the eyes, or difference of colours on the cheeks. In three or four of the skins the tails have been slit into three or four strips—not pieces sewn on, but the original tail cut into strips to make it look more ornamental. The whole of the under-portion is open to the view, and is covered with tags of dogskin with the hair attached: these are there purely as an ornament, in the same way as you see the black tags or threads attached to certain kinds of flax mats. The hairy side of the mat was worn next the skin; the under-side, with tags attached, came on the outside when in use. The skins are sewn together with thin lashings or laces of dog's hide, not a scrap of flax in any shape or form coming into the mat.

"The history, by Whauhoka, is simply the names of, first, his uncle, from whom I bought the mat; then his grandfather, who made the mat. He does not give the name of his great-grandfather, by whom the skins were in part collected and cured.

"W. H. Skinner."

Mr. Tregear gives me the following description of a stuffed specimen in the Wellington Museum: "I should think it must be a genuine kuri, for it is like no European dog that I ever saw. A low long-bodied dog, prick-eared, sharp-snouted, of a dirty white in colour. A very ugly brute, but then some of his ugliness may be put down to bad stuffing. I think that the really reliable evidence as to the hair of the uncrossed Maori dog must be sought in the British Museum, or in some such place, containing cloaks, &c., sent Home a hundred years ago."*

Mr. A. Hamilton, formerly of Napier, tells me that he took a well-preserved skull of a dog from a Maori kitchen-midden near Shag Point or River, and that it was "about the size of that of an ordinary sheep-dog." This he forwarded to the Christchurch Museum; but I have been unable to ascertain what was the result of a scientific examination of it. I will now give the information gained as answers to my letter in the *Otago Witness*:—

Mr. Charles Goodall, Lora Valley, Hokonui, writes, "In the sixties the native dog was common enough in Southland, more so in the lake districts and the Umbrellas close to Switzer's Diggings. About 1861 I and mate were within five chains of four in a pack. These dogs were all white, and about the size of a moderate-sized colley dog, with, as near as I could tell, bushy curved tails. Apart from this, a shepherd there named Sutherland killed many, and I had seen one which he killed, and handled it. This dog was white, marked with beautiful light orange-yellow spots over eyes, feet, and nose, with bushy tail. As near as I remember, this dog's hair was smooth, but close, with prick or straight ears. At that time I thought it was the most beautiful dog I had ever seen. In size and shape it was a counterpart of a fair-sized colley. And I have heard of this dog being domesticated, but it always seemed inclined to go away. I may also state that I have heard them howling very often, but never heard them bark—in fact, I do not think they could bark. On the other hand, while at Waikawa, in the sixties, I have seen scores of the so-called wild dog, and killed some, as the place was full of them and wild pigs. But these were dogs, I think, that had got away from the whalers or Maoris, as there were all sorts among them. These dogs used to destroy the sheep wholesale, and many the night have I been camped out with kangaroo-dogs and gun trying to save the sheep from their rapacity. I would conclude by saying that I see no reason why the native Maori dog should not be in existence yet, in some of the back mountain-ranges."

Mr. Richard Norman, Albert Town, writes, "Mr. Robert

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* I have inquired of a friend on the staff at the British Museum about dogskins taken Home by Captain Cook: he says, "Have gone into the matter carefully, and find that no such skins or mats are in the Museum."—T. W.

Kidd, of Hawea, landed at the Bay of Islands fifty-seven years ago, and resided there a number of years, and started in life with Sir Donald McLean, and became in time a very expert Maori linguist. He tells me that the Maoris were never dog-fanciers; that there were a few dogs in every pa, which were of every colour and size, but the head, ears, eyes, and tail were very similar to those of foxes."

Mr. C. Goodall again writes, "I was in the Wairarapa in 1856 or 1857, when Mr. Kidd was living there. I had been in several Maori pas, and I thought the Maoris were very fond of their canine friends. From the Wairarapa I went to Rangitikei, and visited many pas, and found those swarming with cur-dogs of all kinds; but we have nothing to do with those dogs, as I found the same kind running wild down here. I think I have described the Maori or native dog which was to be found in the mountains thirty years ago, and I have not the slightest hesitation in stating that they were quite distinct from any other breed I ever saw."

"Digger," Preservation Inlet, writes, "Referring to the native wild dogs so well described by 'C.G.,' Hokonui, I believe I have some proof that they still exist. About the beginning of last August I saw a dog answering to the description given, as well as could be judged at a distance of 300 yards. It appeared about the size of a colley, but somewhat lanky; was all white excepting the lower part of the shoulder and upper part of the hind legs. These parts were covered with black or brown patches. When seen it was on the sea-shore some few miles from Puysegur Point lighthouse. The dog came out of a cave, and disappeared in the bush. No dog of the same description was, so far as I can discover, ever seen in these parts before. The country for many miles is covered with thick bush, and there is plenty of good living for dogs, in the shape of birds—kakapos, kiwis, penguins, &c. Would your correspondent, 'C.G.,' kindly state whether the native dogs are dangerous? Would they attack a person without provocation; or, if captured, would their skins be valuable—that is, to stuff?"

"C.G.," Hokonui, writes in answer to "Digger," Preservation Inlet, "I may say that I think this is the same breed of dogs described in a former letter. 'Digger' need not be afraid of their attacking him, or anybody else. As to the value of the skin, if 'Digger' could capture one of these dogs and preserve skin, head, teeth, and tail, they would be valuable to a naturalist, as in all probability it would decide this knotty question. I would remind 'Digger' that to capture one of these animals he would have to go about his work very cautiously, and mark which way the wind is blowing, as their sense of smell is very keen."

"J.B." writes, "On the 27th November, 1859, I came across two of these dogs, and killed one, a slut; and she was carrying seven pups. The dog escaped into the bush. These two were as large as any colley I ever saw. They were both cream-colour, the dog slightly darker and larger than the slut; but there was not a spot on either of them. In regard to their not being sheep-worriers in the true sense of the word, I think 'C.G.' is right, as they were several times among my flock before I killed the one, but not a sheep was killed outright on any occasion, though I had thirteen ewes and one lamb bitten one night, only four of them recovering. When the piece was taken clean out by the snap the sheep got better; but otherwise the place festered time after time until the sheep pined away and died. As to their being domesticated, the first of the kind I ever saw was in the Town of Leicester, in the Midland Counties of England, about the year 1854 or 1855, accompanying two chiefs who were touring the Home-country at that time; and the dog they had with them was exactly like the one I killed in the Umbrella Mountains in 1859. I quite agree with 'C.G.' as to their being a distinct breed."

"C.G." writes again, "I have only seen five of the native dogs. I do not think they were sheep-worriers. I was told by a shepherd about the time the rush to the Lake Diggings took place that this dog existed on Mr. Trotter's run. Not only this, but my informant stated that he had a young pup, which he tried to domesticate, but failed, as it got away. I have seen the Australian dingo, and this Maori dog is much like him, only not nearly so large. The dingo has a lot of wolf about his head, which the native dog has not. I may here state that I have seen a cross of the Australian dingo and the colley working sheep beautifully on the Blue Mountains, close to the Pomahaka, years ago."

I can also give evidence on the capabilities of the half-bred dingo. A large reddish dog, with long hair and bushy tail, said to be a half-bred dingo by his owner, a shepherd to Mr. Joseph Pearson, then of View Hill, Oxford, Canterbury, was used as a sheep-dog.

You will remember in a former paper I spoke of little long-haired white dogs, which were often carried long distances by the Maori women when travelling on horseback. In a letter on various subjects, published in the *Hawke's Bay Herald* a few months back, Mr. H. H. Murdoch, of Hastings, says, "We have dogs of many breeds, and of no breed at all, from the fluffy little white nondescript which nestles in the bosom of the dusky *wahine* to the huge St. Bernard's," &c. Here is an independent observer who also has taken notice of these queer little dogs, which I think are remains of an old breed of Maori toy-dogs. There is no reason why the Maori should not have possessed dogs of different breeds, and of various shape and size. Their known fondness for pets, even of the bird kind, would indicate a probability of their controlling various breeds.

Captain Good sends me the following letter, dated Oeo, 1st May, 1891:—

"Dear Sir,—I have much pleasure in replying to your letter of the 17th ultimo, and in giving such information as I possess relative to the discovery of the skeleton of a dog some twenty years ago in the face of a cliff not far from the mouth of the Urenui River. The discovery was made by my sons, who were then small boys. Seeing some bones projecting from the face of the cliff, they casually mentioned the circumstance on their return home.

"Mr. Rowan, late 43rd Regiment, who was then on a visit at my house, and who took an especial interest in matters of the kind, went at once to the spot and dug the bones out. A skeleton of a dog was found, not in a cave, but in the hollow trunk of a tree, together with portions of coarse matting. The most curious thing in connection with the finding of this skeleton of a dog is, as to how it got there. This you will understand when I describe to you the geological formation of the coast-line near Urenui. The lower stratum is papa rock, or blue lias, evidently at one time submerged, from the number of shells found in this formation; upon this a stratum, 3ft. to 4ft., of gravel and quartz, water-worn; above this light-red porous soil for about 8ft.; upon this a foot or more of vegetable mould. Height from the sea at high water, from 20ft. to 30ft.

"The bones were found on the papa rock, next the water-worn gravel, and about 12ft. from the top of the cliff. The bones became exposed by the falling-away of the cliff, caused by the action of the weather and by the washing of sea-spray in tempestuous weather. This coast is continually falling away. In 1865 an old Maori told me that a pa which once stood on the south headland of Urenui River had been washed away. In all probability this skeleton of a dog had lain hidden for centuries—long before the Southern Ocean had been visited by Europeans—and goes to prove that the people who then occupied New Zealand were possessed of dogs—domesticated dogs, beyond all doubt, as plaited matting was found with the skeleton.

"As I said before, how did the bones get where they were found? I have a theory, which may be taken for what it is worth, which is this: In former times a Maori would for some reason or other bury a dog in a hollow tree, or at the foot of a tree—a ceremony to make the tree, or the land on which it stood, *tapu* or sacred. It is possible that the tree, being on the banks of a river, became undermined, and, falling into the water, was carried to sea and thrown on a boulder-bank; afterwards came the upheaval—the cliffs of papa rock being at one time the bed of the ocean. The upper strata can only be accounted for by volcanic agency. The natives have a tradition of both Tongariro and Taranaki being active.

"With respect to Mr. Colenso's theory of the native dog, I think he must be in error. I have been in New Zealand since 1845, and knew, or did know, every breed of dog in England, and owned at various times different varieties. The terrier, hound, pointer, have ears lying flat with the face. The greyhound and sheep-dog have ears with the front slightly raised, but the tips falling, not pricked or standing upwards. Now, the dogs I saw with the natives in 1845 could not have been produced by any English breed of dog. They were about the height of an English terrier, rather long, tail drooping, colour whitish-yellow inclining to brown on the back, coat long and straight, nose pointed, and prick-eared. I recollect being so struck at their appearance that I inquired what they were used for, and was told that they hunted the kiwi and weka, and their skins were used for making mats. I saw some years ago a native wearing a dogskin mat of a whitish colour, and another native with a mat made from dogs of different colours, the mat being striped white-and-brown.

"The sheep-dog could not have been introduced into New Zealand many years, certainly not a hundred. But, for argument's sake, the particulars of breed would not die out in a hundred years; it would show itself in its markings and in the general structure of the animal. Could the Maoris have brought the dog with them from Mangaia or Rarotonga? The Rev. W. W. Gill, B.A., in his book on 'Savage Life in Polynesia,' speaks of two chiefs, Tawai and Tekarakau, being expelled from Mangaia some two hundred and fifty years ago, but does not state that they took dogs with them. They set sail from Mangaia in two large double canoes. These canoes arrived safely at New Zealand. Old Maoris give names of other canoes which came to New Zealand at a much earlier period, thus accounting for the numbers of people seen by Captain Cook in 1777.

"The natives on this coast have no other name for dog but 'kuri,' and before the arrival of the horse this term was not used to denote any other animal. A horse is now sometimes called 'kuri,' a rat 'kiore,' and a pig 'poaka,' from the English 'pork.' *Waka* or *vaka*, at Mangaia, Rarotonga, and Samoa, means simply a canoe. *Whaka* is a prefix to a verb. *Kau* and *kaukau*, to swim. *Kahorekau* is a superlative negative, and *korakau* sometimes spoken in praise and sometimes in derision of person or thing, but hardly translatable. But *kau* in any sense cannot have the remotest relation to an ox or a cow. Before their introduction by Europeans cattle were not known to the natives of New Zealand. A fully-tattooed Maori will have the whole face covered from forehead to chin with tracings or lines forming distinct patterns, each pattern having a name.

"Taikomoko, half-brother to Te Whiti, a man about sixty years of age, knows well the native dog, and says they were brought to New Zealand by the Maoris from the islands. He says they were quite distinct from the present wild dog in this Island, which is the European dog gone wild. The real native dog is of a whitish or light colour, small, with long straight hair. Their skins were formerly used for making mats, and the hair in ornamenting the sharp end of the *taiaha*. He says the native dog has been extinct on this coast since 1860, but yet may be found on the upper Waitara, Ngatimaru country, or at the remote settlements between Mokau and Kauhi.

"The skull of the dog found in the cliff was sent to Dr. Hector, who pronounced it the skull of a Maori dog.—Yours truly,

"Thomas Good."

Captain Good is in error in respect to the ears of terriers, which are much similar to those of the sheep-dog; but, owing to the custom of trimming, the dog is seldom seen with ears in their natural form. All small puppies of any breed have drooping ears flat to the head.

In the above letter Captain Good describes a small dog or breed of dogs. But, supposing you see a man accompanied by terriers, that is no proof that all dogs are terriers; and, as before pointed out, Maori tradition describes breeds of dogs under different names. For instance, Sir George Grey tells the following story in "Polynesian Mythology:"—

"Houmaitawhiti, an ancestral hero of the Maori, who resided at Hawaiki, had a dog named Potaka-tawhiti. This dog offended the high-priest Uenuku, and was killed by Uenuku and Toi-te-hautahi. This act was revenged by Tamatekapua and Whakaturia, and a great war began in Hawaiki, which was the cause of the great migration of the Maoris to New Zealand."

"A famous native dog or breed of dogs, called *mohorangi*, were brought from Hawaiki in the canoe Mangarara by Tara-whata, and put on the island of Whanga-o-keno. Some time afterwards this dog or one of them was seen by Ponuiahine, the daughter of Kaiawa; but she, not having gone through the proper religious ceremonies, and daring to look with unveiled eyes upon the sacred dog, was turned into a grass-hopper." (J. White's "Ancient History of the Maori.")

It is notable that *moho* is the name for dog in Marquesan. Mr. Charles Herbert tells me that the Maoris at Wainui, near Cape Turnagain, on the East Coast, had no individual names for their dogs formerly, but gave a general call of "Moi, moi." This surprised me, as, some ten years ago, when a number of Taupo Maoris were shearing my sheep, I one day called "Moi, moi," to one of their dogs, and this caused a laugh among the Maoris. On asking for an explanation of their merriment the answer was that it was ridiculous to call "Dog, dog." But these Maoris had adopted most of the customs of the pakeha.

Waero is the tail of a dog, also a mat ornamented with dogs' tails. It is remarkable that the dogs' tails in Mr. Skinner's mat are some of them short, as if from dogs naturally having bobtails. It is possible such may be the case, for the Maori would preserve the dog's tail for the sake of the growth of hair of an extra length; and I feel convinced by further study of European languages that in olden times the European dog was frequently born with a short tail. I will have another trial to prove this: "*Coot* (Celtic) (Middle English, *cote, coote*), a water-fowl: Anglo-Saxon, *cyta*, a kind of bird: Dutch, *koet*, a coot (probably Celtic): Welsh, *cwtiar*, a coot (literally a bobtailed hen, from *cwta*, short, bobtailed; and *iar*, a hen); *cwtiad, cwtyn*, a plover: Gaelic, *cut*, a bobtail: Welsh, *cwtau*, to shorten, dock = *cut* (Celtic): Middle English, *cutten*, a weak verb: Welsh, *cwtau*, to shorten, to dock. Compare Welsh, *cwtws*, a lot, with Middle English *cut*, a lot: so, also, Gaelic, *cutaich*, to shorten, cut short—chief form, Welsh, *cwt*, a tail; Gaelic and Irish, *cut*, a short tail; Cornish, *cut*, short."—(Skeat.) Here is fair evidence that the dog was sometimes born with a tail which looked as if cut or shortened.

The derivation of the word "to cut" I consider is Latin, *cos, cotis*, a flintstone; *cautes, cautis*, a rough pointed rock—which were used by the savage or primitive man to cut and chop with in the place of knife or axe. Or perhaps a nearer word for flint might be found in one of the cognate languages.

Mr. A. R. Wallace gives twenty words as different names for dog used by the natives of the Malay Archipelago, which are—*a'ujing, asu, muntóa, kapuna, ungu, assu, aso, káso, iyór, gáso, asúa, a'su, wasu, yás, nawang, kafúni, afúna, how, yes, yem.* Some of these names are probably phonetic, for among the various names for cat are—*miaò, tusa, ngeäu, miau, nāo, mau, maōw, mar, shika*, &c. These names are decidedly derived from the call of the animal. As Maori names for the (barking or) howling of the kuri, Mr. Tregear gives, "*Tewe*, to yelp as a dog. *Ao*, the bark of a dog: 'Katahi ka whakao mai, "Ao! ao! ao! ao! a-ao-o!"' ('Polynesian Mythology,' by Sir G. Grey). Cf. *au*, to bark as a dog; Tahitian, *aoa*, to bark or howl; Hawaiian, *aoa*, to howl as a dog, to wail for grief for lost friends." These words are evident imitations of a dog howling, or having a *tangi*, and it is probably a misnomer to use the translation "to bark." Myself and correspondents are agreed that the native dog did not bark, and none of the writers were previously aware of my own experience with the native wild dog of the South Island.

Darwin gives some curious instances on this point. Certain dogs kept at the Zoological Gardens, in England, which in their former state did not bark, afterwards learnt to bark from hearing dogs do so which were kept in adjoining enclosures. So it is quite possible for us now to find that the true Maori dog has also learnt to bark from hearing his European relatives do so. So, in searching for the Maori dog, this should be borne in mind. On the other hand, Darwin mentions certain European dogs left or escaped on some island, and which were accustomed to feed on the shellfish along the sea-shore at low-water. The descendants of these dogs had entirely lost the faculty of barking. As New Zealand was formerly only stocked with birds and rats, which were an easy prey to the kuri, barking or baying would be of no service to the dog, and would be lost from disuse. That is with the exception of the moa; and there seems to be no Maori tradition mentioning the use of the dog in catching this bird. It would be interesting to know whether the original dingo of Australia was accustomed to bark, for probably these dogs would be used to bring the emu to bay. I rather fancy they did not bark, but I have no authority to refer to. It is a great pity that travellers in a new country take so little notice of ordinary or domestic animals, which are the first to die out or be modified by interbreeding with their imported relations; with the result that those who come after them addle their brains in a difficult search after relics of the past.

The Maoris of the present day are not reliable sources for information on the kuri. Note that after New Zealand had been occupied by Europeans for fifty years or more the kiore, or native rat (*Mus maorium*), which was said all that time to be extinct, is now proved to exist both in the North and South Islands of New Zealand, and possibly two distinct species, as is the case with many of the birds of the two Islands. This is a reddish-grey rat, touched with black hairs. Then, in the North Island we also have the Polynesian black rat (*Mus rattus*). Of these the Maori and early settlers took no account. The fact is, a rat is just a rat, and nothing more, to the casual observer. And with the supposed extinct kuri it is probably the same. Having now proved beyond doubt that we have the original rat living side by side with the imported Norway rat (*Mus decumanus*), there is every encouragement to observe and search diligently in expectation of finding in a supposed Maori cur a pure descendant of the original kuri.

Some Maoris told me the native name for the land known as Glenshee was Kuripaka, the home or place of the brown dog. It is difficult, unless a good Maori scholar, to be certain in matters of conversation through an inexpert interpreter. My reason for doubting is this: Mr. Tregear gives *kiripaka*, a flint; and *kirikiri*, pebble-stones, gravel. Now, although at Glenshee there is no flint or obsidian, still a remarkable outcrop or wall of conglomerate, composed of water-worn stones, few of which reach the size of a man's fist, firmly cemented together and superimposed on the papa rock, is a notable feature of the country, and might be referred to by the Maoris. They themselves, speaking only from tradition, might slightly confuse the name. But I prefer to take it as evidence that a brown or reddish-brown dog did at one time live there. The Maori tried to explain the colour by referring to the horse; but whether a chestnut, a brown, or a bay horse was meant I could not decide.

I might state that the wild dogs seen by myself, with the exception of one, were remarkably short in the hair—more so even than a cat, as you will see from the use a dogskin was put to. I had a close-fitting tubular case made from it for my telescope, hair outwards, and a cap of the same to slip over the open end of the tube-formed case. Circular pieces of dogskin, with the hair outward, were compactly sewn into either end of the case, and when made the hide was stiff as leather, and the hair short and close, never rumpling or roughing up, though in constant use. This, if you consider it, gives proof of the short and close character of the hair, and is remarkable in dogs living exposed to all weathers in an alpine region.

Few people are aware that the original feral ancestors, or, rather, the descendants of the primeval dogs from whom our domestic dogs are derived, still live in a wild state in India, the scientific name for them being *Cuon rutilans*, the meaning of which is, a dog of a reddish colour, inclining to golden-yellow. From their being every one of the same type and colour, there is evidence that they have been long feral, and probably they are the exact counterpart of the first dogs existing. It is notable that they have no white tip to the tail, which is a common feature with the domestic dog.

The following is a good description of the native dog of India, given by a correspondent under the signature "Shikari," in *Land and Water:* "The general colour is a bright rusty red or rufous fawn, paler beneath; tail moderately brushed, reaching to the heels, usually tipped with blackish; limbs strong; body lengthened; head and body 32in. to 33in., tail about 16in.; height, 17in. to 20in. They generally hunt in packs of from five to twenty, and appear to run by scent as well as sight, and are nearly mute, except an occasional low whimper. Such are their speed, strength, and persevering endurance, that they are formidable enemies to all the deer tribe, and they will run down and kill even such large animals as the sambur (*Rusa aristotelis*) and nilghau (*Portax pictus*), their usual mode of attack being snapping and tearing at their victims' belly and flanks till they tear them open and the entrails protrude. They exhibit but little fear of man, and many are the instances recorded of their calmly sitting down and staring at the sportsman who has met them. I have personally several times come across these jungle poachers, but never bagged one, as with one exception I did not fire at them for fear of disturbing the jungle. I need not have had such scruples, however, for I invariably found the jungle that harboured them was deserted by all nobler game. I was once a spectator of their mode of hunting. I was out one time on a sporting trip during very hot weather in Berar, and during a morning stroll my attention was attracted by a low whimper. Looking in the direction from which the sound emanated, I saw a little four-horned antelope (*Tetraceros quadricornis*) defending itself against two wild dogs. The little antelope would make a short run and then pull up facing its assailants, one of whom would make a snapping feint at its front whilst the other made snatches at the antelope's flanks and quarters from the rear. The little antelope displayed wonderful agility, bounding round and round and evading its tormentors. This went on for some little time, till I put an end to the entertainment by firing at one of the dogs—which, alas! I missed. The two dogs looked towards me and then trotted sulkily off, whilst the antelope disappeared in the opposite direction. A friend of mine who was with me shot two of these wild dogs a few days later, and so I had an opportunity of examining them closely; and very handsome brutes they were. We had reliable news of tigers in this bit of jungle, but never came across them, which strengthened me in my belief that *Cuon rutilans* had something to say to their absence."

A writer in the *South of India Observer* a few years ago gave a graphic description of a sight witnessed by a friend of his in the Wynaad jungle. He says, "My friend was passing through the jungle in the Wynaad when he heard close to him a curious snapping noise. He fancied it was parrakeets or some such birds having a row amongst themselves, but, on taking a few steps forward, to his no small astonishment he found himself in the presence of a tiger surrounded by a pack of wild dogs snapping and snarling at him, but at the same time keeping well out of reach of the terrible fore-paw. The tiger was lashing his tail from side to side and showing great excitement, or, as I feel inclined to put it, 'funk.' He was standing with his back to the new arrival, and consequently did not see him; but, as he was no more than 30 yards distant, my friend wisely decided on beating a retreat, shortly returning, however, with some of his friends, when they found the tiger had disappeared, but the pack of wild dogs were feasting on a sambur fresh-killed by the tiger. There was no mistake about this, for the marks of the tiger's teeth were distinctly visible in the throat of the deer. Ten dogs were counted, but there might have been, and probably were, more. This is certainly a proof that wild dogs will attack a tiger, not for the purpose of killing him, but to drive him away from his prey. Though the wild dog does not throw his tongue when in chase, beyond giving a low tremulous whimper, yet he will bark and howl at night, as most sportsmen who have shikared in the East know full well. By no means a shy animal, he is at times even bold and saucy in his demeanour. As a dog he is decidedly handsome, and as good-looking as the *best colley*; but from a sportsman's point of view he is a decided scourge, and we may rest assured that, looked at even from the most favourable point of view, he is beyond doubt a most destructive poacher, and does infinite harm not only by the numbers of game he kills, but by the numbers he scares away. My parting advice, therefore, to all sportsmen is to slay *Cuon rutilans* without compunction wherever they may meet him, and by any means, whenever they have the chance." You will notice that this writer also makes comparison with the shepherd's dog, although he must have been more conversant with the forms and habits of sporting dogs.

The scientific name for the domestic dog is *Canis latrans*, or the barking dog, barking being its distinctive feature as compared with other Canidæ—the wild dog, wolf, jackal, fox, &c.

Art LII.—*Discoveries of Moa-bones.*

By H. C. Field.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

In October, 1890, when visiting at my eldest son's house, at Waikanae, I found the remains of a very large moa within about six or seven hundred yards of the house. They consisted of the large hinder portion of the back, the tip of the lower jaw, and fourteen vertebræ, as well as the upper bones of the legs. The bones had been exposed by the drifting-away of the sand in which they had been buried, and of the leg-bones only the tops were visible, so that I had to scrape away the sand with my hands to remove them. In fact, the large backbone was held down by them, and thus was much damaged by being trampled on. The rib-bones were also there, but so broken by the feet of the stock, which go to drink at the adjoining lagoon, as not to be worth picking up. The bones were so large that I felt almost doubtful whether they could be those of a bird. The large backbone is 14½in. long by 8¾in. in extreme width, and the leg-bones 13¼in. long by 6¾in. in circumference at the smallest part. Along with the bones, and within a yard or two of them, were bits of hoop-iron, broken bottle-glass of two colours, two bits of earthenware of different patterns, and two bits of clay tobacco-pipe. There were also a number of pieces and flakes of stone. Though such things are often found thereabouts in company with moa-bones, it obviously does not follow that they have been deposited at the same time. They may have been dropped when the sand was at a higher level, and have sunk to that of the bones as the sand drifted away. In fact, owing to the long residence of whalers in that locality, the whole ground is more or less strewn with such articles.

On the 9th of this month (October, 1891) I visited the spot again, thinking that possibly the long bones of the legs might have become exposed. I saw that they had evidently been so, and that some one had carried them away; for I found the lower leg-bones, all the toe-bones, and the long thin bones from beside the large bones of the legs. On inquiry of my son and his men, I learnt that Mr. S. H. Drew, of Wanganui, who was at my son's place at Easter, had picked up some large moa-bones, and I naturally supposed that they were the tibiæ of my bird. I learn, however, that his bones belong to a smaller bird, and were found in quite a different direction from the house. Thus there have been the remains of two moas found within a few hundred yards of each other at

Waikanae, in the course of six months. I ascertained subsequently that the tibiæ of my bird had been picked up by my second son, who has sent them to me, so that I have now the nearly complete skeleton. In the case of the bones found by myself, their position indicated that the bird had crouched down, with its face towards the west, and had died and been buried in that position. The Waikanae Maoris, however, say that their fathers, up to within the last fifty or sixty years, used to catch young moas and bring them up as pets. If this was so, it seems very likely that the bird whose remains I found may have been one of these pets, and may have been actually interred by its owners. A Maori mode of interment was to place the body in front of an advancing sandhill, and shovel down some of the sand to cover it, leaving the winds to increase the depth of sand over the corpse. The position of the upper bones of the legs showed clearly that the bird had been covered up by sand without falling over on to its side, and this looks as if it had been purposely interred. The position of the lower leg-bones and of the toe-bones also corresponded with that which they would have occupied if this were the case. It was evident, from their relative position, that the bones had never been exposed, until lately, since they were first covered by the sand; yet within about 6ft. of them, and at a slightly lower level, I picked up on the 9th instant a hoop-iron adze $3\frac{1}{2}$in. long by $1\frac{1}{2}$in. broad. I am quite certain that this tool was still buried in the sand last year, or I should have seen and secured it, and probably it had not become visible even when the finder of the tibiæ picked them up, or he would have seen and taken it too. My son would have been sure to do so. This seems to make it certain that the bird was alive after Captain Cook anchored in Queen Charlotte Sound—or how should such a tool be buried at the same level as the bird's leg-bones?—and would even point to a more recent date, when iron adzes became so common as to be dropped about heedlessly. The lower leg-bones are $15\frac{1}{4}$in. long, $5\frac{1}{4}$in. in circumference at the smallest part, and $4\frac{5}{8}$in. across the toe-processes; and the tibiæ 27in. long by $5\frac{3}{4}$in. at the smallest part. The spot where the bones were found was close to an old Maori burial-place, where, a few years ago, there were human skulls and bones lying about pretty plentifully, owing to the sand having drifted off them.

P.S.—24th February, 1892.—As Mr. Drew knew that I should be sure to go to Waikanae during my present visit to Wellington, he asked me to examine the spot where he obtained his moa-bones, and bring him any others that might be now exposed. I accordingly visited the spot on Monday, and found it to be an old kitchen-midden, which was being exposed by the drifting-away of the sand. The bones, of which I found several, are those of a bird which had been cooked and eaten, and they are much broken, and far more decayed than those of my bird. Some of them, however, seem to have been cut to pieces with a sharp implement like a tomahawk, as I do not think breaking the bones with a stone club would have fractured them so cleanly, and stone tools of other kinds would hardly have broken the bones at all. Along with the bones, too, I found broken bottle-glass of two colours, and two pieces of bones of animals, which would indicate that the remains were of comparatively recent date, though both bones are much decayed.

In the afternoon I passed by the place where my moa-bones were found, and my companion, Mr. L. Anderson, picked up a portion of some large animal's jawbone (apparently that of a young ox or horse, as the bone is much decayed), containing three molar teeth, within a few feet of where I had found the bones. A large series of kitchen-middens extends for fully a mile south of the Waikanae River, and these are constantly being disturbed by the wind, so that their contents are scattered over probably twenty or thirty acres of ground. Most of these middens were certainly in use during the whaling days, as all sorts of European articles are found in them. For example, we found on Monday part of a school slate, no doubt imported by the missionaries, and a pair of scissors—articles which indicate a date certainly subsequent to 1830, and probably some years later—as well as hoop-iron, iron bolts, sheet-copper, and fragments of broken glass, crockery, and clay pipes. My eldest son, who has lived at Waikanae for many years, and taken notice of the drifting of the sandhills, regards the shifting of their position there as much more rapid than at Wanganui, and the date at which the kitchen-middens went out of use as very recent indeed. There was a great native-fight at a place called Te Uruhi, a little south of the mouth of the Waikanae River, between the years 1835 and 1840; and up to that time many Maoris resided there, and no doubt helped to form the middens, which contain a curious mixture of European articles with old Maori ones, such as stone tools, obsidian flakes, and bits of carving.

Moa-bones have within the last few years been found in the bush ten miles inland of Hawera, and in the Momahaki, Mangawhera, and Kiwitea valleys, proving that these birds were not confined to open country, but penetrated far into the forests. At Upokongaro, near Wanganui, a large number of bones were lately found in draining a boggy spring, in which the birds had evidently sunk and been smothered. The bones must have belonged to at least a dozen birds, as the tibiæ vary in length from 34½in. to about 9in.; and the difference in the relative length and thickness of corresponding bones shows that the birds must have been of at least two varieties. Among the bones are a lower jaw and part of the upper one of the same bird. Moa-bones have also just been found among the sandhills near Nukumaru, but so decayed that they would not bear handling. In fact, people are hardly aware how common such bones are, as they mistake them for those of cattle or horses, and thus many finds are never reported.

ART. LIII.—*On the Shifting of Sand-dunes.*

By H. C. FIELD.

[*Read before the Wellington Philosophical Society, 8th July, 1891.*]

IN reading the Transactions of the New Zealand Institute, one often sees mention made of the shifting of sand-dunes through the action of the wind; but, except in a paper by myself, read in Wellington in December, 1876, I have never observed any estimate of the rate of such movements. I then judged the rate to be about a chain in ten years on the north side of Cook Strait, but it probably varies in different parts of the colony; and I think it would be well if persons in various localities would note the rates which they have had opportunities of observing, as we might thus get tolerably accurate data from which to estimate the dates of past events, particularly that of the extinction of the moa, which, so far as I can judge, has varied very greatly in the several districts. Possibly, therefore, the following results of forty years' observation on the coast from Paikakariki to Patea may be worth recording.

My first experience of sandhills, on any scale, was when I walked from Wellington to Wanganui in 1851. I had seen such hills on a small scale in several parts of England, but had no conception of their ever attaining the dimensions which they do in New Zealand. As, however, I was a new-comer, and there were so many novelties, in the way of strange birds, shells, fish, vegetation, scenery, &c., to engage my attention, the extent of the sandhills was the only thing which I particularly noticed. When I again travelled by the same route, in the following year, I found a very noticeable change at one point—viz., Otaki. In 1851 the river had run northwards, parallel with the beach, for about a quarter of a mile, before it entered the sea, and the accommodation-house kept by the ferryman was on the south or Wellington side of the river.

In 1852 the river had broken itself a fresh course straight out to sea, leaving the accommodation-house so far from the river's mouth that it was very difficult to attract the ferryman's attention by shouting. On inquiry, I learned that the drifting of the sand had left a hollow opposite the point at which the river bent northward, and that consequently a flood had broken through. On this same journey, I observed that the mouths of the Ohau and Waikawa Rivers had also shifted, so as to be farther apart than in the previous year; and that the track leading from the beach to Putiki Pa (in those days we had to follow the beach nearly to the mouth of the Wanganui River) had also changed materially in appearance, though I could hardly describe the change, further than that the hollows through which it ran had shifted their position.

At Waikanae, at the dates which I have mentioned, there was a constabulary station a short distance from the river's mouth, on the south side. A nice grassy flat served as a parade-ground, and the men lived in whares on both sides of it, while the commanding officer's house faced the upper end. I did not pass the spot again till I went to Wellington by coach in 1868. I was only there for the few minutes that were occupied in changing horses; but the place seemed entirely changed. The station was gone, and, though there was a small hotel, it did not seem to stand on the site of the former officer's residence. I have since learned that I was right in all this. The river by this time had entirely changed its course for a considerable distance inland; the new channel had cut right through the old parade-ground; and the only trace of the officer's house consisted of some narcissus roots which had been planted in the garden, and which still struggle up through the sand year after year. Since 1880 the hotel, as such, has ceased to exist, and has been occupied as a residence by my eldest son, whom I have visited once or twice in each year, and so have observed the changes that have latterly taken place. A sandhill 30ft. to 40ft. high, which formerly stood almost behind the hotel, and which, from the immense amount of pipi-shells which it contained, formed a very conspicuous landmark for entering the river, has been entirely blown away, and its contents are now scattered over nearly flat ground. An isolated hill nearly as high, which stood close to the beach on the south side of the river, and behind which there was a hollow through which the coach was sometimes driven, has also almost been blown away; and where the track passed there is now a damp sand-flat, some eight or ten chains wide, arising from the other sandhills behind it being blown further inland. A very appreciable portion of this flat occupies the site of a shallow lagoon, the size of which has been proportionately reduced.

At the back of the hills a considerable extent of what was good grass-land is now buried under sand.

In the course of these changes many long-buried articles have come to light. Not only have old kitchen-middens and immense numbers of old cooking-stones been exposed, but at one place what appeared to have been an ancient Maori cemetery was laid bare, and a good many skulls were picked up and carried away by visitors. Very many moa-bones—some broken and bearing the traces of fire, and others forming more or less perfect skeletons—have been exposed, as well as large numbers of obsidian flakes, adzes (more or less perfectly finished) of greenstone, chert, obsidian, and hoop-iron, intermixed with other articles of unquestionably European origin.

On my last visit, in October, 1890, I found the remains of the largest moa I ever met with about a quarter of a mile south of the river. I secured the pelvis, tarsi, and eleven of the vertebræ, and, had I had means of digging, should no doubt have got the remainder of the leg-bones, as the remains appeared to be on the spot where the bird had lain down and died. The rib-bones were there, as well as fragments of the skull, but all so broken by the trampling of men and animals as not to be worth picking up. Alongside of the bones, however, and within a yard of them, I picked up two pieces of hoop-iron, three of broken bottles, of which the surfaces are dulled by the action of the sand, two bits of crockery of different patterns, and two of very old clay tobacco-pipe. Of course it does not follow that these articles were contemporary with the bird—they may have been dropped at a higher level, and have sunk to that of the bones as the sand drifted away; but the frequency with which such things are found in company with moa-bones in this part of the colony certainly seems to bear out the uniform statement of the Maoris that the last of these birds hereabouts were destroyed by means of firearms, about the time when Christianity was introduced.* I have

* Shortly after this paper was read, the drifting-away of the sand enabled my son and myself to get the lower leg-bones, and all those of the feet. Close to the last, and at a slightly lower level, I found a small hoop-iron adze, which seems to indicate that the bird must have been alive after Captain Cook visited that locality, and probably after whalers were located there. Later still, the further drifting-away of the sand exposed, just above the site of the moa-bones, and at a higher level by 2ft. or 3ft., a fragment of a jaw of some large animal—apparently ox or horse—containing three molar teeth. This fragment is actually more decayed than the moa-bones, but this may arise from its having belonged to a young animal. I also found some moa-bones in a neighbouring kitchen-midden, which, from the straightness and cleanness of the fractures, seem unquestionably to have been cut to pieces with a steel weapon. The drifting of the sand seems far more rapid at Waikanae than at Wanganui, owing, probably, to the winds being stronger so near the narrow part of Cook Strait.

been repeatedly assured by old Maoris that they had eaten the flesh of the moa in their youth; and they seemed well acquainted with the habits of the birds. They have a proverb, "*Huna i te huna a te moa*" (Hidden with the hiding of the moa), to express a clumsy attempt at concealment, as they say that the birds, when hunted, would often try to hide themselves among bushes quite inadequate to enclose their bodies, just as the ostrich is said to do.

The Waikanae natives assert that their fathers, even sixty or seventy years ago, not only ate moa's flesh, but that they also used to catch young ones and keep them as pets. Mr. Wilson, too, who kept the hotel, and who came to the colony about the year 1830, always asserted that he had not only seen live moas on the Nelson side of the Strait, but that, on one occasion, he and his mates caught a young one and sent it as a present to a gentleman at Sydney, though he could not tell whether it reached there. I have also apparently reliable evidence of the birds having been both heard and seen alive in the neighbourhood of Collingwood as late as 1857 or 1858, and of one being cooked at a Maori feast at Taupo not long previously.

Besides the instances mentioned in my paper, read on the 22nd January, 1882, of gigantic birds, answering to the description of moas, having been seen by settlers in this part of New Zealand, I lately heard of a man who asserts that he saw two of them a few miles inland of Marton within the last thirty years. In all these cases the reports have come from ignorant labouring-men (newly-arrived immigrants), who were not likely to have heard of moas.

When I came to Wanganui, there were several young totara-trees on a flat below Putiki Pa which the Rev. R. Taylor told me had been planted to mark the sites of Maori graves. They were at that time fully 30ft. high, but when I surveyed the place in 1863 they were so deeply buried in an advancing sandhill that only a few feet of their tops were visible, and even these have long since been covered up, and the foot of the hill is two or three chains beyond them. In the same way I saw a nice patch of pine-bush on the late Captain Rhodes's run, south of the Turakina River, which in 1858 was being buried in sand, and which a few years later had quite disappeared.

On the north side of the Wanganui River, just below the town, there was, in 1851, a large and high sandhill, on which the artillerymen stationed here used to set up their mark when they practised with cannon and mortars from the old York Stockade. This sandhill has long since been nearly all blown into the Wanganui River, to the detriment of the navigation, and its site is now occupied by the flat on which the new gaol and sundry cottages stand. Farther north there used to be two tracks leading to the mouth of the Kai Iwi Stream. I used generally to travel by the inland one, as the other, though shorter, passed for considerable distances over drift-sand. I used, however, occasionally to go that way, and always found a difficulty in following it, owing to the changes that occurred in the position and form of the sandhills. About ten years ago, I tried in vain to trace the old route, which had ceased to be used, through the enclosing of the land. I found that several lagoons, by the position of which I had thought to fix the line of the track with approximate accuracy, had been entirely filled by the sand, so that their sites could not be identified.

I have mentioned the manner in which the Otaki River ran parallel to the beach when I first saw it, and afterwards straightened its course. The Wanganui has a similar bend to the northward as it approaches the sea; and since 1851 the actual mouth of the river has shifted several hundred yards farther north, what is known as the South Spit becoming lengthened in proportion. Two or three times the river has actually broken over the spit when the drifting of the sand has formed low places; and our Harbour Board have foolishly spent thousands of pounds in raising these places—in resisting the efforts of nature to improve the navigation of the river, instead of being thankful for such assistance.

Between 1852 and 1856 I very frequently travelled up and down the coast between Wanganui and Waitotara, and, as the track at the Waitotara end passed for more than five miles across and among sandhills, I acquired a very accurate knowledge of the locality. As a rule, the changes were so gradual as hardly to attract notice, though occasionally, after a heavy gale, some of the sandhills would perceptibly shift their position, the alteration being marked by the fact that the forward end of the hill assumed a steep slope, which afterwards eased off under the influence of lighter winds from other quarters, and of the traffic along the route, which was very considerable.

I did not visit the locality again till I went out, a few days after the fight at Nukumaru, to point out to General Cameron a route by which cannon and carts could easily be taken from the Nukumaru camp to a point near the mouth of the Waitotara where it was easily fordable at low tide. On this occasion I was quite surprised at the changes that had taken place. Old landmarks by which I had been accustomed to steer my course had disappeared, and nice grass flats and Maori cultivations had been buried by the sand. I have visited the same locality on several occasions since then, and each time I have observed further changes. The trampling of the stock disturbs and breaks the surface-soil; drifting begins, and in the course of a few years what has been a hill covered with fern and grass becomes a barren waste of shifting sand, which overwhelms the good flat land to leeward of it. Thus the area of the drift constantly increases, and, as the old hills shift their position, kitchen-middens and other buried articles are exposed. It was in a hollow thus formed by the drifting-away of a sandhill that I found the moa-bones, with unmistakable tomahawk-cuts upon them, in 1881; and I have never since visited the locality without finding more moa-bones.

About the year 1853 the Waitotara natives told me that their river formerly flowed out to the sea two or three miles south of its present mouth. At the time I felt very doubtful as to the correctness of the statement, as bare sand filled up what they pointed out as the old course to a height of considerably more than 100ft. Even the name "Tomotomo Ariki" (Lordly Entrance) by which they called the place failed to convince me. I have since, however, found that they unquestionably spoke the truth, as the drifting-away of the sand has left the whole course of the river perfectly well defined, though at a height of at least 80ft. above the present channel. This is only one of many instances in which I have found the Maori tradition of ancient geological changes perfectly reliable, though the changes must have occurred ages and ages before they came to New Zealand; and thus they must have received the traditions originally from their negretto ancestresses.

Nearer this way, the route from Wanganui to Waitotara used to run ordinarily for about five miles along the sea-beach. At high tide, however, the sea came right up to the base of the cliffs; and it was then necessary to follow a track which led among sandhills upon the cliff-tops. At one point, just to the northward of the Okehu Stream, on the land now belonging to the Hon. R. Pharazyn, the track passed just to seaward of a very high bare sandhill, which was known by the name of "Popoia," and is so marked on the original Waitotara map. I often wondered at this particular drifting sandhill having a special name, as such a thing is not usual. In 1871 I had to lay off a road just inland of it, and it then struck me that the hill was far lower and flatter than before, and that it was encroaching on the good soil farther from the sea. A few years later I found that it had not only buried all Mr. Pharazyn's land immediately inland of it, but that it had crossed his boundary-fence, and was covering up Mr. J. Handley's land as well. The latter gentleman has checked its further progress in his direction by planting a sand-grass, but the hill has travelled onwards towards the Okehu Stream, and has left a flat where it formerly stood. This flat has a hollow, evidently an ancient watercourse, running along it towards the Okehu; and near the head of this hollow the site of an ancient pa has been exposed.

I visited the spot several months ago, and found that there were all the ordinary traces of Maori occupancy, in the shape of old cooking-places and cooking-stones, with bits of bones and shells, flakes of obsidian, and damaged stone implements lying about (any perfect ones had no doubt been picked up); but what was particularly noticeable was that the sites of the old huts were defined not only by the stumps of the uprights of the huts, or holes in which those uprights had stood, but by the receptacles for the hot embers used to warm the huts. These receptacles differ utterly from any which I ever saw elsewhere. As a rule, these are merely shallow round hollows in the centre of the floor, but sometimes are surrounded by a ring of long oval pebbles sunk in the floor to form a margin. In this case, however, the arrangement was far more elaborate. On the beach at the mouth of the Okehu, and thence to the Kai Iwi, there is a seam of thin white stone, resembling the Yorkshire flags used for footpaths in London and elsewhere. Pieces of this stone had been carried up from the beach, and each had had one edge dressed straight, and its arrises rounded, after which they had been sunk in the floor, so as to form oblongs of about 18in. by 12in., standing up 1in. or 2in., and nicely level on top. The neatness of the arrangement, and the trouble taken to effect it, were very noticeable; and there were at least a dozen similarly formed. There had evidently been far more, as the stones which had formed them were lying in groups, having been kicked out by the stock, or pulled up by mischievous Europeans. I have no doubt that Popoia was the name of this ancient pa; and that hence it came to be applied to the sandhill by which the pa was overwhelmed. As invariably happens in cases where an ancient surface is thus exposed, the soil had entirely disappeared. It might have been supposed that the pa stood on a flat of bare clay but for the fact that there were the fern-roots and roots and stems of shrubs lying about to attest the former existence of soil. It seems strange that drift-sand should have the property of apparently absorbing and destroying vegetable mould in this manner, and making fertile land barren.

It was on the top of the Popoia sandhill, as it drifted away, that Mr. Handley found a curious object, now in Mr. Drew's museum at Wanganui. It is of dull obsidian, about the size of the implement known as a bed-key, and formed, in the same way, into three arms radiating from a common centre. Each arm is about as thick as a man's finger, and they are beautifully evenly chipped, but not ground or polished. The use or object of it is unknown: in fact, the only reasonable suggestion that I have ever heard respecting it is that it may have been formed by some early Christian convert as an emblem of the Trinity. Whatever its purpose was, it is an article that I could hardly have supposed it possible to form in such a material, and indicates wonderful skill on the part of the person who made it. If any similar article has been found elsewhere, possibly the above description may lead to its being mentioned, and its use ascertained. Possibly, too, the above notes may elicit similar ones from persons in other parts of the colony, and thus useful data may result.

At the commencement of this paper I have referred to one which I sent to Wellington in 1876, describing some ancient *caches* which the late Mr. M. V. Hodge and myself had examined on the top of the cliffs north of the Wanganui River, and the articles found in them. Among these were pieces of silicified wood, for the existence of which I was unable to account, though, from the same substance having been met with in company with stone tools elsewhere, it seemed evident that the Maoris used it or valued it in some way. The late Mr. J. White afterwards told me that it was obtained from silicifying springs in the volcanic regions, inland, and was highly prized by the Maoris, who used it for giving the final polish to greenstone. He said they called it "whakaue" and "te ika a Ngahue." When I visited the Terraces at Rotomahana, just before they were destroyed, I found that the object called "the boar's head" was actually the end of the trunk of a very large silicified tree, which was being gradually enclosed in the substance of the White Terrace.

Since 1876 I have several times heard of stone adzes and other articles being picked up near where Mr. Hodge and myself found the *caches*, and of moa-bones and Maori implements being found near the coast between the Wanganui and Wangaehu Rivers. Among these have been perfect skeletons of moas, one of which—a small one—was put together by Mr. Drew, who placed it in his museum. These bones are generally so decayed that they will not bear rough handling, and, unless secured soon after they are exposed by the drifting-away of the sand which has covered them, they rapidly crumble away, and are lost altogether. The only tolerably sound moa-bones which I have ever seen have been found in the beds of streams. Such bones are by no means rare; but settlers fancy, from their size, that they are those of cattle or horses, and so pay no attention to them. If they were collected, I am sure that we should soon have ample evidence that the latest moa survived the introduction of steel weapons; but the difficulty is to make settlers aware of what they are, and so get them to interest themselves in them.

Art. LIV.—*On Earthquakes in the Vicinity of Wanganui.*

By H. C. Field.

[*Read before the Wellington Philosophical Society, 24th February, 1892.*]

As efforts are being made to determine the sources of earthquakes in the colony, any extended observations in a given locality may be of value. In the volume of the Transactions of the Institute lately to hand I notice a paper by Mr. G. Hogben on an earthquake which occurred in Wanganui on the 7th March, 1890, in which he fixes the source of the shock at a point under the sea about three hundred miles east of Wellington. In this he is certainly wrong, as his calculations are based upon the assumption that the times and direction recorded at the telegraph-stations are those not of the normal wave, but of an imaginary subsequent transverse one, at right-angles to it. I do not attach importance to such data, either as regards time or direction, as I know that in many cases (as in those quoted for this shock by Mr. Hogben) the times given are very uncertain, and the points of the compass are apt to be exactly reversed. That shock, like every other that has occurred in Wanganui since 1851, came from the south-west.

I have long been under the impression that an important earth-fissure passes beneath, or very close to, Wanganui; and the late Rev. Richard Taylor, the Church missionary at Putiki, who had paid considerable attention to the subject, entertained a similar opinion. He believed that there was a subterranean communication between Mount Erebus and Ngauruhoe, and that earthquakes hereabouts were caused by vast volumes of gas or superheated steam being suddenly formed in this passage, and rushing towards Ngauruhoe as a vent. Unfortunately, Ngauruhoe is not visible from my house, so that I am unable to observe whether our earthquake-shocks are succeeded by any unusual discharge of vapour from the volcano. About twenty years ago, however, as I was walking home from town one evening about 10 p.m., I heard an earthquake-explosion, and at once stopped to note the result. Before the shake had well passed, there was a very bright and prolonged explosion from the volcano, followed, after the usual five minutes' interval, by an unusually loud and prolonged report. This single observation certainly bore out the Rev. Mr. Taylor's theory that Ngauruhoe is our safety-valve.

I have paid particular attention to earthquakes for more than forty years, so can speak very positively respecting them as they affect this part of the colony. Slight earth-tremors often occur, and are not noticed by our local papers, unless in the form of a telegram from some other place, where the motion has been more strongly felt. The shocks, however, which are noticed in the local papers follow an invariable course. First there is a dull explosion away in the south-west. This is followed, after an interval varying from one to three seconds, by a sharp upward jerk, also often very perceptibly from the south-west. Then comes a rapid horizontal vibration, evidently caused by waves travelling from south-west to north-east. A rumbling sound usually accompanies these, and sometimes slightly precedes them. As these die away, they are succeeded by a gyratory motion, usually, if not always, from left to right. It is not a steady gyration, but progresses by sharp jerks. If a person is standing up, he has to shift his feet to prevent falling; and in this way he describes sometimes a triangle, but more generally a square. It is this gyratory motion which is so destructive to chimneys. The courses of bricks are often twisted to the extent of 20° or 30°, and in severe shocks frequently at several different levels; thus necessitating the rebuilding of the chimney, even if it has not fallen. This usually concludes the performance, but occasionally some slight return-waves from north-east to south-west are felt afterwards. My own conviction is that in all our earthquakes there is an upheaval, which is maintained during the passage of the waves, and that the gyratory motion occurs during subsidence.

As no newspapers were published in Wanganui in the early days of the settlement, there is probably no record of the early shocks felt here, however violent. The shock in October, 1848, which caused such alarm in Wellington, seems to have been comparatively slightly felt here; but, on the other hand, one which occurred in 1841 was very severe. It occurred about midday; and persons who experienced it have often assured me that they were not only thrown down, but that they had to lay hold of the fern and grass to prevent themselves from being rolled about on the ground. No damage, however, appears to have been done, probably because there was nothing easily damaged. The shock of the 23rd January, 1855, seems, however, to have been the most severe that has been experienced since the foundation of the settlement—at any rate, there has been nothing since that could be compared with it. I was building a mill for the Maoris at Waitotara at the time, and was living in a toitoi whare, which I fully expected would be shaken to pieces over my head. There was a very peculiar condition of the atmosphere that day—I never experienced anything like it before or since; though, of course, I cannot say whether it was connected in any way with the earthquake. The day was perfectly calm, and unusually cold for the time of year. Dull leaden clouds hung low, threatening rain. Altogether it seemed a day specially suited to hard work, and yet no one could work. I had a job on hand which I was anxious to complete, yet found it impossible to work at it for more than two or three minutes at a time, with long intervals between, owing to restlessness and lassitude. Every one in Wanganui seemed to have felt the same. The poultry crept about, with their wings and tails drooping, as if they were all ill. There was a herd of forty or fifty wild goats grazing near where I was at work. Ordinarily they ran like deer if any one approached within a hundred yards of them; but that day I had repeatedly to drive them out of the house or mill, and they even let me handle them. About 6 p.m. a steady drizzly rain began to fall, and continued up to the time of the earthquake, when it ceased quite suddenly. I had just turned in, at about 9 p.m., when I heard a very loud earthquake-explosion, which was followed by a sharp upheaval and violent shakes, accompanied by loud rumbling. I at once lighted a candle to see what was happening, and found everything rocking in a most alarming manner. There seemed to be three shocks joined together. Twice the motion slackened, and then became more violent again. The third time the motion was so violent that my table (a small one, and perhaps a little topheavy with a pile of English papers which I had just received, and which stood on top of it) was turned completely upside down. This was the culmination of the shock, which then gradually subsided, the gyratory action being so violent as to produce a feeling like sea-sickness. Altogether the shock must have lasted fully three minutes. It was succeeded by another, and then by a third, after which others occurred at longer intervals. There was a Wesleyan Mission family living about half a mile from me. The missionary had been away from home for some days, but had returned that evening, though I was not aware of his having done so. Thinking his wife and sister must be greatly alarmed, I dressed myself and started in the dark for their house. The track was merely a native path through high fern; and several times, as I went along, I was fairly thrown right and left into the fern, and could hardly keep my feet. On reaching the house, I found the family sitting with the doors open, ready to rush out if the house should be actually falling. The ladies were to carry blankets, which lay ready folded on the table, and the missionary was to snatch up the little girl, who was sleeping on a sofa. I remained there till morning. When daylight came, we found that the ground was cracked in all directions, and that on an alluvial flat just in front of the house there was a crack fully 50 yards long, through which sand and water had been thrown up from a depth of 15ft. or 20ft., and scattered on the surface to a width of about 20ft., and to a depth of several inches. After taking a cup of coffee, I started for Wanganui, to see how my wife and children had fared. On reaching the pa where the track to Wanganui crossed the Waitotara River, I found the Maoris sitting outside their huts in great alarm. The ground was cracked in all directions, and, as the slight shocks passed along, the cracks could be seen to open and close—a thing which the Maoris said they had never known to occur previously. The Maori mailman was just on the point of starting for Wanganui, so we travelled together. On reaching the sea-beach, along which our route ran for about five miles, we found that the whole face of the cliff was thrown down, and that further small slips were constantly occurring. An isolated mass of shell-rock, called "Te Ihonga," similar to the Pulpit Rock at the Isle of Wight, which had stood at the top of the cliff, and had for ages marked the place at which to turn off from the beach to go across the sandhills to the Waitotara crossing, had been thrown down and dashed to pieces. On reaching Wanganui, I found that, though my own folks and property were safe, immense damage had been done, particularly in the stores and hotels. The ground was cracked in many places. The foreshore of the river fronting Taupō Quay (which faces south-east), from the quay roadway to low-water mark, was like an ill-ploughed field; and the alluvial flats beside the river were specially fissured. At what is known as "Sutherland's Flat," about five miles above the town, two cracks, fully 100 yards long, and from 30ft. to 50ft. asunder, extended from the river back into the flat, and the interval between them had sunk down fully 6ft., so that at high water boats could be taken into the flat. Except two low double ones, which were so built into the framework of a house that they could not move, every brick chimney in the neighbourhood was destroyed; but the pumice chimneys and houses, of which there were many at that time, all escaped injury. There was a brick church at Putiki, with walls about 8ft. high and a heavy roof. Though built with a mortar of shell-lime, specially burnt for the purpose, scarcely two bricks were left adhering to each other. This extraordinary disintegration was no doubt due to the weight of the roof, which had come down *en masse*, grinding the brickwork to pieces. A brick wall at the adjacent mission-station was also thrown down and broken to pieces. Prior to this earthquake, a good many houses had been what was called "brick-nogged"—*i.e.*, the intervals between the studs had been filled with brickwork, and the inner facing plastered. Nearly the whole of this brick-nogging was shaken down, and what was not so was so loosened as to be unsafe, and had to be removed.

There was no loss of life or limb, but several narrow escapes. In one case an old bed-ridden woman had just been carried into the next room while her bed was made, and all the brick-nogging beside it was shaken down on to the bed from which she had been removed. In another case a nurse and several children had to huddle together at one end of a room while the chimney fell between them and the door, and then scramble over the fallen brickwork to make their escape. The Rev. R. Taylor, too, and his family had rushed out of doors on feeling the shock, and had only just passed the brick wall when it fell and covered the path which they had traversed. A certain amount of good was done by the shock in draining swamps. These had been formed by layers of ironsand becoming rusted together and forming a pan, which prevented the surface-water from soaking downwards. The shock cracked these pans, and enabled the water to escape.

Shocks occurred at frequent intervals for some time afterwards—in fact, for several months it could never be said that the earth was still. Even when it was dead calm there was always a long, low swell running up the Wanganui River, and as we lay in bed at night we could feel that we were being gently rolled from side to side. It seemed as if every wave which broke on the beach continued its course through the land. This continued till the equinoctial gales of March and April rendered it no longer noticeable. Wanganui was upheaved by the shock to the extent of from 1ft. to 15in.; but all but about 6in. was gradually lost afterwards.

It was asserted that a fire, supposed to be volcanic, was observed in the vicinity of the Inland Kaikouras; and vessels sailing south of Wellington reported the sea covered with dead fish. The people on board a vessel, which reached Wellington a few days after the earthquake, reported having felt the shock fully 150 miles west of New Zealand. They had been much alarmed, as they thought the vessel was dragging over a shoal or reef not marked on the charts.

A friend, who had camped by the mouth of the Rangitikei River, with a herd of cattle, on the night of the earthquake, lately told me that the ground there was extensively and very deeply fissured, and that a sulphurous smell was distinctly perceptible. A similar smell was said to have been perceived at Wanganui, but I did not observe it at Waitotara.

Art. LV.—*Notes on the Earthquake of the 24th June, 1891.*

By George Hogben, M.A.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

Plate XXXIX.

This earthquake is one of the most considerable recorded in the Auckland District; but there is some difficulty in arriving at a definite conclusion in regard to the origin. Nevertheless, the facts of the earthquake, and some attempt at an explanation of them, should, I think, be placed on record. The data, obtained through the Telegraph Department, are given in the accompanying table (pp. 575, 576).

1. For the determination of the epicentrum the usual time-methods were employed. Assuming all the times to relate to the same shock, by the method of circles, with velocity twelve miles per minute, we obtain from the times at Auckland, Cambridge, Thames, and Tauranga an epicentrum E, about twelve miles south of Mercer; but this does not agree with the time at Mercer (probably a good observation), nor with that at Helensville. By taking a point F, about twenty miles south-west of E, and a slightly greater velocity, we may make our solution suit Mercer better, but Thames hardly so well; it would agree with the effects observed at Raglan. The normal equations derived from the equations of observation (see Trans., vol. xxiii., p. 476) give N for the epicentrum; but, though this may give the mean position of the epicentra of several shocks near together in time, it does not agree closely with any of the data. None of these three points—E, F, N—agree with the times at Wanganui (a good observation) and New Plymouth (doubtful). The investigations, however, lead us to suspect two shocks following one another at a brief interval, the first proceeding from below some point within the circle whose centre is A, and the second (and chief shock) from below the circle whose centre is B.

2. I next tried to arrive at some conclusion by considering the intensity of the shock at various places. For this method of working I am indebted to a paper on the "British Earthquakes of 1889," by Charles Davison, of Birmingham (*Geological Magazine*, 1891). The dotted lines on the map (Pl. XXXIX.) show the isoseismals (lines drawn through places at which the intensity was the same): the intensity has been marked on the Rossi-Forel scale. The intensity of the shock was greatest within the innermost curve, the area marked VII. to VIII. on the map. The shaded portion shows the area

Place.	Time of Beginning of Shock. (N.Z.M.T.)	Nature of Shock.	Apparent Direction.	Apparent Duration.	Effects.	Remarks.
New Plymouth III.	A.M. 10.50	Slight ..	N.E. to S.W.	10 secs.		
Mercer .. VII.	10.52*	Sharp ..	S.E. to N.W.	2 secs...	A chimney partly shaken down. Cups swung on hooks for some time after shock. Horses alarmed	No previous tremor or warning.
Thames .. III. to IV.	10.53*	Sharp; two shocks	N. and S.	About 8 secs.	Telegraph lines outside office oscillated	No previous tremors or rumblings or premonitions of any kind. The shocks were sudden.
Cambridge .. VI.	10.53*	Severe and prolonged	S.E. to N.W.	¾ min.	A few clocks stopped, and a few glasses knocked off a shop-shelf	No previous warnings. Shock came suddenly. Several persons heard rumbling as shake approached.
Helensville .. VII.	10.54*	Sharp ..	S.E. and N.W.	15 secs.	Crockery broken, and other articles thrown down and displaced, causing people to rush out of houses	
Tauranga .. IV.	10.55*	Sharp ..	S.E. to N.W.	About 5 secs.	Clock stopped in post-office ..	The rumble distinctly heard, say, a second or so before the shock felt. Window-sash weight could be heard knocking against wall.
Hawera .. IV.	11.3	Sharp ..	S.W. to N.E.	3 secs...	One of the office clocks stopped at 11.3	Liquid in battery-jars used for recording observation:—the marks left on side of cells show approximate direction and severity.
Katikati .. III. to IV.	10.52	Very severe	N. and S.	2 min.		
Grahamstown III.	10.53	Two smart shocks	N. and S.			

* Times checked by New Zealand mean time.

Place.	Time of Beginning of Shock. (N.Z.M.T.)	Nature of Shock.	Apparent Direction.	Apparent Duration.	Effects.	Remarks.
Coromandel .. III. to IV.	A.M. 10.55	Sharp shocks	About S. to N.	Some secs.		
Auckland .. VII. or VIII.	10.54*	"Severe" ("sharp")	W. to E.	15 secs.	Clocks stopped. Crockery thrown down and broken. Several chimneys reported overthrown. Bricks dislodged from a badly-built brick wall	Loud rumbling noise immediately preceded and accompanied the shock. Professor Aldis corroborates time; mentions second shock ten, fifteen, or thirty minutes later; very slight. Direction observed precisely N. to S. Vibrations of water in a pail in kitchen E. to W., approximately.
Waikato .. VII. or VIII.	..	..	..	..	Windows broken, bells rung. Children in school thrown off seats.	
Hamilton .. III. to IV.?	10.54	..	S. to N.	20 secs.		
Raglan .. VII.	..	..	N. to S.	..	A few windows broken. Pendulum clock at rest placed east-and-west started going by shock	Natives first heard a loud report out at sea.
Waiuku .. VII.	10.55	..	S.E. to N.W.	15 secs.	Stopped clocks	Loud rumbling.
Wanganui .. III.	10.55*	Very slight indeed	..	2 secs...	..	Very slight tremor (preceding), hardly perceptible.

* Times checked by New Zealand mean time.

NOTE FROM AUCKLAND.—"Shock felt more or less severely over the Auckland District, excepting the north, beyond Kaipara.—W. S. FURBY, Auckland P. O."

which probably includes the chief epicentrum. The roman numbers under the names of the places in the table show the degrees on the Rossi-Forel scale of intensity that seemed most nearly to correspond to the details given. The isoseismal III., it will be seen, would lead us to suppose a focus not very far from N or A, and certainly would prepare us to believe that there were two distinct shocks. Both these methods, Time and Intensity, seem therefore to point to the same conclusion.

3. To sum up. A possible hypothesis, which explains all or nearly all the facts, is that a fault-movement began below A, going northwards, was accelerated rapidly at or near B, and continued for some time afterwards in minor shocks along the line AB. There is no evidence of the existence of such a fault, nor is there likely to be, as the region indicated lies under the sea.

4. The velocity of propagation was between twelve and fifteen miles a minute.

ART. LVI.—*Notes on the Earthquake of the 5th July, 1891, in Cook Strait: an Attempt to define the Epicentrum.*

By GEORGE HOGBEN, M.A.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1891.*]

THIS was a slight earthquake, without any marked effects, and I do not propose to deal with it at any length. Its sole interest is derived from the fact that the observations of it, though not many in number, were sufficiently exact to enable us to ascertain the epicentrum very nearly. The data—all obtained through the Telegraph Department—are these:—

	Time.	Direction.	Duration.
Blenheim	10.53 p.m.	W. to E. (but uncertain)	10 secs.
Upper Hutt	10.55 p.m.	N.E. to S.W.	3 secs.
Masterton	10.53 p.m.	N.E. to S.W.	about ¾ min.
Woodville	10.54 p.m.	W. to E.	5 secs.
Marton	10.53 p.m.	N.E. to S.W.	8 to 10 secs.
Foxton	10.55 p.m.	N. to S.	5 secs.
Wellington	10.55 p.m.	S.E. to N.W.	5 secs.
Picton	10.52 p.m.	N. to S.	10 to 15 secs.
Featherston	10.52 p.m.	N.W.	2 secs.

The times are those of the beginning of the shock: the first six are stated to have been verified by New Zealand mean time, the last three being given to the best of the officers' belief to N.Z.M.T. No qualification of the times at the Upper

Hutt, Foxton, and Wellington appears to be required on account of the time being a multiple of five minutes, as the observers at those stations have been in the habit of giving the time to the nearest minute—in the case of Wellington, to the nearest half-minute. At three places the shock is said to have been preceded by rumbling; at Picton "the house shook and the windows rattled;" at Foxton "crockery rattled about considerably;" and at Masterton the Postmaster was awakened by the shock. An important detail is mentioned by the Foxton observer—namely, that the shock he records was "preceded by a slight premonitory shake," how long before he does not state. This seems to show that there were two shocks, and I think we are justified in assuming that the times at the Upper Hutt and Wellington, as well as that of Foxton, belong to the second shock.

The simultaneous arrival of the vibrations at Blenheim, Masterton, and Marton gives us for the epicentrum a point in Cook Strait sixty-five miles from each of these places (forty-four miles N. 24° W. from Wellington). The inclusion of Picton and Woodville with them gives us almost exactly the same spot. If we take in Featherston also, we must suppose an epicentrum five miles further to the south-east.*

For the second shock the time—10.55—at the Upper Hutt, Foxton, and Wellington implies an epicentrum two miles north-west of the first epicentrum. A circle of three miles radius would include all the epicentra found, and if we reject Featherston a circle of one mile radius would satisfy all the data. The velocity of propagation is eighteen miles per minute.

The agreement of the observations is remarkable, for with the utmost allowance for probable errors the epicentric area found is very small. The velocity must lie between fifteen miles and a quarter per minute and eighteen miles per minute, and the time at the origin between 10.48½ p.m. and 10.49½ p.m. Compared with time-observations those of direction are usually of small value; they may, however, be used cautiously for testing our results. In the present case it will be found that (lines being drawn in the given directions, and at right-angles thereto, so as to include cases of normal and transverse vibrations) the direction of the epicentrum found agrees almost exactly with Upper Hutt and Marton, and is in accordance to the nearest half-quadrant (or within 22½°) with all the rest except Blenheim, Masterton, and Picton, the errors of these directions being 25°, 31°, and 27° respectively.

We have thus as good a confirmation as we can expect of

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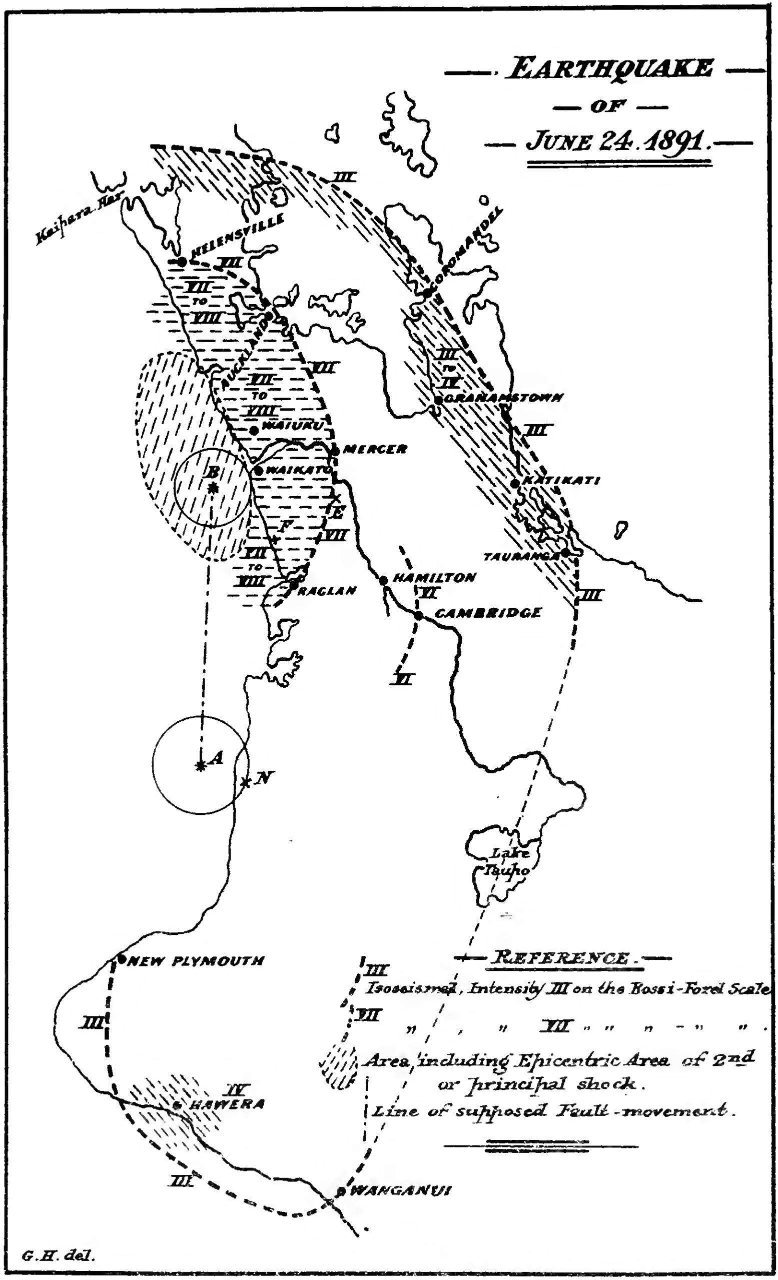
* If the clock at the last place was forty seconds slow the same epicentrum would be given as for the other places.


EARTHQUAKE
OF
JUNE 24. 1891.
Kaipara Har.
HELENSVILLE
AUCKLAND
COROMANDEL
GRAHAMSTOWN
KATIKATI
TAURANGA
WAIUKU
MERCER
WAIKATO
RAGLAN
HAMILTON
CAMBRIDGE
Lake Taupo
NEW PLYMOUTH
HAWERA
WANGANUI
A
B
E
F
N
REFERENCE.
III Isoseismal, Intensity III on the Rossi-Forel Scale
VII " " " VII " " " " "
Area including Epicentric Area of 2nd or principal shock.
Line of supposed Fault-movement.
G.H. del.

the conclusion already arrived at by means of the *times*. The observations are not such as to enable us to ascertain the depth of the origin; they are opposed to one at great depth—indeed, the origin was probably very shallow.

Dr. Lemon has kindly allowed me to supply earthquake memorandum forms to a large number of telegraph-stations near Cook Strait, so that I trust this attempt is only the first instalment towards the exact determination of the epicentric areas in that district.

POSTSCRIPT.—The earthquake of the 4th December, 1891, for which the number of data is very large, gives nearly the same origin. It will form the subject of a separate paper.

ART. LVII.—*On Geyser-action at Rotorua.*

By CAMILLE MALFROY, C.E., J.P., Chevalier de la Légion d'Honneur.

[*Read before the Auckland Institute, 22nd June, 1891.*]

Plates XL.-XLII.

BEING appointed engineer in charge of the Government thermal-springs district at Rotorua immediately after the eruption of Tarawera, in 1886, it became part of my duty to observe and report on any changes which might take place in the hot springs, geysers, &c. The eruption seemed to have had great influence over them. Many which had been quiescent, and some which had been considered as dead (having in the course of time become filled with rubbish and overgrown with weeds and brushwood), suddenly burst into renewed activity; and almost daily during the first six weeks after the eruption I could observe some changes in the thermal action—something new here and there throughout the district.

The geysers immediately attracted my attention. Waikite Geyser, at Whakarewarewa, which had been quiescent for about ten years, again burst into full activity, with eruptions about every quarter of an hour. Pohutu, Wairoa, and the other geysers were also playing occasionally, but were very irregular in their action. Sometimes weeks would elapse without one or the other of them showing any sign of activity, whilst at other times they would be active for several days in succession.

Not having had a long acquaintance with the district, I made inquiries of old residents (European and Maori) for any theory to account for the inequality in the thermal action of these springs and geysers. The generally-received opinion was that the geysers were influenced by the wind: with southerly wind they were quiescent, and with northerly they were active. As I could not well understand how the wind could affect geysers or springs situated in sheltered positions, I began a system of personal observation, and soon found that southerly wind generally meant high barometer, and northerly a low one; and, if I could not understand the wind theory, I could the hydrostatic effect, and the influence of atmospheric pressure, which was simply equivalent to a reduction in the column of water. Every spring and geyser being naturally hydrostatically balanced, the reduction by any means of the weight of the column of water should bring a corresponding increase in the activity of the spring. Acting upon this theory, I determined to experiment privately upon Te Puia, a thermal spring in a secluded spot near an old pa, on the right-hand side and well down in the bed of the Puarenga River, therefore little influenced by winds. It was at that time boiling, but not very actively. By means of a drain which I cut in the sand formation by the level of the river I removed about 2ft. of the water from the pool which formed around the spring. This removal of 2ft. of dead-water had an immediate effect on the spring; it began to boil furiously, and a few minutes afterwards burst into a geyser, throwing water from 30ft. to 40ft. high, discharging at the same time the whole of the dead-water of the pool. I watched this eruption of what I thought a new geyser—for there was vegetable growth of several years' standing around it—with wonder, and with a certain amount of anxiety, as I began to fear that I had started something which I could not control. However, after a few minutes, taking advantage of a decrease in the eruptive force, I ran to the drain I had made, and refilled it as quickly as possible, causing part of the water thrown up by the geyser to be again caught in the pool or basin. Here it soon accumulated, and after a while the geyser-action ceased, and the water of the pool ran down the geyser's tube, together with a considerable quantity of water from the river which had flowed back through the partially-closed drain. In about ten minutes the tube was filled with cold water to the surface.

I watched it for a while, and saw the water getting hotter and hotter. Eventually it began to boil, but without any geyser-action. After a time I again opened the drain, and almost immediately there was another splendid eruption similar to the former. I determined to allow this to play, and see what it would do, as I began to have some confidence in my ability to control it by the same process as before if it was found necessary. It played for about twenty minutes, the geyser-action getting weaker and weaker, and the cooled water in the pool getting stronger all the time. The water eventually got the best of it, and flowed down the geyser-tube, to repeat the same action as before.

Having made this geyser play and cease playing several times, I reclosed the drain thoroughly and went away. I did not see it play again that day; and the following day about noon, when I went near, I found by the marks I had left that it had not been in eruption since I left it the night before. The water of the pool would boil up violently at times, but there was no eruption. I then again tried what the opening of the drain would do. The result was the same as on the previous day—a splendid eruption of the geyser. I again watched the action for three successive times, and eventually went away leaving the drain open; and from the volume of steam which went up periodically from that spot I could see that intermittent geyser-action was taking place.

I repeated and watched these experiments on many occasions during the months of August and September, 1886. Once, the river being rather high, I turned the cold water from it on the geyser when in full eruption. This almost instantly stopped its action, but at the same time it caused a great noise, probably owing to the sudden condensation of steam within the geyser-tube. After a while, however, the noise ceased, the pool filled up, and all was quiet; and as long as I allowed the cold water to flow across over the mouth of the geyser-tube there was no eruption, nor even any perceptible action of the springs.

Having thus acquired some little practical knowledge of the working of this particular geyser, I began to compare it with that of others, to see if any of them could be made to play at will. I then watched and studied the action of Pohutu, which is situated on the principal geyser-fissure of Whakarewarewa. This fissure supplies no less than seven active geysers and blowholes, besides quite a number of old geyser-tubes which have been inactive for many years, though they still emit steam and make a rumbling noise as of boiling water at some considerable depth below the surface. They do not seem to affect or be affected by the working or the non-working of the active geysers.

The annexed plan (Pl. XL.) gives the position of the seven active geysers.

A. The "Torpedo" is situated in the bed of the Puarenga River, and is so named from the peculiar noise it makes in its explosions, which occur every few minutes, through the river-sand under 3ft. or 4ft. of cold water. This commenced in September, 1888, at the same time as the renewed activity of Pohutu.

B. The "Kereru" is an old, well-established geyser, with intermittent irregular action, sometimes throwing up water 40ft. high. Its water deposits a black sinter formation, quite different in character from that of the others. I am therefore inclined to think that, though on the same line of fissure, it is not directly connected with them.

C. The "Indicator" is a small hole, 6in. by 1ft., on the common fissure. It generally plays intermittently for an hour or so before Pohutu, throwing a jet of steam and water, at an angle of 45°, to a height of 5ft. to 10ft.

D. "Pohutu" is a perpendicular oval tube or funnel, about 2ft. long by 18in. wide (formed in the fissure), worn quite smooth. It is an intermittent geyser—the greatest in Whakarewarewa, if not in the whole thermal district—throwing a splendid column of water to a height of from 50ft. to 80ft., and lasting from one to two hours at each eruption. Previous to September, 1888, it was very irregular in its action, sometimes inactive for several months.

E. "Te Horo."—This is a splendid pool of blue water, about 15ft. diameter and 20ft. deep, with a kind of drain leading out of it, thus:

This pool is hydrostatically connected with Pohutu. It is usually full of water to the line *a* (section, Pl. XL.); but when Pohutu is about to play the water becomes hot and boiling, and, rising to the level of *b*, it overflows through the outlet. The action then becomes more intense and furious, large volumes of water being thrown up from 10ft. to 20ft. in height, and falling back into the pool in beautiful showers, the large drops sparkling like so many diamonds. It is a splendid sight, well worth seeing. Sometimes this ebullition goes on for an hour or so, when all at once the water in the tube of Pohutu rises to overflowing and the eruption of Pohutu takes place.

F. "Waikoroihi" is a small geyser-tube situated about 40ft. south of Te Horo, and a few feet higher up. It plays almost constantly, throwing water from 5ft. to 20ft. high.

G. "Wairoa" is a splendid geyser, and the last southwards in the fissure. When in eruption it somewhat resembles Pohutu; it is very irregular, being sometimes inactive for six months at a time.

Having noticed the great irregularity of action of the different geysers, I thought that it must, to a great extent, be attributed to outside or surface influence. I noticed that when Pohutu was in eruption Waikoroihi would stop, and *vice versâ*. This showed that they were hydrostatically connected, and, as long as Waikoroihi played, the water ejected, finding its way into the Blue Pool of Pohutu (E, Te Horo) at a considerably-reduced temperature (about 160° Fahr.), would so cool the water in the Blue Pool that it would not boil up whilst this lasted. As it did not cause the water to rise in that pool, I concluded that it might find its way back into Waikoroihi, and thus be thrown up again and again. I tested this by discolouring the water in the Blue Pool with loam, and found that, though the small bits of grass, moss, &c., were not re-ejected, the water from Waikoroihi was to some extent discoloured.

Taking the opportunity of a visit of the Hon. Mr. Mitchelson, the late Minister for Public Works, to our district, I explained my views on these matters to him, with an imaginary sketch of the geyser-tubes. Mr. Mitchelson took considerable interest in it, and authorised my making some experiments. At the beginning of September, 1888, I built a temporary wall, diverting the Waikoroihi water away from the Blue Pool. This soon had the effect of raising the temperature of the Blue Pool to from 200° to 210° Fahr. The water rose a few feet and began to boil furiously; then the pipe which I call the Indicator became active, and as soon as this took place the water of the Blue Pool would cease boiling and go down again to the low-water line. I watched this same action for several hours, but unless the water of the Blue Pool rose to the level of the overflow-drain there was no eruption of Pohutu. Seeing that this small Indicator tube acted as a kind of safety-valve, I tried to close it up with bags, stones, &c., but failed, the steam and water finding its way through small fissures in the rock. It then occurred to me to build a kind of dam around the Indicator, so as to collect the water ejected by it, and also lead some of the water from Waikoroihi into this dam, thus causing this cooled water to flow back down the Indicator tube. This had the desired effect. The Indicator stopped playing altogether as long as I could keep a small stream of cooled water running down it. On the following day Waikoroihi stopped playing. The water of the Blue Pool rose to the level of the overflow-drain, became more and more active, and on the 9th of September, two days after the works were finished, Pohutu gave a grand eruption, lasting nearly two hours, throwing large volumes of water from 60ft. to 80ft. high. This eruption was repeated in the evening, and from that date until December, 1889, it played regularly about twice in twenty-four hours.

During the time I was absent from the colony as Commissioner at the Paris Exhibition there was no one on the spot to look after these special works. The consequence was that Pohutu again stopped playing regularly. On my return, in February, 1890, I was informed that Pohutu had not played or been in active eruption for the last nine weeks. I at once went over to see it, and, finding that the works I had made had been tampered with, I had them put into temporary repair, with the result that Pohutu played up again a few hours after the work was finished; and its action has continued ever since, though not so regularly as before, but this is no doubt only due to the defective repairs of former walls, &c.

As a further illustration of what may be done in regulating the action of geysers, or even in creating or starting new ones, I may state that in the Sanatorium grounds there are two hot springs, with concrete basins around them, which were never known to have geyser-action, though the formation of the surrounding rocks shows that they had been geysers at some remote period. These springs supply the hot swimming-bath, but during the year 1889 they had gone so low, and were so much influenced by the atmospheric pressure, that sometimes they would remain for several days 2in. or 3in. below the level of the outflow-pipe, thus discharging no water. This became a matter of great importance, as the bath, which had cost £1,000, threatened to become useless, owing to the impossibility of keeping it at a proper and regular temperature.

It occurred to me that by contracting the springs proper into pipes it would prevent the hot water from becoming cold by admixture with the water in the basin, for I had noticed that when the springs were active the temperature of the water of the basins would rise from 140° minimum to 180° maximum. I thought that this increased activity of the springs when the water was hot was owing to the difference in the specific gravity between hot and cold water which the spring-tube or fissure might contain in its column, and that this difference might be sufficient to cause the water to rise a foot or two above present level, according to the depth at which this influence (on the temperature of the water) would take place. I had some temporary works carried out to prove the correctness of this theory, and to my delight found that it was quite true, and that, instead of a small rise of 2ft., which would have been quite sufficient for our purpose, there was force enough in the springs under these altered circumstances to form geysers. Having further acquired the knowledge that the whole of the springs contained in the Oruawhata and Chameleon basins were hydrostatically connected, I arranged a system of pipes over the three principal springs, connecting each of them by secondary pipes to three valves, by means of which either of the springs can be made to play as a geyser at will. (See Pl. XLI.)

To keep the springs quiet, low, and cool during the time the works were being carried out, cold water from the town main was injected into one of the three spring-tubes, pumping it with an ejector out of another, whilst the work of cementing the geyser-tube was going on in the third; and by shifting the injector- and ejector-pipes from one spring-tube to another I had the three geyser-tubes firmly secured. These works were finished early in May, 1890, and the springs were thus kept quiescent for three weeks to allow the concrete to set properly, and eventually four days longer, so as to start them into action for the first time on the Queen's Birthday at 2 p.m. A considerable number of people gathered to see this novel experiment. The new fountains were christened the Malfroy's group of geysers, their distinctive names being the "Victoria," the "Nelly," and the "May."

The three geyser-tubes, A, B, and C, on Plate XLI., consist of 6in. earthenware pipes sunk in the ground from 6ft. to 9ft. deep, right over the outlet of the springs, secured with cement concrete, and allowed to project about 2ft. above the water-level of the basin. *a*, *b*, and *c*, the three valve-pipes connected with A, B, and C, consist of 4in. earthenware pipes from 6ft. to 10ft. long, laid zig-zag, and thus forming double traps; they are provided with wooden valves to regulate the quantity of return water to be admitted into any of the geyser-tubes.

D is a supposed steam-chamber, showing probable connection between the geyser-tubes and the hot fissure or fissures which supply the heat or superheated steam and water to the springs.

When the three geyser-tubes are allowed to work without interference on the surface, C begins to get heated, the water rises in its tube and discharges through the small pipe *c*, the action and heat increasing steadily for a quarter of an hour or so; eventually the water boils furiously, and, as the water and steam come up the tube with considerable velocity, it takes the path of least resistance, and is shot up the tube and ejected into the air to a height of from 15ft. to 30ft.

This geyser-action lasts from five to ten minutes, dying away gradually until the cooled water gathered in the basin penetrates into the tube C from the valve-pipe *c*, which eventually stops the geyser-action, the water sinking rapidly down the tube. It is then quiescent for about ten minutes, while the heat from below seems to accumulate its force. The column of water in the geyser-tube again rises, begins to discharge, heats up, and repeats the geyser-action as before explained.

This intermittent action of C goes on for an hour or two, during which time the temperature of the water in tube B is gradually augmented. The water now rises in this tube, discharges through pipe *b*, boils up, &c., as in the case of C, and eventually bursts into a beautiful geyser, throwing water 20ft. to 40ft. high for a period of one or two hours, when it again stops, as previously described in the case of C. Sometimes B and C will play up simultaneously for a short time. B, however, eventually takes the lead; C will then stop, the water in its tube receding 5ft. to 6ft., the cooled water which runs down the tube in considerable quantity being re-ejected by B. I have noticed that the eruption of B is of longer or shorter duration in proportion to the temperature of the water taken in at C.

While B and C are thus active a small stream of cooled water constantly finds its way down the tube A, keeping it silent; but it can be made to play by the following arrangement of valves: If A is required to play constantly, close the valve *a* and open *b* and *c*, so as to allow a considerable quantity of the cooled water ejected by B and C to find its way back down these tubes. If intermittently, allow rather more water to flow in the tubes B and C, and also a little in tube A: this will cause A to stop occasionally for a few seconds or for a minute; but, owing to the quantity of water being, say, half what finds its way down B or C, the heated water will still follow the tube A, as it is the one offering least resistance, and every now and then the accumulated or pent-up steam will eject the water. If, now, the tube A is required to be transformed into a mere boiling-spring, close the valve *a*, and open the valves *b* and *c* to allow as much of the cooled water to find its way down B and C as they will take. This has the effect of swamping the force; the superheated steam seems to be condensed by coming into contact with this large quantity of cooled water, and the action almost disappears.

If, on the contrary, B or C is required to play up separately and constantly, it is only necessary to reverse the working of the valves in a similar manner to what has been described to make A play up.

Further, the springs supplying the baths at the Palace Hotel having become quiescent some two or three years ago, I advised Mr. McRae, the proprietor, to do certain works to try and bring them into geyser-action: this proved entirely successful, and the spring became a small active geyser, and has remained so ever since, supplying his baths with plenty of hot water.

From the experience thus gained, I support the theory that the geyser-tubes are connected with subterranean caverns or chambers, and that heat or superheated steam penetrating through fissures supplies the natural or motive force; and I conclude that the difference between the specific gravity of hot and cold water within the geyser-tube will thus produce every phenomenon of geyser-action to be observed at Rotorua; and I am led to believe that, by studying the action of geysers and springs in this district, they could in most cases and to a certain extent be regulated and controlled.

Geyser-action may be briefly explained according to the foregoing, as follows: Supposing that an even-sized tube full of water becomes so hot that steam generated at the bottom, under heavy pressure, rises through it without being condensed, there comes a time when several globules of this steam will be in the tube at the same time, and as they rise to the surface they will expand in proportion to the release of the pressure exerted upon them, and when coming near the surface they, as it were, explode, throwing the small quantity of water contained in the tube into the air, forming irregular intermittent explosions. Eruptions of longer duration can be explained thus: The actual weight of water in the tube, acting as a valve on the force, may by means of these globule explosions find itself suddenly released by, say, half the pressure of the column of water. The equilibrium being thus destroyed, the pent-up steam rushes up the geyser-tube with a force proportionate to the depths at which the reservoir containing this force may be situated, and, acting on the principle of a Giffard ejector, the pent-up steam rushes up the tube, taking up with it a certain quantity of the water which may find its way into the tube, and ejecting it in the air, in the form of high, low, or intermittent geysers, in proportion to the different size, position, force, and volume of the spring, and other circumstances of the case.

I have also observed that the chemical composition of the water is sensibly altered by the different actions of the geysers: thus, if the geyser is made to play very actively, the water becomes softer to the touch, it being more silicious and oily than when the geyser-action is subdued and allowed to boil up quietly. This will account for the comparative rapidity observed in the formation of terraces or mounds around the most active geysers, and the very small amount of silica deposited by springs of less pressure and activity.

POSTSCRIPT.

Doubts having been expressed, by some gentlemen who have studied and written on the thermal action of this district, as to the theory propounded in the foregoing paper, I have constructed an apparatus (see Pl. XLII.), with which I can illustrate the hot spring, the constant, short- or long-interval intermittent geyser, the steaming fumarole, and the mud-volcano—in fact, all the different series of phenomena to be observed in this district—by simply altering and regulating the admission of cold or cooled water into the flask or retort, and altering the length and relative positions of the glass tubes.

I have adopted 27in. as the length of the glass tube, as this represents about 1lb. pressure to the square inch; but the longer the tube the better the influence and effect of the difference between the specific gravity of cold and hot water, the water boiling under pressure, and the ascending steam-globules will be demonstrated; and the greater the pressure the stronger will be the geyser-action, as explained in my original paper.

I would also mention that the flask need not necessarily represent a cavern or cavity, for it will act equally well when filled with pieces of pumice or stones, thus representing broken rubbly ground, where water can lodge and accumulate from any source or direction.

I will now endeavour to describe how some phenomena may be demonstrated.

First, fill the tray (B) with water so as to cover the top of the glass tubes, say, $\frac{1}{8}$in. above them; light the spirit-lamp (F), and set it so that it will cause the water in the flask to rise to a temperature of, say, 3° or 4° above boiling-point. Then, to illustrate—

1. *A Hot Spring* (say, 140° to 180°).—Set the two glass tubes C, D, to the same length both at the top and bottom, leaving both fully open. After a short time, when the water of the flask reaches a temperature of, say, 60° to 100° above the temperature of the water in the tray B, introduce a piece of sponge on the end of a thin wire into one of the tubes (say C) nearly to the bottom; then draw it smartly up: this will cause the hot water in the flask to fill the tube C, while the cool water in the tray will run down D. This will, owing to the difference between the specific gravity of hot and cold water, destroy the hydrostatic equilibrium; and, by putting a little sawdust in the tray, it will be seen that the hot water will continue to ascend in C, and the cold to descend in D, fast or slow in proportion to the quantity of heat generated by the spirit-lamp. The ascending hot water, on being exposed in the large cooling-surface of the tray B, will naturally lose its temperature, re-enter the tube D, descend into the flask F, get reheated, and ascend C; and this action will continue as long as the heat and the water last. If it is desired to change the action from one tube to the other, it is only necessary to repeat the action with the sponge in the opposite tube, and, when once the trend of the hot water is established, the reverse action will be caused and continue as before described, thus illustrating that the heat generated by the spirit-lamp

can be absorbed by the discharge of a rather large quantity of water at a comparatively low temperature.

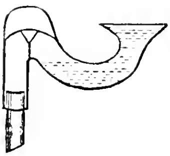
2. *An Intermittent Geyser.*—Supposing the action of the hot spring above described to be going on, take the piece of sponge before described (in this case it should be of such a size as to allow about a quarter of the tube to be open); introduce it into one of the tubes (say C), pushing it well down near the bottom: this will stop part of the cold-water supply. The heat of the spirit-lamp being still the same, the temperature of the water in the flask will rise to the boiling-point due to altitude and pressure; steam will then form and accumulate in the neck of the flask, and force the water up the tube D, which water will be seen full of small steam-globules as it ascends the tube. These steam-globules, displacing a certain quantity of the water of the tube, naturally reduce the specific gravity of the column of water in the tube D, thereby reducing the pressure exerted on the water in the flask. The water, finding itself released from the pressure, will begin to boil furiously; large globules of steam mixed with a certain quantity of water will enter and ascend the tube D, and be ejected in the air to a height corresponding with the pressure exerted by the column of cold water contained in the opposite tube C: this furious boiling-action of the water in the flask will continue until such time as the water in the flask is reduced to some considerable distance below the bottom end of the glass tubes, D being then quite empty. The whole of the pent-up force due to the pressure being exhausted, the water in the flask will continue to boil quietly, whilst a small quantity of the cooled water contained in the tray (B) will find its way back into the flask through the tubes C and D, and as soon as the level of the water of the flask reaches the bottom of the glass tubes it will begin to ascend the tube D; and the pressure thus exerted on the water of the flask will totally stop the boiling-action until such time as the water again acquires the necessary temperature to overcome altitude and pressure, when the same action as before described will repeat itself as long as the circumstances remain the same.

3. *A Constant Geyser.*—From the foregoing it will readily be understood that, by allowing only a very small quantity of water to find its way down the flask, say through C, and raising the tube D so that it projects above the water in the tray, the action of a constant geyser will be illustrated.

4. *A Fumarole.*—If a still smaller quantity of water be allowed in the flask,—in fact, just as much as is consumed in steam,—a steam-jet or fumarole will be produced.

5. *A Mud-volcano.*—If a boiling mud-volcano is to be demonstrated, act the same as for the fumarole, and fix a funnel (see figure, p. 590) full of some soft kind of mud on the top of

the tube D (Pl. XLII.), leaving the tube C full of cool water. By having the sponge nearly closing the tube down near the bottom, so as to allow the mud in the funnel to be the point of least resistance, the steam generated will, when it acquires a certain force, escape through that point of least resistance, and the condensed steam about the mud will keep it constantly soft; thus, after every steam-bubble, the mud will refill the hole, and a constantly boiling mud-volcano be illustrated.



With this apparatus most of the phenomena which excite the wonder of tourists to our district can readily be explained. Thus, we are told that at Wairakei a packhorse accidentally fell into a mud-volcano: this caused the volcano to change itself into an intermittent geyser, which lasted for six months, after which the mud-volcano resumed its former quiescent normal action—the packhorse in this case causing the same effect as the introduction of the sponge into the tube.

EXPLANATION OF PLATES XL.-XLII.

Plate XL.

Plan and section of geysers at Whakarewarewa.

Plate XLI.

Plan and section of Oruawhatua and Chameleon Springs.

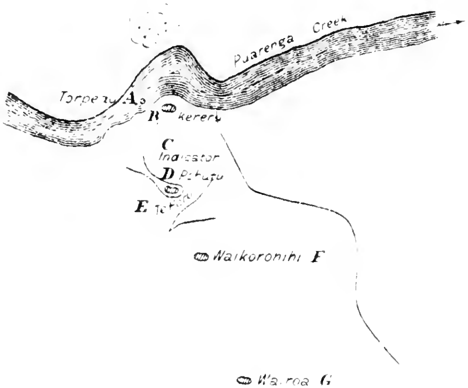
Plate XLII.

Apparatus designed to show geyser-action.

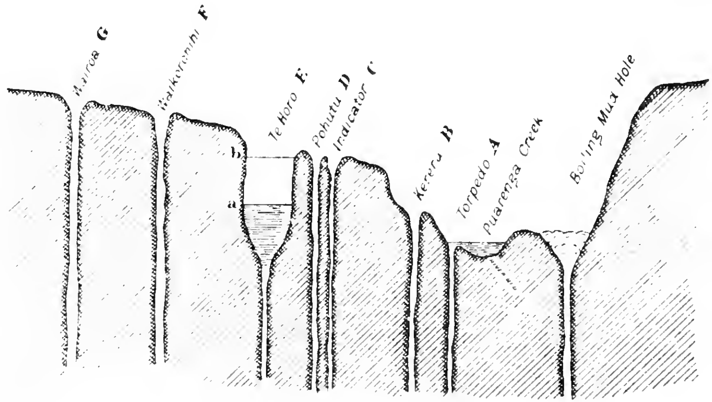
A. Wooden stand, 12in. by $\frac{3}{4}$in. by 4ft. high, fixed on a 12in. by $\frac{3}{4}$in. board, 1ft. 6in. long at bottom, with brackets to keep same in position, and brackets at top supporting tray (B).
B. Tray or tin vessel 14in. by 9in. by 2in., with hole in centre to admit of large cork through which the glass tubes are passed.
C, D. Glass tubes, $\frac{1}{4}$in. diameter and 2ft. 3in. long.
E. Glass retort or flask, to hold about a quart.
F. Spirit-lamp.
G. Iron tripod supporting flask.
H. Maximum thermometer introduced through cork of flask.

Sketch shewing position and Sectional View of
POHUTU AND OTHER GEYSERS
AT WHAKAREWAREWA.

—PLAN—



—SECTION—



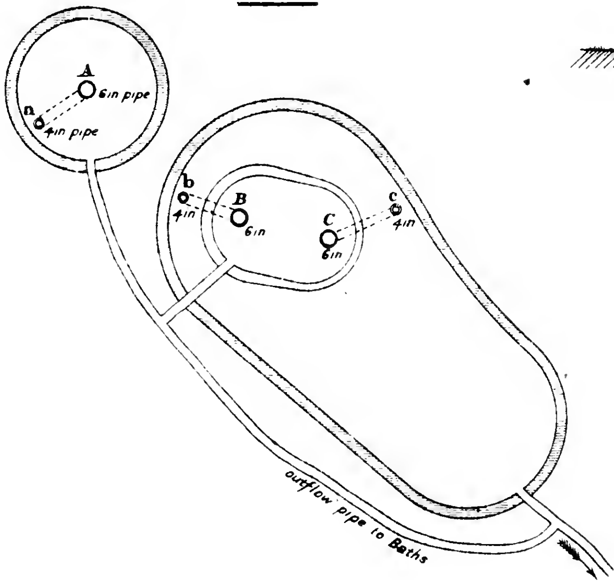
Sketch shewing position of

ORUAWHATA AND CHAMELEON SPRINGS

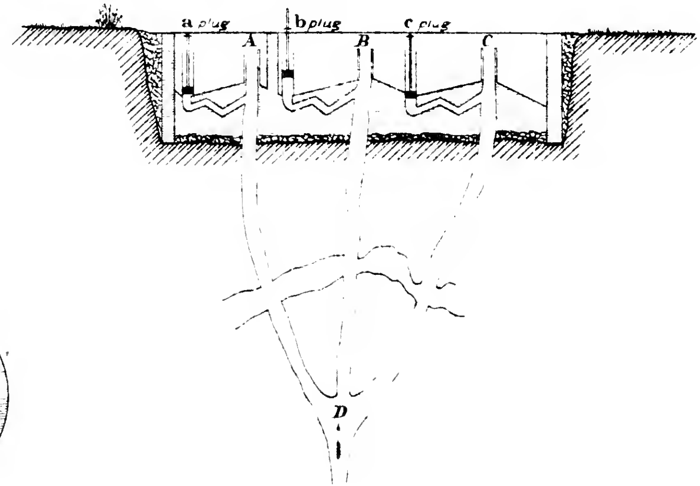
With section of the Arrangement of the Geyser Action.

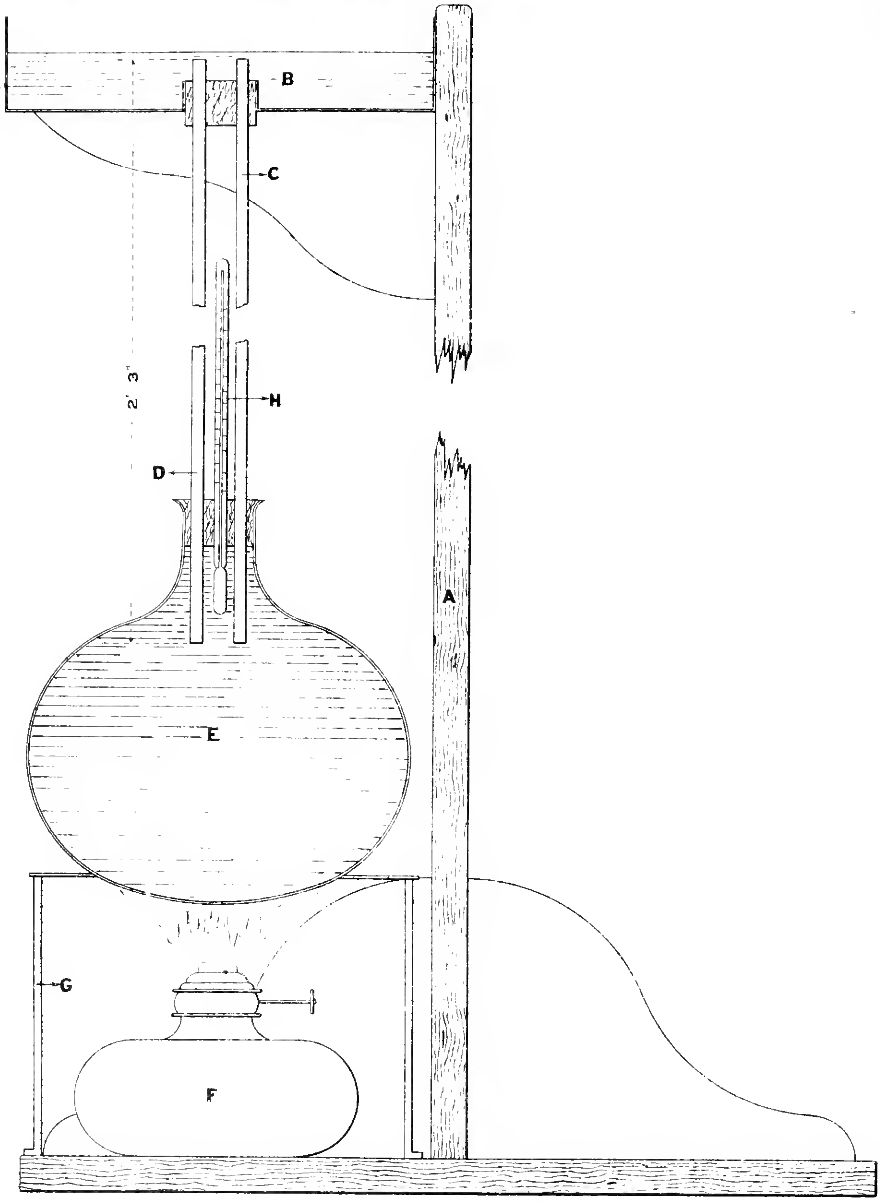
Concrete shewn thus

PLAN



SECTION





Apparatus illustrating

THE THERMAL SPRINGS ACTION

Designed by C. Malfroy.

¼ Full size

Art. LVIII.—*The Rotorua Railway and District.*

By James Stewart, C.E.

[*Read before the Auckland Institute, 14th September, 1891.*]

When I was requested to contribute to the usual series of lectures which it is to be hoped is now a permanent feature in the annual work of the Institute, and the subject of to-night was suggested (no doubt because it is one in which I have been personally engrossed during the last ten years), I felt, notwithstanding the interest the public is supposed to take in all things pertaining to Rotorua, that it would be extremely difficult to treat the matter in a popular manner, and at the same time to steer clear of a tiresome repetition of things you have all heard before.

It would be out of place, to use a mild term, to attempt here any description of the wonders of the Lake district, which has been more or less a favourite subject with every writer on the topography of New Zealand ever since the establishment of the colony. All that is necessary now is confined to subjects connected with the bearings of the railway on the district, and the capabilities of the district to respond to the influences of rapid, cheap, and certain means of communication.

The tourist traffic to Rotorua had so gradual a development that it is impossible to fix any date at which it may be said to have commenced; but just in proportion to the facilities for conveyance and residence offered to the public so did the public respond, and this may be taken to be certain of continuance, up to a limit determined by the population interested, eventually, let us hope, to be, for all practical purposes, unlimited by having the population of the world at large to draw on, for we may easily conceive it to be soon possible for the teeming millions of the Northern Hemisphere to contemplate a journey to Rotorua with less thought of difficulty, arrangement, and even expense than twenty years ago used to confront those in New Zealand who wished to view Rotorua and Rotomahana.

Previous to 1872 accommodation for travellers at Ohinemutu was a whare owned, and the business run, by five Maoris. The business capacity of this firm was very limited, and there is a tradition that, on receipt of every item of 1s. 6d., they at once divided the money, each receiving 3½d., and tossing for the remaining odd halfpenny. European enterprise soon stepped in, and the native element gave way, so far as hotel-keeping was concerned, and confined itself to making the most of the travellers otherwise, an art in which they have acquired great proficiency.

The early route of travel was by Maketu, a small native settlement about eighteen miles east of Tauranga; thence packing by native tracks to Rotoiti, Te Ngae, and Ohinemutu; or from Rotoiti direct to Waitangi, on Tarawera, *en route* to Rotomahana. The costs and charges up to this time were, until the final squaring-up by the party, an unknown quantity, and largely depended on the aptitude for commissariat management of the leaders, and the energy of the then indispensable guide.

Under the public-works policy of 1870 and succeeding years, a coach-road was formed from Tauranga to Rotorua and Taupo, and through to Napier; also from Maketu to Rotorua, *viâ* Te Taheke, on Rotoiti. From the early part of 1873 may be dated the possibility of through coaching and waggon-traffic. Fares were high, and the cost of freight quite warranted the charges made for the necessaries of life at Rotorua. For years £14 per ton was the charge to Rotorua, and double that to Taupo. Under this tariff, any bricks used in the first fireplaces and rudimentary chimneys at Ohinemutu cost for freight 1s. each.

With the exception of a very few parties who found their way overland, *viâ* Waikato, Tokoroa, and Horohoro, the Tauranga–Rotorua Road was the exclusive route from the Auckland District for about eleven years. The length is forty-two miles, and it traverses very broken country, crossing the north-eastern and eastern drainages of the great wooded range which, from Maketu northwards to Cape Colville, rises to a great height, more or less abruptly, and is deeply furrowed by ravines, one of which, the Manga Orewa, is, where it is crossed by the road, nearly 500ft. deep.

In the beginning of 1880 Mr. F. J. Moss, then M.H.R. for Parnell, made his way back from Rotorua by an almost disused track, called the Ara Kaharoa. He was aided and guided by Wi Maihi te Rangikaheke and other chiefs of the Ngatirangiwewehe, that hapu being favourable to the opening of the road, but whose authority extended only about half-way from the eastern side. The Ngatitukorehe hapu, which had authority on the western side, at once acquiesced in the proposal, and the writer, then District Engineer, was directed by the Government to make the necessary explorations to open up a road between Cambridge and Rotorua. Previous to the exertions of Mr. Moss we can trace no evidences of desire on the part of the people of Auckland to have direct communication with the lakes. Whether this was owing to an impression that an insuperable native difficulty barred the way, or the result of indifference, it is hard to say; but, as we have seen, the native difficulty, if it ever existed, vanished on being faced in 1880. Two or three years previously the Ngatitukorehe hapu began to assert their independence of the isolating decrees of Tawhiao, and it is probable that previous to that period the Native Office would not have moved in the matter, or allowed any one else to take it up.

Tourist traffic rapidly developed in the seventies, and became a matter of great importance to Tauranga and Taupo. The result to Tauranga cannot be said to be an unmixed blessing, as it seemed as if everything else was neglected for the trade caused by coaches, waggons, and steamships. And when, in the natural course of things, a better route was found the reaction was naturally very severe.

The new road *viâ* Cambridge and Oxford avoided all the ravines which pierce deep into the mountain-range. It leads up the western ascent, on the dividing-ridge between the Waiohotu and one of the branches of the Waimakariri streams. The descent on the eastern side is between the Waiteti and Manurewa. The road was first available for saddle-traffic in 1881, and was opened for coaches in the summer of 1883 and 1884. It at once became popular, as involving no sea-voyage, and, although the coaching at first extended from Hamilton, a distance of sixty-six miles, the road was, for all able-bodied tourists, easy and pleasant compared with the extremely broken country traversed by the old route.

During all the time of lavish expenditure on railways, in the years when loans were raised with the same facility with which the money was scattered and got rid of, when it became an exercise of ingenuity to discover fresh fields for expenditure of the quota which each provincial district claimed as its due, no mention was ever made, or hint of any kind given, of the desirability of having railway-communication with Rotorua, or direct communication of any kind in fact, for we have seen it was in 1880 that Mr. Moss moved in the matter of the road, and the halcyon days of spending for the sake of expenditure were then just about closing.

It was reserved for private enterprise to inaugurate what will yet prove to be, all things considered, the most profitable railway in the colony, and a blessing to hundreds and thousands of the suffering and distressed in many lands. And it came about in this way: In the years 1879 to 1881 large purchases of native land were effected in the country, extending from about twenty-six miles south of Cambridge, towards Rotorua. Some of the claims under alleged agreements to sell extended to the lake. Eventually, in 1881, blocks to the aggregate area of about 260,000 acres became the property of a syndicate called the Patetere Association; and it was a matter of vital importance to dispose of these lands to the best advantage, or to any advantage. At that time all business matters were in a flourishing condition. There was a demand for land, and no difficulty was foreseen in the realisation of the property, provided easy access could be established. Between March and July of 1881 several communications took place between the writer and members of the Patetere Association with the view of promoting a railway to open up the new lands. This meant a line passing up the Thames Valley from the Waikato–Thames line of the Government to the Mangakaretu Block, or to where Putaruru Junction now stands. This was the first inauguration of the Thames Valley and Rotorua Railway, into which the proposal at once developed on being placed before the leading Auckland citizens. It was at once recognised that the Government could not move in the making of this line, which was in the first instance avowedly intended to open up large blocks—in all, about 400 square miles—of private property; but the Legislature had made provision for such cases by the District Railways Acts of 1877 and 1878. Under the provisions of these Acts, on the landowners of a district agreeing to be rated to a certain proportion of the annual cost of a railway proposed to be made through it, and on approval of such railway by the Governor, the Government was empowered to contribute a certain further proportion of income necessary to recoup the shareholders. Borrowing-powers were given, and several lines had at that time been constructed in the South Island under these Acts. As a further means of assisting private railways, an Act was, in 1881, passed through the Legislature, called the Railways Construction and Land Act, by which, instead of an annual contribution by Government towards interest on cost, waste lands to a value of 30 per cent. on cost of construction, not to exceed £5,000 per mile, were arranged to be transferred to the company, which, out of the increased value of such lands, consequent on the making of the railway, was presumed to be able to make a very good investment.

In the case of our railway it was found desirable to divide the line into two sections, and proceed under the provisions of each of the two Acts. Thus, from Morrinsville to Lichfield, about forty-two miles, was placed under the District Railways Act; and from Putaruru to Rotorua, nearly thirty-two miles, it was found possible to work only under the Railways Construction and Land Act. For the first section the lands were all rateable, and the district comprised over half a million acres, including the whole of the Patetere company's lands. Of the necessary land required for endowments for the second section in terms of the Act, the Government held at the time only about 29,000 acres of certainly the best of the open country, but very far inferior to the forest land for settlement purposes. The prosecution of the second section was therefore contingent on the Government acquiring further lands in the forest, or of the company being able to negotiate with the native owners for the same.

The formation of the company was proceeded with; and the rapidity with which £70,000, in as many shares, was subscribed, and the large portion of these held by Auckland merchants and others having no interest in the lands proposed to be opened up, amply redeems the bone and sinew of the commerce of Auckland from any charge of apathy in regard to its interests in Rotorua, whatever may with propriety be said of our representatives at that time, and for many years afterwards. The total shares subscribed amounted to about 125,000, and of these only 37,000 were held by those interested in the land. The others were taken up in numbers of from twenty to three thousand by people whose only interest lay in the opening-up of the lakes to Auckland.

In February, 1882, orders were given for the survey of Section I. and the exploration and preliminary survey of Section II., for the purposes of estimate and compliance with the Acts. These were immediately put in hand, and we may now proceed to describe the country through which the Thames Valley and Rotorua Railway was designed to pass.

The three rivers, Piako, Waitoa, and Waihou or Thames, occupy and drain one and the same great valley, which extends inwards in a perfectly straight direction, about south-east, from the head of the Firth of Thames to a distance of about sixty miles, having an average breadth of probably eight. Morrinsville is situated about the middle of the length of this great plain, and on its western side. From this station, on the Waikato–Thames Railway, the Rotorua Railway starts, and keeps in the Piako Valley for about seven miles; then, crossing over diagonally, reaches the great Matamata levels between the Waitoa and Waihou, and follows the main valley of the latter until the hills are reached beyond Oxford. At this point the Thames is divided into three branches—the Oraka on the western side of the valley, the Waihou in the middle, and the Waimakariri on the eastern border. The middle one has the parent name, and perhaps the greater volume of water, but the Oraka has by far the longest course, and should be considered the parent river of the system. It rises in an almost imperceptible trickling of water from one little pool into another in a valley in the wild recesses of the Rotohokahoka forest, not quite eight miles in a direct line from Rotorua. A clear stream, flowing on silver sand, is soon formed, and after a course of about a mile it falls into the coffee-coloured lagoon called Rotohokahoka. Thence it issues by an underground passage of a few chains in length, forming a stream called the Pekapekarau. This, after a course of about four miles in a wild ravine, is named the Takapuhurihuri, on which the falls and rapids common to all these streams are situated. Being joined by the Paihau the stream becomes the Oraka, which successively receives the Mangakotaha and the Mangatapu, retaining its name, and joining the Waihou below Okoroire. The streams mentioned all run in very deep ravines, and in each and collectively some of the wildest scenery out of the alpine ranges may be seen. The streams are never-failing, and abundant in volume. There is one corresponding locality in all of them, where they form, in almost all cases, clear falls of about 50ft., and a long descent in rapids among the boulders below. A little to the south of the rise of the Thames above described the water-shed between the Thames and Waikato systems is first formed, and the head of the Mokaihaha may be seen. The falls of this stream are probably the largest in the whole series, and can be heard a long way off in the dense forest, wherein sound does not usually travel far. It is remarkable that, although the Mangatapu and Wairakau drain apparently into the Oraka, they contribute very little water, although they are among the largest ravines in every respect in the whole range. There are evidently rents and chasms, which lead the rainfall of probably thirty or forty square miles of forest into the Waihou. On the eastern side of the valley the three great dens of the Waimakariri furrow the flanks of the range, much as the Oraka does on the south-west. Between these immense gullies are elevated flat lands, sometimes a mile or more wide. And there also the open country dove-tails into the forest. The flats and ridges push the fern far up the flanks of the range, and the forest holds its own in the ravines to a distance of two or three miles from the border-line of the solid bush. Then there are any number of dry *awaawas* at a high level above all streams, marking the course of former watercourses, but bearing now no traces of running water. These, with the uplands, are all excellent soil, and only want some arrangement for a small but constant supply of water to become the most enjoyable of medium-sized holdings; while for the smallest class of farms, of from 50 to 100 acres, the forest plateau and sloping flanks offer advantages which, all things considered, are now hard to be equalled in the Auckland District. The formation is pretty much alike on both sides of the range, but the scale is less on the eastern, as might be expected from the less rise from Rotorua basin than from the Thames Valley—about 900ft. in one case, and 1,500ft. in the other.

The country which had to be explored for the railway may, in extent, be described as a plateau extending from Hiwiroa to the north of the coach-road above Tapapa, to Horohoro, a length of twenty miles, having, on the table-land, an average breadth of three to four miles, and about as much more on each flank, bordering on the open country. Probably a fair average of the whole would be about ten miles, giving an area of about two hundred square miles, or 128,000 acres, of workable country, depending on roads and railway for access. The table-land is of very uniform elevation, being from 1,800ft. to 2,000ft. above the sea. Owing to the formation, which is an enormous upheaval of rhyolitic lava, full of fissures, some filled with sand, others open, there need be no wonder that surface-streams are almost unknown, and, where they are found, exist only during part of the year. Each nucleus of settlement will require to be supplied with water by means of a hydraulic ram, after the manner of the railway water-supplies to be described. The soil, when wet, is a rich brown, almost black, or chocolate loam, 1ft. to 2ft. thick, resting generally on the grey soft rock, with often a stratum of small yellow gravel between. The soil takes grass, and holds it well, as evidenced by a rough clearing burnt off nearly six years ago, and sown with grass-seed of not the very best kind for the purpose.

The whole of this very desirable field for settlement can be thrown open by the construction of the railway, and an ordinary bush-road from Kaponga northwards to the Oxford–Rotorua Road—a length of about four miles—and a road from Kaponga to Horohoro as settlement advances, joining the Taupo Road, a length of sixteen miles. Good roads are, however, somewhat expensive in that country. The soil is so soft and deep that it works with traffic in wet weather into a black mud, and often impassable holes. The soft grey rock, however, when applied in sufficient quantity, makes and maintains a surprisingly good road-surface. Any scheme for settling that country should include large temporary, and smaller permanent, reserves of the natural forest—first, for affording winter-feed for the settlers' cattle before they can clear ground enough to supply that want; secondly, for general public purposes; but principally for climatic reasons. Tree-planting on a large scale, in clumps and belts, as the native bush is cut down, should be enforced. The timbers are ordinary kinds. Totara is very rare, excepting towards Horohoro. Rimu and the other pines, excepting, of course, kauri, are plentiful. The great bulk is tawa, some of which is very large, and could be put to many useful purposes. The climate in the open land of Patetere is very dry and bracing, and one of the most enjoyable parts of New Zealand to live in. On the forest plateau the air is very moist; and all the summer, and through the driest seasons, the magnificent *Todea superba* fern, which cannot exist without much moisture, lives and thrives in great beauty. There are numerous lagoons, which retain water for a great part of the year, and the facility with which the soft rock can be cut into reservoirs and rendered watertight by means of a thin skimming of cement will cause the water difficulty to be of very little account in the settlement of the land.

The whole country bears evidence of the action of water in a remarkable degree. The numerous and deep ravines which have been cut out of the solid rock can only be the result of enormous floods of water laden with sand. Many shallow and dry channels exist, filled with large waterworn boulders. Dry *awaawas* are more sparingly found than in the low open lands, but they are otherwise very similar, and without a trace of running water in their beds. In the great Te Toto Ravine, leading eastwards from Kaponga, a dyke of hard rhyolite is seen standing up and crossing the valley like a natural bridge. It is pierced with a waterway 8ft. or 10ft. high, and a deep hole below, always full of water. But water is never seen flowing through it now; and what the condition of the country could have been when that ravine was scooped out, and the hard dyke pierced, is not easy to describe. All over the plateau also are to be found isolated rocks, rearing their storm-beaten pinnacles 30ft. or 50ft. above the surface, the remains of masses which have resisted the grinding and denuding process which levelled the plateau and carved out the ravines as the country yielded, probably gradually, to the upheaving forces. The strata of yellow pumice-gravel and surface-soil, being conformable to the rock, are no doubt due to subaërial deposits made after the erosive action of water had ceased; and very little change has taken place since then, other than the forest growth, of which there is evidence of more than one generation.

Up to the time of commencing the railway survey very little was known of the interior of the plateau beyond the Kaharoa Track, traversed by the intended road. Two other native tracks existed—one from Kokako to Ngongotaha, and another from Te Whetu to the Utuhina Valley. The surveys for the land-claims had included lines run through the forest in some places, and the great "Rohe-Potae" of the Whaite Kuranui Claim had just been cut; but information derived from those engaged in that work was of the mistiest, principally owing to their want of knowledge of the great height of the table-land. The writer's road explorations in the forest and open lands of Patetere supplied a good foundation on which to work. It is not necessary to describe in detail the operations of the various survey explorations. The hopes and fears, expectations and disappointments, which alternated in the experience of about twelve months of hard and harassing work, eventually secured the location of a route favourable in everything but grades. A limit of gradient of 1 in 40 was aimed at, and a route was actually graded to the plateau *viâ* Kokako; but the works and curves would have been heavy. It was determined that none of the deep ravines were suitable, on account of the want of access which would have resulted to a great part of the line should it be located half-way down the sides of one of these. Besides, the amount of works and danger from slips were such as could not be entertained or risked.

By the adoption of 1 in 35 for the maximum grade, it became possible to breast the ascent on the west side, mainly in a dry valley between the Mangatapu and Mangakotaha ravines. And in the descent to the lake-basin two of the gullies—Te Uhi and Manurewa—are not too deep to be embanked, and the heavy fall of the country is overcome by grading diagonally downwards until the levels near the lake are reached.

It is unnecessary also to enter into the records of the railway company and the purchase by the Government of all the district railways in the colony. Those are matters of history, and, presumably, of no general interest now. When the Government determined to push the line to Rotorua, and the writer's firm was engaged as the engineers, it became necessary to at once locate the line for contract. For this purpose a set of very stringent conditions were imposed in addition to a limit of time. These comprised the compensation of grades for curvature, so that, as the haulage would be increased by curves, it would be diminished at these places by proportionately reducing the grades. Also, all stations were required to be straight in alignment and level for a length of 15 chains. These conditions, and the retention of the ruling grade of 1 in 35, rendered the work of location in that dense forest one of very great nicety and labour. It was effected, but with hardly a foot to spare in the critical parts of the grading on both flanks. Ten chains is the minimum radius of curvature, and this only occurs three times, and each at a place close to a station. The preliminary survey from Putaruru to Rotorua showed about 116 curves. These the contract location reduced to 49, many of them being a mile and upwards in radius.

The heavy grading on the western side may be taken at from 1 mile 15 chains below Ngatira to five and a quarter miles above, where the plateau is reached at 1,748ft. above datum. The plateau is just five miles broad as traversed by the railway. At Kaponga, 1,910ft. above datum, the descent begins, and the maximum grade is used on a length of six miles, exclusive of Tarukenga Station. Ngatira Station and Rotorua Terminus are practically on the same level, being 961ft. and 959ft. respectively above datum.

The works vary in character to a large extent on different sections. On the lower part, near the Oraka, there are fourteen bridges, covered by a length of three miles. Only one of these—the Oraka viaduct—has permanently flowing water under it. The others are all built in case of extraordinary floods, which may be caused by the bursting of rain-clouds in the hills, seeing that two of the larger of the ravines—the Mangatapu and the Wairakau—drain down this valley. After leaving the Mangatapu and its bridges no permanent stream requiring a bridge is found until a small one is crossed about one and a half miles from the lake. Thus a length of line of just twenty-one miles has no understructures excepting culverts and pipes and two under-bridges put in for road-crossings. The remaining six miles along the flats rounding the lake will have six small bridges, and the works and grades are of the easiest, until the line, rising gently from the Utuhina, cuts into the hard pumice gravel of the terminus in the new township of Rotorua.

The line was opened to Oxford, thirty-one miles from Morrinsville, on the 8th March, 1886, and that place became the resting-place for the night. The rapid increase of the tourist traffic during the short remainder of the season was remarkable, and taxed the resources of the hotel severely. On the 18th June, following the awful calamity of the Tarawera eruption took place, and marked a standing-point in the prosperity of the whole country. Very few ever considered what the great influx of foreign capital caused by the tourist traffic, and the very small outlay given in return for it, really meant to Auckland. But the hard times we all hear of, and too many of us experience, date from that time.

The line was opened to Lichfield on the 21st June, eleven days after the destruction of the Terraces. The surveys of the second section were completed by Christmas of that year. Although the Ngatira contract was ready, and had been approved in May, 1886, it was not until March, 1887, that a tender was accepted for it. At the same time the natives of Rotorua were granted work at that end, and during about fifteen months they were employed in forming about six miles and a half, which they performed in a most satisfactory manner. The Ngatira contract was completed in June, 1888; and a most unaccountable delay took place until February, 1890, when work was resumed on the Kaponga contract, which is now drawing to completion. This leaves 13 miles 32 chains to complete the line to Rotorua.

The proposals of the Public Works Statement made last week lead only to a present extension to Tarukenga Station, at the crossing of the line with the coach-road, a length of 4 miles 62 chains, although the Statement puts it at only three miles. That length includes the heaviest works to be found on an equal distance on the whole line, and comprises the rocky grading down Te Toto Ravine and the crossing of Te Uhi and Mangarewa Gullies. The coaching length from Tarukenga to the old township of Ohinemutu is nearly eight miles. The through journey can be easily performed in one day, but nothing short of the complete railway-line will ever satisfy the demands of invalids, or be commensurate with the requirements and amenities of the district.

There is no better constructed railway in the colony than this line. The rails are of steel, and the heaviest in use here. The stations and buildings are most ample in accommodation. The same remark applies with greater force to the water-supplies, which are fixed with regard to the necessary expenditure of steam on the various parts of the line. The water-tanks are brick towers, and are of a description to be found on no other railway in or out of New Zealand, unless it is true, as has been reported, that they have been copied in Victoria by a bricklayer who worked at all of ours. Matamata tank holds 20,000 gallons, at an elevation of 15ft. above rails, and is supplied from a well by wind-power. The other four—at Oxford, Putaruru, Lichfield, and Ngatira—are 6,000 gallons capacity each, and are supplied by hydraulic rams, which force up from 3,000 to 4,000 gallons per diem. Lichfield, Putaruru, and Ngatira are supplied from the Ngutuwera, Oraka, and Mangakotaha Streams, and to heights of 100ft., 120ft., and 340ft. respectively. At the middle of the Kaponga contract the contractor has put down for his own use a ram which forces a splendid supply of the purest and coolest water from the Mangatapu to a height of 310ft. and a distance of five-eighths of a mile. Two more supplies will be required for the extension, besides the terminal one at Rotorua, when the line reaches there. It is proposed to install a supply at Kaponga from the Ohinenui, a stream two miles off. The height to be forced is 210ft. This will provide a water-supply for the nucleus of the expected settlement of the plateau; and by adding, when required, a second ram, for which provision is made, 20,000 gallons may be sent up every day. The proposed temporary terminus at Tarukenga will be supplied from the Okakari Creek, 1 mile 30 chains distant, and the required lift is 310ft. The overflows of waste water from Lichfield, Putaruru, and Ngatira are led so as to be of service to the settlements and lands adjacent. This has been of immense benefit to those thirsty lands, and serves to show how easily the water problem may be solved all over that country.

The total length of the railway, including the branch to Lichfield, is 73½ miles. The average cost of this when finished, including the rolling-stock sold by the company to the Government, will be about £4,300 per mile. The cost of Section I. alone, handed over in working-order to the Government, was £3,600 per mile. The cost of Section II., finished to Rotorua, but without any rolling-stock, will be £5,300 per mile. When it is remembered that the average cost of the New Zealand railways is about £7,500 per mile, and that Section II. is of more than average in amount of works, we have every reason to feel satisfied with the result on financial grounds.

The total length of the railway-journey from Auckland to Rotorua will be 170¾ miles, and at the present rates the fares would be £1 15s. 8d. first class, and £1 3s. 6d. second class. At the same journey-speed as at present run between Auckland and Lichfield the time required would be ten hours forty-seven minutes, but there would be no difficulty in reducing it to eight hours by reducing the number of stopping-places, and retaining the present maximum running-speed.

Such is a brief, and, I fear, rather disjointed, description of this very important railway. The delay in the expected early completion is a severe blow to many of us, as we were led to think that at last a broad view was likely to be taken of *bonâ fide* railway requirements, albeit somewhat late in the day, instead of the craving for local expenditure—no matter on what—which has so long been the rule. The course of action decided on has not caused much surprise to those who have had long and varied experience of the wheels within wheels which give motion to our railway policy. The jealousy between the old and new townships of Rotorua is to blame for the delay since 1888, including the present indefinite postponement of completion. Persistent attempts have been made to prevent the line going past the old township, and this after an expenditure of between £20,000 and £30,000 on the Government Sanatorium, and many thousands besides on the purchase of the new township.

There are now in Auckland invalids who cannot go to Rotorua because of the coach-journey. There are no doubt thousands in other lands in the same position. Last year the officially-reported number of tourists was over 2,500. The money turned over in the country by that number would probably be £100,000. Ten times that result would speedily follow complete railway-communication. That is the sordid view of the matter. Let us hope that it will soon appeal to the powers that be, if nothing higher will, and that the long-looked-for completion of the line will be undertaken before the intended new contract is finished.

ART. LIX.—*Ruapehu and Ngauruhoe.*

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 10th August, 1891.*]

Plates XLIII.-XLIX.

IN October, 1889, I had the honour of reading before this society a descriptive account of the geology of the country between Napier and Ruapehu Mountain by way of Kuripapango and Erehwon.* In this paper it is proposed to continue the description so as to include the volcanic district extending from Ruapehu in the south to Tapuaeharuru at the northern end of Lake Taupo. This portion of the volcanic belt of the North Island is even now seldom visited by tourists, and it was almost a *terra incognita* to scientific men up to the date of the Tarawera eruption in 1886. The destruction of the priceless Terraces and the disappearance of the Rotomahana hot lake drew the eyes of the scientific world of geologists to the spot which Hochstetter in 1859 had made classic ground by the brilliant yet simple description of his journey at a time when what is known as the Hot Lake District was little more than a name to Europeans. Hochstetter had travelled from Auckland to the Mokau River, and from thence had struck across country to Tokaanu, an important native settlement at the south end of Lake Taupo, and within a few miles of that portion of the volcanic region embraced by the mountains which go by the name of the Tongariro Range. He had ardently desired to visit the active volcano of Tongariro—or, more correctly, Ngauruhoe—just as Dieffenbach had wished to do when he visited the same spot eighteen years before. But Te Heuheu, a great and renowned Maori chief, ruled in those parts; and the native proverb around Taupo ran thus: "Ko Tongariro te maunga, ko Taupo te moana, ko Te Heuheu te tangata"—that is to say, "Tongariro is the mountain, Taupo is the sea, Te Heuheu is the man." The authority, or *mana*, of Te Heuheu extended from Tongariro over the whole of the Taupo district. *Tapu* had been set upon the Tongariro Mountain since the *tohungas* had deposited there the bones of a former chief who lost his life at Te Rapa, near Tokaanu, in 1846; and woe to any one, be he European or other, who disobeyed the word of such a chief. Thus, then, it was that Hochstetter, though within four hours' walk of the northern slopes of Mount Tongariro, did not set foot on the mountain; nor was

* Trans. N.Z. Inst., vol. xxii., p. 422.

be able to see the crater-lakes, Pounamu and Rotoaira, that nestle between Pihanga, an extinct volcano overlooking Tokaanu, and Tongariro, and where once stood, so the Maori legend runs, the volcanic cone of Mount Egmont, now situated some eighty miles to the south-west. It must have been a great disappointment to Hochstetter, as it was to Dieffenbach, to find himself so near to one of the most interesting volcanic spots in the Southern Hemisphere, and yet unable to traverse its slopes, where his great insight would have been of special scientific value in interpreting the geological history of so important a district.

In 1869 the *mana* of Te Heuheu over the district was in a measure broken, for colonial troops passed along the western side of the Tongariro Range when, in October of that year, the power of the rebel chief Te Kooti was shattered at Porere, a stronghold situated almost under the shadow of the active volcano Ngauruhoe. The district, however, was seldom or never visited until the year of the Tarawera eruption.

The earliest ascents of Ruapehu, as far as I can find, were made by Messrs. Maxwell and Beetham in 1879, followed by Mr. and Mrs. Birch, of Erehwon, in 1881, who crossed the mountain from north to south; but no account of either journey has hitherto been published. In the early part of 1886 Mr. Park, F.G.S., of the Geological Survey, and subsequently Mr. Cussen, of the Auckland Survey Department, reached what is known as the southern peak of Ruapehu; but neither appears to have attempted to cross the mountain, as was done by Mr. Birch's party, as the sequel will show. The accounts given by Messrs. Park and Cussen will be found in vol. xix. of the Transactions of the New Zealand Institute. In vol. xxi. of the same Transactions there is a paper by Professor Thomas on "The Geology of Tongariro and Taupo District," in which an excellent description is given of the northern parts of the Tongariro Range, illustrated by some capital pictures and diagrams. Professor Thomas visited the Tongariro district at the beginning of 1888, but he does not appear to have ascended either Ngauruhoe or Ruapehu during his visit. As far as I am aware, the only available information with regard to the district under notice is to be gathered from the papers referred to here.

My own experience of the volcanic district extends over a period of twelve years, during which time the entire district from north to south has been visited by me, the southern portion three times, and the central or Taupo district many times. All the mountains or volcanic peaks belonging to the Tongariro series have been ascended and crossed, and the sources of the Whangaehu, Waikato, and Wanganui have been explored. The following remarks are based upon the knowledge gathered during my various journeys to the district. The southern division of the volcanic zone extending from north Taupo, where the Waikato River leaves the lake, to Karioi, south of Ruapehu, is situated on a plateau varying in height from 1,700ft. to 4,500ft. above sea-level. The highest part of this plateau is between Ruapehu and the active volcano Ngauruhoe, which is the true watershed separating the sources of the Waikato and Wanganui Rivers. The plateau extends generally in a north-east and south-west direction for a distance of sixty miles, with a breadth varying from ten miles to thirty miles. Its eastern boundary is formed by the Kaimanawha and Tewhiti ranges of mountains, and on the west it has the old trachytic mountains known as the Hauhungaroa Range, of which Hauhunga is the principal point. The latter range passes along the west side of Taupo Lake at a varying distance of from ten to fifteen miles. The plateau itself has a slope to the north-east and south-west, the height around Tapuaeharuru being about 1,700ft., and at Karioi 2,550ft., above sea-level. Almost in the centre of the plateau in its longest direction runs the present line of volcanic activity, which includes hot springs, fumaroles, solfataras, extinct and active volcanoes, and volcanic shafts or volcanoes in embryo. If a line could be drawn from the most southerly peak of Ruapehu, known as Paraetetaitonga, to Mount Tauhara, at the north end of Lake Taupo, it would include the following active and extinct cones: Ruapehu, Ngauruhoe, Tongariro (3), Pihanga, and Tauhara, besides numerous smaller ones. On the plateau to the west of Ruapehu there runs in a direction almost west by north a line of low volcanic cones, but craterless, for a distance of about two miles, the height of the cones being from 150ft. to 250ft. above the general level of the plain. Between the north end of Tongariro and Pihanga, and the latter mountain and Tauhara, are areas of depression, in the first of which is situated the beautiful Lake Rotoaira, and in the second Lake Taupo, the largest of New Zealand lakes. Rotoaira is 1,710ft. above sea-level, and Taupo is 1,250ft.

It would seem that at one period Taupo formed a much larger lake than it now does, and possibly it extended over and included Rotoaira, and much of the swamp-country between that lake and the streams which drain into the upper waters of the Wanganui. Rotoaira has an area of about 12,000 acres, and is about four miles and a half long by two miles broad. It is connected with Lake Taupo by a stream called Poutu, which passes over a trachytic lava-flow from Tongariro, and which has partly filled up the valley between the latter mountain and Pihanga. The distance between Rotoaira and Taupo is about fourteen miles, so that the fall is less than 40in. to the mile. In the Poutu Stream, at a place called Karika, may be seen the legendary footprints of the great chief Ngatororairangi, who, when returning from the ascent of Ngauruhoe, crossed the stream at this spot. Whether Ngatororairangi crossed the river or not, the fact remains that there is what seems to be a human footprint in the rocks at the place named.

It is difficult to say whether Lake Taupo is simply an area of subsidence similar to what Rotomahana now is, or whether it is the remnant of what was once an immense volcano; but its whole surroundings seem to point to the latter surmise as being the correct one. It is surrounded by lavas and volcanic ejectamenta of almost every variety, and the craters of Pihanga, Kakaramea, Tauhara, and the fractured ones between Opepe and Tauranga-Taupo, with many others, are merely remnants of a volcano which exceeded even the dimensions of Ruapehu. Were the Tongariro volcanic range to subside, it would form a larger area of depression than even Lake Taupo, which covers an area of nearly 243 square miles, or 154,560 acres, as determined by Mr. Lawrence Cussen in a survey he made of the lake a few years ago.

The length of the volcanic range south of Tokaanu is about thirty miles, and the distance round the group, exclusive of Ruapehu, is sixty-five miles. The distance round Ruapehu cannot be less than forty miles. The portion of the plateau running along the eastern side of Ruapehu and Ngauruhoe is known as the Onetapu (sacred sands) or Rangipo (cloudy sky) desert, and it well deserves either name. Some parts of it are swamp and exceedingly dangerous, whilst the portion not swamp is made up of moving sands, scoria, cinders, clinkers, and tufas; and, although its traditional history is not reassuring, it is a spot well worth the attention of geologists, for some very curious and rare specimens of volcanic rocks are to be found in places left bare by the ever-moving sands.

On the plateau to the west of the mountains the conical hills of trachyte, to which attention has already been drawn, are objects worthy of attention. They are twenty-two in number, and extend in a north-west direction across the plateau for two miles or more, between the Tawhai and Whakapapanui Streams. In shape they are perfect cones, but there is no trace of a crater in any of them examined by me. They resemble large blisters on a lava-flow, and possibly they were formed by rapidly-moving lava passing over pot-holes filled with water, which, when heated, would tend to pass off as steam, thereby causing the lava to rise in the shape of a cone. I have observed that, when melted lead is poured into a mould which is wet or damp, blisters rise by the expansion of the steam, just in the way I imagine the volcanic cones were formed.

I shall now proceed to describe the three separate volcanoes of Tongariro, Ngauruhoe, and Ruapehu.

1. TONGARIRO.

This mountain, when viewed from a distance, and especially from the saddle between Pihanga and Kakaramea volcanoes, over which passes the Maori track from Tokaanu, appears to have a gentle slope, and it seems as if one could ride to the top without difficulty. This, however, cannot be done; at least, it would be inadvisable to make the attempt. At the north end of the range is the solfatara known as Ketetahi. The date of the breaking-out of this solfatara is not known, although the natives residing in the vicinity of Rotoaira Lake are able to state that it has had periods of greater activity than now prevails. This curious and weird-like spot is situated at a height of 4,800ft. above sea-level, and is outside what properly belongs to the original cone of Tongariro. When approaching this spot the side of the mountain appears as if an immense slip had taken place in a clay-field; but a closer acquaintance shows that igneous forces have been and are still at work, the noises from the numerous steam-vents showing that intense activity prevails in this part of the mountain. Clays of various colours—red, white, and yellow—are found in abundance; whilst in many places sulphur, alum, pumiceous earth, and a somewhat brittle sinter are the prevailing surface-rocks. Some of the crater-basins contain a pitch-like material, which is thrown up in jets towards the centre, whilst in the walls surrounding these basins steam-vents occur, through which steam rushes with a tremendous force. Crystals of sulphur and alum are found in abundance near the vents, whilst large beds of almost pure sulphur are met with for several chains in the vicinity of the crater-basins.

The hot muddy waters flowing from this place are said to possess wonderful curative properties, and in the course of a few years no doubt this spot will be frequented by many persons of a rheumatic and gouty tendency.

About a mile further to the east, but still on the northern slope of the mountain, and at a height of 5,600ft., are situated the volcanic shafts known as Te Mari. The place is difficult to reach, but it presents special features both curious and suggestive to the student of vulcanology. There are three irregularly-shaped craters, surrounded by loose stones and *débris*, and in the centre of each crater is a circular shaft exactly like the shaft of a coal-mine, except that the diameter is perhaps a little greater. From these shafts steam containing a good deal of sulphuretted hydrogen is constantly rising, and deposits of sulphur are to be seen towards the margin of the shafts, as if a solfatara were forming. The shafts appear to be of great depth, as boulders rolled into them could be heard rebounding, as it seemed, from rock to rock for some seconds. These curious craters are of recent origin, and were first called Puia Hou, or New Puia, when they broke out during the last eruption of Ngauruhoe, in 1868–69. They were subsequently named Te Mari, after the sister of Matuahu, chief of Otukau, situated a few miles to the north-west of the mountain, and whose death was supposed to have been hastened by the dreadful sounds that preceded, and the falling of stones, dust, sand, &c., that succeeded, the breaking-out of the New Puia.

At the time of the Tarawera eruption these craters sent out dense clouds of black smoke, but no eruption took place, although rumblings were heard for days before, both at Paparoa and Poutu, situated near Lake Rotoaira. The craters forming Te Mari appear to me as being quite different in their mode of formation from the ordinary volcanic craters to be seen in other parts of the district. They certainly were not built up as ordinary cone-craters, such as are formed by the welling of lava from a vent, after the manner of an artesian flow, the plastic mass forming a cone round the vent; but they appear to have been formed by a gyrating process from below, and as soon as the gyrating force became sufficient to overcome the pressure of the overlying mass it gave way, and craters of irregular shape were formed. It appears to me that this gyrating force might even be approximately measured by simply estimating the mass of rock removed from the crater at the time of its formation. It may also be worthy of inquiry whether the opening of shafts of immense depth is the forerunner of volcanic action, or is simply a phase of decay similar to fumaroles and solfataras. The subject is one of much interest, and demands further consideration.

It will not be necessary for me to refer to the remaining part of Tongariro, as it has already been fully described by Professor Thomas in the volume of the Transactions to which reference has been made above. I would simply mention the fact that the Red Crater, which does not appear to have shown signs of activity at the date of the professor's visit, was steaming furiously in March, 1887, and in the same month in 1890; and I was told by Mr. Maunsell, a gentleman intimately acquainted with the mountain, that it was much more active a few years ago. No one visiting the district should miss the opportunity of seeing the craters known as the North Crater, South Crater, and Red Crater, in addition to Ketetahi and Te Mari, already described.

2. Ngauruhoe.

This, the most active of all the volcanoes of New Zealand, has a perfect cone-like shape, and is joined to the Tongariro group of craters by a saddle composed of heavy basic lavas, along which one can travel from one mountain to the other in safety. At one period it would appear that Tongariro and Ngauruhoe were separated from one another; and, from the conformation of the country to the south and west of the mountain, Ngauruhoe has grown on the lava-plateau that once separated Tongariro from Ruapehu. Curiously, no lava-flow shows itself as if proceeding from Ngauruhoe either towards Ruapehu or Tongariro, and the only junction is by means of the saddle, which is an old lava-flow from the latter mountain. Ngauruhoe has been climbed by me on two separate occasions, the first time being on the 25th February, 1887, and again in March, 1890. Messrs. Owen and Peacock accompanied me on the first occasion, and Messrs. Russell, Caccia, and Studholme on the second. The ascent was made from the north-west by way of the Mangatepopo Stream, which is really the head-waters of the Wanganui River. On the second occasion our party not merely went round the crater, but as far as they dared into it, and the descent was made on the east, our camp at night being on the Waiohonu, a tributary of the Waikato.

The valley of the Manga-te-popo, when nearing Ngauruhoe, is a very interesting one. On the south side it is bounded by a high pig-backed ridge known as Pukekaikiore, a trachytic lava-flow, which is quite separated from Ngauruhoe by a deep V-shaped valley. This range was formed in the early history of Tongariro, and really belongs to that mountain, as all the lower slopes on the western side passing into the Waimanu Plain are made up of trachytic lavas, whilst there appear to be no such lavas in connection with Ngauruhoe. The north and north-west side of the valley is bounded by the old lavas from Tongariro, which are seen to pass underneath the lavas which now block up the valley. Near the west end of the valley there is an old crater known as Pukeorake, the northern half of which appears to have been blown out. This crater has a close resemblance to the one on Pihanga between Tongariro and Taupo South. The valley itself is filled with a lava-stream, or, rather, two distinct lava-streams, one of which is so fresh that it has the appearance of having recently cooled. The material is a heavy, black, shining lava, with a surface so rugged that travelling over it is extremely tedious, and even dangerous. There is no trace whatever of any vegetable growth over the second or more recent flow, which does not extend more than 700 yards or so from the foot of the cone. This lava-flow, although so fresh in appearance, must have flowed from the mountain many years ago, as Bidwill, who ascended the mountain over fifty years since, refers, curiously, to this same lava-stream, and from this fact I am able to state the direction he took in making his remarkable ascent in 1839 But reference will be made to this subject further on in the paper. Directly at the base of Ngauruhoe the Mangatepopo Stream takes its rise in a number of fine springs, some of which possess medicinal properties. The largest spring, however, is a soda-water one, with a flow large enough to supply the wants of Australia. I have kept a bottle of the water from this spring for four years, and it is still fit for drinking purposes.

The base of the cone on the Mangatepopo side is 5,560ft. above sea-level (bar., 25·2in.). Except in a single place, the foot of the cone presents a steep face of lava to the valley, resembling a dark black wall with piliars. It is from here that the lava-stream passed into the valley, and traces of the same stream can be distinguished here and there up the side of the mountain till the crater is reached. Judging by the appearance of the wall referred to, the lava appears to have been exceedingly plastic, and of the consistency of treacle. The cone is very steep, being at least 40° on the north-west, and even more towards the south. The slopes are made up principally of ashes, cinders, and lava; but traces of sulphur are met with here and there. For 1,300ft. there is no trace whatever of vegetation, the last trace of a flowering-plant (*Gentiana saxosa*) being at a height of 6,100ft. In 1887 the ascent was made in two hours twenty-five minutes from the soda-water springs; but it took me twenty-five minutes longer in 1890, although three members of our party reached the summit in one hour fifty-five minutes, much to the inconvenience and danger of the others. In the first ascent our party kept together, and we rested six times—viz., at 5,900ft., bar. 24·9in.; 6,150ft., bar. 24·7in.; 6,550ft., bar. 24·3in.; 6,850ft., bar. 24·1in.; 7,200ft., bar. 23·7in.; and 7,500ft., bar. 23·5in. At the top the aneroid marked 7,655ft., and the barometer 23·4in. Thus the height of the cone by aneroid measurement is 2,095ft., with a barometric variation of 1·8in. Hochstetter, from a distance of twenty miles, estimated the height of the cone at 1,600ft., and its slope at from 30° to 35°; but he was not able to see any portion of the cone below the ridge which joins Tongariro and Ngauruhoe.

The top of the mountain I estimate to be not more than 150 yards across, being nearly circular, but very uneven as to height, and much shattered and broken between north-east and south. The crater itself consists of a primary or major one, within which are two minor or supplementary craters. The north-east and south-east walls of the major crater are much higher—perhaps 120ft.—than those towards the north-west and south-west. The lowest part of the crater-rim, which is the true lip of the crater, is towards the north-by-west. Here the crater-lip has been broken away as seen in Plate XLV., and it is possible to walk for a distance of 50 yards or more into the major crater, along the eastern side. The walls of the major crater show banded rocks, as if stratified—old lava-flows—of various colours, for a depth of more than 200ft., and intense activity appears to be going on over the greater portion of the face exposed, as the steam and sulphur-fumes are seen to be issuing with much force. As already explained, the western half of the crater is much lower than the eastern half, and it is along the former side that two distinct and clearly-defined craters are formed within the major crater. Each crater is separate from the other, and the phenomena in each are different. The western rim of each of the minor craters is coterminous with that of the major crater, and, whilst the minor crater on the south-west may be said to belong to, and is possibly a remnant of, the old crater, the one on the north-west is as perfect in shape as the extinct crater to be seen on Mount Eden, in Auckland, and was, I should imagine, formed at a very recent date. Between the two minor craters, towards the west, there is a flat area on which an observer may stand and look into both craters. The diameter of the major crater I estimate at not more than 200 yards, and each of the minor ones at about 80 yards. As to their depth, I should think that 250ft. would be sufficient for the major crater, and from 100ft. to 130ft. for the minor ones; but this has reference to the craters only, and not to the shafts which are centres of activity in each. Neither of the minor craters can be entered, for not only is there great activity in the several holes in the floor of each, but the surrounding walls are steaming furiously. In the north-west crater I noticed that a great change had taken place during the interval between my first and my second visit. In 1887 the walls of the crater showed very little signs of sulphur; but last year, with the single exception of a beautiful vermilion band, there was nothing to be seen except sulphur (ferric chloride ?) over the crater walls.

At present the south-western crater is the most active portion of the mountain, and dense volumes of steam and sulphurous fumes are constantly being given off. From the several shafts there is sound as from a thick rapidly-boiling substance; but the dense volumes of poisonous vapour which are constantly issuing make it impossible to penetrate the gloom; nor, indeed, is the observer anxious to make any close acquaintance with the seeming fiends whose noises and screechings continually arise as from those in the direst agony of despair. Extending from the lip of the crater on the north side for some distance down the slope of the mountain is a sulphur area—an immense solfatara which can be readily distinguished from Tokaanu. And it would seem that the mountain is giving way in this direction: in some places a hard crust has formed over the sulphur; but the whole place is in a state of intense activity, and is very dangerous. Mr. Batley, of Moawhanga, Inland Patea, who is well acquainted with the mountains, has told me that on the east side of Ngauruhoe, about one-third of the way up, there is a vent which he has seen active on several occasions. "The vent," he writes, "is rarely active, but I saw it busy enough a few weeks before the Tarawera eruption." There was no trace of this vent in March last year, and I am inclined to think that the vapour which Mr. Batley has seen on several occasions comes from a decaying solfatara at the base of the saddle between Tongariro and Ngauruhoe, and which showed signs of activity in 1887. This solfatara to an observer on the south-west would appear as being on the east side of Ngauruhoe, at about the height named. Mr. Batley further says that the mountain was much higher in 1868, when he first saw it, the summit being sharp when viewed from the south-east. Horima, an intelligent Maori residing in the district, states that the top of the mountain fell at the time of the last eruption, which is said to have taken place in 1869; but it is certain that no lava was erupted at that date.

Although this mountain was held to be sacred, it was ascended so long back as 1839 by Mr. Bidwill, and in 1851 by Mr. Dyson. It is especially interesting to compare the accounts which have been kept of the ascents made by those gentlemen, as great changes must have taken place in the crater during the past fifty years. Mr. Bidwill's account is to me the more interesting for the reason that I have been able to tell from his description the exact spot he reached in the Mangatepopo Stream at the base of Ngauruhoe, and the track he took in his ascent of the mountain.

Bidwill's Account. Mountain ascended, 2nd and 3rd March, 1839.—"When I arose in the morning I was astonished to see the mountain around covered with snow except the cone, which was invisible. The natives said the mountain had been making a noise in the night, which at the time I thought was only fancy. As I was toiling over a steep hill I heard a noise which caused me to look up, and saw the mountain was in a state of eruption: a thick column of black smoke rose up for some distance, and then spread out like a mushroom. The noise, which was very loud, and not unlike that of a steam-engine, lasted for half an hour, and then ceased after two or three sudden interruptions. . . . I could see no fire, nor do I believe that the eruption was anything more than hot water and steam, although from the density of the latter it looked like very black smoke. I toiled on to the top of the hill, and was much disappointed at the other side of it: instead of being like what I had ascended, there was a precipice with a large stream of water at the bottom (Mangatepopo). . . . . . As I progressed toward the cone I arrived at another stream of lava so fresh that . . . . it looked as if it had been ejected but yesterday. . . . I had no idea of the meaning of a sea of rocks until I crossed them: the edges of the stony billows were so sharp that it was difficult to cross them without cutting one's clothes into shreds. . . . I at last arrived at the cone. Ther., 65° in sun; bar., $25\frac{14}{20}$in. The cone is entirely composed of loose cinders. . . . After I had ascended about two-thirds of the way I got into what appeared a watercourse. It was lucky for me another eruption did not take place while I was in it, or I should have infallibly been boiled to death, as I afterwards found out it led to the lowest part of the crater, and, from indubitable proofs, that a stream of hot mud and water had been running there during the time I saw the smoke from the top. The crater was the most terrible abyss I ever looked into or imagined. The rocks overhung it on all sides, and it was not possible to see above 10 yards into it from the quantity of steam which it was constantly discharging. From the distance I measured along its edge I imagine it is at least a quarter of a mile in diameter, and is very deep. The stones I threw in which I could hear strike the bottom did not do so in less than seven or eight seconds; but the greater part I could not hear. It was impossible to get to the inside of the crater, as all the sides I saw were, if not quite precipitous, actually overhanging, so as to make it very disagreeable to look over them. . . . I did not stay at the top so long as I could have wished, because I heard a strange noise coming out of the crater, which I thought betokened another eruption."

The following is Mr. Dyson's account as taken from Hochstetter, p. 372, *et seq.* (ascent made March, 1851): "The crater is nearly circular, . . . and I should think it was 600 yards in diameter. The lip of the crater was sharp. Outside there was almost nothing but loose cinders and ashes; inside the crater there were large overhanging rocks of a pale-yellow colour, evidently produced by the sublimation of sulphur. The lip of the crater is not of equal height all round—the south is the highest, and the north, where I stood, the lowest. There was no possible way of descending the crater. I stretched out my neck and looked down the fearful abyss which lay gaping before me; but my sight was obstructed by large clouds of steam or vapour, and I do not think I saw 30ft. down. I dropped into the crater several large stones, and it made me shudder to hear some of them rebounding from rock to rock."

What makes these accounts more interesting and valuable is the fact that both Mr. Bidwill and Mr. Dyson were personally known to my respected and valued friend the Rev. William Colenso, F.R.S.—who, I am pleased to say, is present with us to-night—at whose house, curiously, each traveller stayed on his return from the mountain. To me the circumstance is doubly interesting, because, when relating my own experiences to Mr. Colenso, I had no notion whatever that he had heard almost a similar story nearly fifty years before—indeed, years before I was born—and this from the very men who succeeded in what at that time was a dangerous and, indeed, perilous undertaking.

It will have been noticed that there are wide differences of opinion between the accounts given by Messrs. Bidwill, Dyson, and myself as to the diameter, depth, activity, &c.

At the time of Bidwill's visit the mountain appears to have been in the condition of a geyser, or *puia*, as the Maoris term an intermittent spring; nor does it appear that lava has been ejected from the mountains in any eruption since 1839, although flames are said to have been seen above the dense clouds of smoke which have always been present during times of increased activity.

That the crater was formerly much deeper than it now is appears certain; and it would seem that at the times of Messrs. Bidwill's and Dyson's visits the crater was not divided as it now is, but consisted of a single yawning abyss in a state of activity, resembling what was seen at Rotomahana shortly after the eruption of Tarawera in 1886. I can only account for the wide differences of opinion as to the diameter of the crater by supposing that the eastern walls were much higher and the rim much more unequal than at present. Hochstetter's drawing of the summit of Ngauruhoe, as seen by him in April, 1859, shows the western lip as being exceedingly low as compared with the eastern; and this, if it existed at the time of Dyson's visit, may have misled him as to the width of the crater during what was evidently a hurried and anxious visit. It is much to be regretted that no rough drawing was made of the crater by either Bidwill or Dyson; but it is evident that important changes have taken place within the past half-century. On the south and west, which are really the steepest and longest slopes of the cone, the mountain is deeply furrowed, and the peculiar arrangement of the lava bands with loose ashes and scoria interbedded is causing the mountain to wear away at a rapid rate wherever the lava-stream has broken away so as to expose the loose ashes immediately underneath. It is owing to this that the eastern slope, which at one time was covered with a reddish scoriaceous band of lava about 4ft. in thickness, is now rapidly breaking to pieces; and it is from this side that the ascent of the mountain would be easiest, were it possible to reach the place with the same degree of convenience as on the western side.

The rock-materials composing the mountain are greyish-red and jet-black lavas, containing large feldspar crystals, several of which I found of more than 1in. in diameter. There is no trace of pumice on the mountain, or in the valley of the Mangatepopo; but all the lower slopes to the east are covered with a kind of tufaceous material, overlaid with pumice grit and pebbles for a depth varying from a few inches to as many feet. With respect to the activity of Ngauruhoe, Mr. Maunsell, who is well acquainted with the mountains, informed me that the changes in the crater during the past twenty years have been numerous, that they are more marked after each winter, and that the activity of the mountain has been greater since the eruption at Tarawera. One curious feature with respect to the solidity of the mountain appears to me as being worthy of mention. One of our party at the time of my first visit, seeing a large boulder on the ledge between the two minor craters, thought to create some pleasure by rolling it down the side. The top of the mountain has a peculiar bulge, so that the first leap of the huge stone must have been 200ft. or more. The effect on the mountain, as likewise on each member of our party, was remarkable. The mountain shook as if it had been hollow, and each member on the instant voted against the rolling of boulders either down the mountain or into the crater.

At the base of Ngauruhoe, on the south-west, are two crater-lakes known as Nga-puna-a-Tama, or Tama's Wells. These lakes are situated on the highest part of the plateau between Ngauruhoe and Ruapehu, at a height of 4,560ft. They appear to have no outlet, and were seemingly formed in the same way as Echo Lake, Black Crater, and South Crater in connection with the Tarawera eruption, as loose boulders are to be seen scattered about in every direction. The water at the date of my visit barely filled the floor of the crater, in the centre of which could be seen the circular shaft, as in the Blue Crater lake on Tongariro. These lakes in the early summer are frequented by hundreds of mutton-birds (*Puffinus griseus*); but it is difficult to say on what they feed, as the water is fresh and apparently free from any kind of animal life. The birds breed in the vicinity of the lake, and the Maoris visit the spot for the purpose of taking the young when nearly full-fledged, being at that time extremely fat and good eating.

3. Ruapehu.

This mountain is separated from Ngauruhoe by a valley-plateau varying from a mile in the west to three miles towards the east in width. The highest portion of the plateau separates the sources of the Ohinepango and Whakapapanui Streams, tributaries respectively of the Waikato and Wanganui Rivers. The lakes just referred to are situated on the rise which really constitutes the watershed of the two rivers. There is no surface-connection whatever by means of lava-flows between the two mountains, the only junction being between Ruapehu and Tongariro by way of the Pukekaikiore trachytic range, to which reference has already been made. Ruapehu is the highest mountain in the North Island, and is an immense truncated cone, the base of which covers an area equal to Lake Taupo. It is situated a few miles to the north of the parallel of Napier. Although covered with perpetual snow for a depth of 1,200ft. or more, it is still active, and possesses a crater in the solfatara state, situated in the midst of the everlasting snowfields, and having ice-walls on two of its sides. The mountain consists of three principal peaks—namely, Paraetetaitonga on the south, Ruapehu on the west, and Te Heuheu, or Victoria, as it is sometimes called, on the north. The two former peaks each exceed 9,000ft. in height, whilst Te Heuheu is about 500ft. lower. These three peaks form the limits on the south-west and north respectively of what was once a single crater of more than a mile in diameter from north to south. From east to west the crater must have been greater; but the eastern wall is now broken away, and it is possible to go, as it were, into the heart of the mountain, to the base of the present crater, which appears to have been formed since the destruction of the original crater took place. I have visited this mountain on three separate occasions—first, from the north-west, in March, 1887; then, from the east, in January, 1888; and again, by way of the Kaimanawhas, in March, 1890. The mountain on the east and west is almost bare of vegetation, with the exception of a few low bushes along some of the guts which are evidently mountain-torrents in winter and early spring, when the snow begins to melt from the lower slopes. On the west and south a light bush reaches up the sides of the mountain to a height of between 5,000ft. and 6,000ft. The snow-line is lower on the west and south than on the other sides of the mountain, although towards the north-east there is a large snowfield of a trapezoid shape at a height of about 7,000ft.

I have already stated that a kind of rift has been made in the east side of the mountain, which carried away the east portion of the original crater-lip. There the lava-flows are of immense extent, and the south wall of the old crater must be at least 1,000ft. in perpendicular height, appearing in its banded regularity as though the several lava-beds had been deposited by aqueous rather than by igneous agencies. Standing on the top of what once was the neck of a volcanic orifice, now full of black heavy lava, at a height of 7,400ft., in the midst of an amphitheatre of surpassing grandeur, one sees, as it were, the mighty results of heat and cold by contrasts. Towards the east there are miles of cinder-, ash-, and scoria-fields, with lava-flows of basalt, trachyte, and phonolite; whilst to the north and west snowfields of vast extent rise to the summit of the mountain. It is here that the Whangaehu River takes its rise, in two distinct sources—one where the water is clear, but so impregnated with alum as to be undrinkable; the other where the water is of a milky-yellow colour, and "so strongly charged with sulphates of iron and alumina as to taint the water from its source to the sea," a distance of more than seventy miles. From what I have seen of this river I am satisfied that it has no connection whatever with the hot lake presently to be described. Like all streams fed by glaciers, the river is subject to sudden changes in both volume and colour; and its taste might be accounted for by the fact that its waters are forced to pass through rocks which are undergoing rapid decomposition by means of chemical and physical agencies. A long low spur on the left bank of the Whangaehu in its upper reaches separates the drainage of the Waikato from that of the Whangaehu. The two rivers rise within a few chains of one another; but the source of the former has already been described by Mr. Kerry Nicholls in his book on the King-country. It is possible to climb the mountain by way of the long low spur just referred to, but a spur running nearly north-east and south-west is perhaps the best track to take, as there is really no difficulty up to 6,400ft., where a party consisting of Messrs. Russell, Caccia, Studholme, Walker, Maunsell, and myself tethered our horses when making the ascent last year. From this height to Te Heuheu Peak the climbing is really hard, owing to the loose character of the material to be traversed.

By 10.30 a.m. we were on Te Heuheu Peak, in the midst of the snowfields, with a cloudless sky, and with a prospect glorious and inspiring. The whole of the Kaimanawhas, the Kaingaroa Plain, the Tuhua country and Waikato basin, and the whole of the volcanic belt as far as the Bay of Plenty, and even the ocean near Kidnappers and Te Mahia, could be distinguished in our panoramic view. Running from Te Heuheu Peak still to the south-west is a sharp line of rocks broken here and there, which forms the ridge of the mountain and was the old margin of the crater-lip in its earlier history. From Te Heuheu there can also be traced, running to the south-east, another ridge, one portion of which I have named the Pinnacles, from its turret-like appearance. This ridge runs in the direction of that portion of the mountain already described as forming the sources of the Whangaehu and Waikato Rivers. About a quarter of a mile beyond Te Heuheu Peak the south-west ridge of black-lava rock suddenly disappears, and the snowfield, which has been separated up to this point, becomes one single field of great extent, traversed by hundreds of long crevasses of unknown depth. Curiously, all these crevasses appeared to have a general parallelism—that is, their general direction was south-by-west and north-by-east, showing that the slope or direction of movement in the ice was nearly east-and-west. It was interesting to observe how soon our party became accustomed to the crevasses, and actually in one place passed across several where a kind of ledge of broken ice had been left half-way across the gaping chasms.

Almost midway between the last ridge of rocks and the south peak of the mountain known as Paraetetaitonga, the crater-lake is situated. The icefield from the latter peak and Ruapehu slopes at a high angle towards the lake, and here the crevasses are very large, and the travelling is beset with some danger. Before reaching the lake our party was reminded of being in the vicinity of something different from ice by the unpleasant smells that came from the direction in which we were going. Presently the lake appeared in full view, and this within gunshot of the spot where I had stood two years before, at the head-waters of the Whangaehu. A little careful travelling over steep sloping ice, traversed by crevasses, brought us—the first party that had ever been there—to the lip of the crater, and at once it became apparent that the lake was in a state of intense activity, exactly similar to what one sees at Wairakei in some of the mud-craters and geyser-springs there. Having learnt from Mr. Birch, of Erehwon, that it would not be possible to reach the lake, but that it might be possible to get to the lip of the crater, I took with me about 150 yards of thick twine and a tin bottle, with the intention of obtaining a specimen of the water, or mud, or whatever the lake should contain, for testing purposes; but all my efforts were unavailing, as the bottle got entangled by the jagged edges of the crater-wall, and eventually the string parted, much to my own disappointment. The length of the crater from east to west I estimate at about 450 yards, and its breadth from north to south about 375 yards; but, as the context will show, its size must vary at different periods of the year. On the south and west the crater-wall is composed of a solid mass of ice 250ft. or more in perpendicular height, and this wall forms the terminal face of the glacial icefield extending from Ruapehu Peak to Paraetetaitonga. In one place only in this portion of the crater-wall was there a rock visible, and this was immediately in front of the last-named peak. The east and north portions of the crater-walls are composed of cinders, ash, and lava of varying colours, and banded with as much regularity as if the rocks were sedimentary deposits. The dip is east-north-east, at about 5°. The outside of this part of the crater has a steep cone-like slope, the base of which forms an almost perpendicular face towards the eastern side of the mountain already described, and it is still too warm for the snow to remain upon it. Steam was seen to be issuing from the red bands in the cinder-walls 100ft. or so above the surface of the lake, although the whole of the eastern half of the crater appears to be intensely hot. At the point of junction between the ash-beds and the ice on the south side is a waterfall; and the only sound to be heard as we sat on the rim of the crater, viewing a scene magnificently grand and awe-inspiring, was that produced by falling water, save that now and then a mass of ice gave way, and, with a fearsome crash, fell into the boiling lake. The colour of the water was soapy, or greyish-yellow, covered over in parts with a kind of scum, which now and again showed an iridescence similar to that of oil on the surface of water, and peculiar ripple-lines and scum-like bands could be seen spreading themselves over the entire surface of the lake. The water is in constant motion, the general direction of movement being apparently from west to east, the motion being not unlike that to be seen in a kettle of water when near boiling-point. There appear to be regular pulsations in the lake, and at intervals of from two to three minutes steam is suddenly given off, so that the surface of the water is hidden for a few seconds. After every pulsation, and explosion —no other word will explain the phenomenon—of steam, I noticed large cavern-like recesses below the ice-wall on the west side of the lake, as if the waters had subsided somewhat; but these slowly disappeared as the maximum of activity in the movement of the water approached, the hot water seeming to reach the ice-wall about the moment when the steam was thrown off the surface of the lake. I remained alone on the lip of the crater for more than an hour—the other members of the party having gone—Mr. Caccia to Paraetetaitonga, the others to Ruapehu—watching every movement of what appears to me as the most interesting and remarkable phenomenon in the whole range of the volcanic district. There can be but little doubt that this lake undergoes great changes, and it would seem that explosions somewhat like the one described by Bidwill as having taken place in Ngauruhoe take place from time to time on Ruapehu. "On the 1st May, 1889, the residents in the vicinity of Taupo Lake witnessed, about 11 o'clock, and again at noon, the spectacle of a grand and magnificent explosion of steam on Mount Ruapehu." So runs a telegram from Tapuaeharuru of that date; and it appears that the Whangaehu was in high flood, and rose 3ft. or 4ft. in the short space of a few minutes. At the date of my visit there was ample evidence to show that a great geyser-like explosion had taken place, for quantities of blue mud and many large boulders were to be met with along the east and north-east portions of the snowfield in the vicinity of the lake, and a kind of wave-margin of coloured snow and blue mud could be traced on the ice between the south and west peaks, and which had evidently been deposited by an explosion of some kind. The wave-rim could be traced over the entire icefield sloping towards the lake, and the bluish-grey material upon it resembled what was thrown out at Rotomahana during the time of the Tarawera eruption, and bore no likeness to any of the surface-rocks on the mountain.

In volume xix. of the Transactions there are two papers relating to Ruapehu. One of them is by Mr. Park, F.G.S.; the other by Mr. Cussen, of the District Survey Office, Auckland. Mr. Park ascended Ruapehu on the 8th January, 1886, from the south, and succeeded in reaching Paraetetaitonga, or the south peak. Mr. Cussen appears to have reached the same peak from the west on the 9th April of the same year. Each writer makes reference to the crater-lake, and it is exceedingly curious and interesting to find such a wide divergence between two most careful observers in their description of the crater, and who seemingly saw it from the same vantage-ground, and at an interval of only three months between them.

Mr. Park, in his account, says, "Immediately below us lay the great crater of Ruapehu. The crater proper, or what was probably the former vent, is situated not in the centre of the basin, but appears to be nearer to Paraetetaitonga than to the northern or western peaks. The vent, as far as could be judged from our high position, is probably 10 chains across. At this time it was occupied by a great sheet of ice of a bluish colour, and there was no appearance of steam or water."

Of the same crater Mr. Cussen writes, "Deep down in a crateral hollow of basin-like shape, its steep sides covered with perpetual snow and ice, is a pool of water of a greyish-cream or drab colour. . . . From its peculiar surroundings of snow and ice it was difficult to estimate with any degree of accuracy the diameter of the lake. . . . It appeared to me to be of a nearly circular form, and 500ft. or more in diameter. . . . When I got to the top of the peak I noticed little clouds of steam rising from the surface of the water. On watching more closely, the water appeared now and again to assume a rotatory movement, eddies and whirlpools passing through it from the centre to the sides, and steam flashing up from the eddies, leaving little doubt, to my mind, that the water was in a boiling state."

It is difficult to harmonize the two accounts here given, so chameleon-like in character, as to the condition of the crater, except on the supposition that the glacier or icefield which surrounds the western half of the crater pushes itself forward as an immense sheet over the lake, covering it like a hollow dome, in the winter months, and that this ice-cap does not melt before February or the beginning of March. I do not see how it is possible to account for the crater being "occupied by a sheet of ice," as Mr. Park states, in any other way, as from the manifestations of temperature on the walls towards the north and east it is certain that the activity of the mountain is not of recent date. When this lake was first seen, in March, 1881, by Mr. Birch and his party it presented phenomena almost identical with those seen last year, as the following account, supplied by Mr. Arthur Russell, a member of the party, will show. He writes, "We made straight round the east slope of the west point (Ruapehu), having now the crater in full view. It was about 400ft. perpendicular below us, the snow sloping easily to it for 400 or 500 yards, and then falling sheer down some 200ft. into the crater. . . . The lake is nearly round, with its greatest diameter south-east and north-west some 700 yards by 600 yards. The surface of the lake, which is of the colour of very dirty soapsuds, was covered with steam-wreaths, which made it difficult to say whether the water was in motion or simmering. . . . Small clouds of steam rose and passed off at intervals."

Here, then, we have proof that the crater of Ruapehu presented the same appearance when seen ten years ago as what it did in March last year, when seen under much more favourable conditions; so that the difficulty of accounting for the state of the crater as described by Mr. Park becomes still more perplexing. But I think it is possible to go yet further back for evidence to prove that the crater is by no means of recent origin. This evidence is to be found in a peculiar kind of heavy siliceous pumice on Ruapehu itself. I well remember that in 1888, when Messrs. Petrie and Hamilton were with me in the exploration of the Whangaehu River, on our approaching the mountain we were led to believe the eastern slopes between 5,500ft. and 7,000ft. were well grassed but somewhat browned, owing, as we supposed, to the long period of dry weather experienced in the district. A special journey was made to the supposed grassy slopes in anticipation of some rare botanical specimens, and the disappointment of my friends, who are ardent botanists, can be well imagined on finding that they were nothing more than a dull-brown heavy pumice — a trachyte pumice — partly rounded and partly angular, and varying in size from an apple to a cocoanut. This pebbly pumice covers certain of the slopes below the snow-line to the north-east and south-east of the crater, and it has the appearance of having been ejected at a very recent date. It is certainly distinct from the other varieties of rock on Ruapehu, and either it must be the frothy remnant of very recent lava-flows, or it must have been deposited by explosions from Ngauruhoe, Nga-puna-a-Tama, or the crater on Ruapehu itself. My own opinion is that activity on Ruapehu has been continuous, similar to that on Ngauruhoe and Tongariro, and that each mountain is in the condition of a solfatara.

We have seen that Ngauruhoe, fifty years ago, according to Mr. Bidwill, was in a geyser, or *puia*, condition, and ejected mud and hot water at intervals; whilst in 1869–70 the same mountain, and also Te Mari, threw out vast quantities of fine dust, pumice, and ashes. Less is known of the hoary Ruapehu. It is a spot dreaded by the Maoris, and its history dates back scarcely a dozen years; but during this brief acquaintance with the mountain there has been sufficient evidence to show that the crater is by no means dormant. The deposit of pumice on its eastern slopes, the present heated state of the crater-walls, and the cone-like slope of the crater towards the east and north, all go to support the view that the activity of the present crater is of long duration. Indeed, had it been otherwise the ash- and cinder-bands and the crater itself must have broken away long since by reason of the rapidity with which the work of rock-disintegration proceeds in the upper regions of the atmosphere, more especially within the limits of the zone of perpetual snow.

Geology.

The rocks composing Ruapehu are principally made up of basic and what Judd terms "intermediate" lavas, the only trace of truly acidic rocks on the mountains being the pumice trachyte, which is found on certain slopes in the vicinity of the crater. By way of the Whangaehu River heavy black lavas predominate; but there is a range made up principally of phonolite, or clinkstone, which Mr. Park also describes as being found on the south side of the mountain. Slabs of this rock were seen more than 10ft. across, very smooth and thin, almost like slate, but with a metallic or bell-like ring when struck. At the junction of the two head-streams of the river there is a large waterfall, and here the principal rock is a pitchstone. Along the north-east slopes there are heavy basalts and rust-red lavas. Pieces of tachylite were also found scattered over the slopes, but no large rock-masses of this were seen by me in any of the places visited. The highest point of the mountain on the west is made up of heavy black lavas, but lower down the lavas are of a dull-red colour, and they present the appearance underneath Te Heuheu Peak of having but recently cooled.

The curious thing about Ruapehu is the distribution of acidic rocks over basic ones. Professor Thomas points out, in his "Notes on the Volcanic Rocks of the Taupo District,"* that "The order of succession of the rocks at any given vent or in a given volcanic district is such that the more basic follow the acidic lavas." As basic rocks are mainly found on Ruapehu, it may be assumed that the volcano is in its final or later stage of progress. There is plenty of pumice everywhere surrounding the mountain—in fact, the whole plateau appears to be composed of pumice and tufas. But by what process a pumice-trachyte came to be scattered atop of heavy lavas I make no pretension to explain. It may be that the crater-lake is the beginning of a new period of activity in the history of Ruapehu; but this would be contrary to the prevailing theory as to the sequence of flows from a volcano during its periods of activity. After all, the world knows comparatively little as to the changes which volcanoes undergo from time to time, and the periods of activity and their causes are still unknown or are imperfectly understood. By observation and the collection of facts it may be possible to generalise with regard to volcanic phenomena; but facts must be the basis of all generalisation, and it seems that the facts regarding the products of Ruapehu point to the possibility of acidic rocks succeeding as well as preceding basic ones in the history of a volcano.

TRADITIONS CONCERNING THE MOUNTAINS.

When at Tokaanu three years ago I endeavoured to obtain all the information available, traditional or otherwise, bearing upon the mountains. Of Ruapehu there is a legend that it is haunted by a spirit called Te Ririo, who entices men from their homes and causes them to wander hither and thither over the mountains until they become insane, when he leads them into one of the mountain caves to die, or until rescued by their relations. This is very meagre concerning such an important mountain; but it rather shows what a dread the natives had of the Rangipo desert and its trackless and ever-moving sands, towards which many of their people passed never to return. As far as I can learn, these Maoris possess

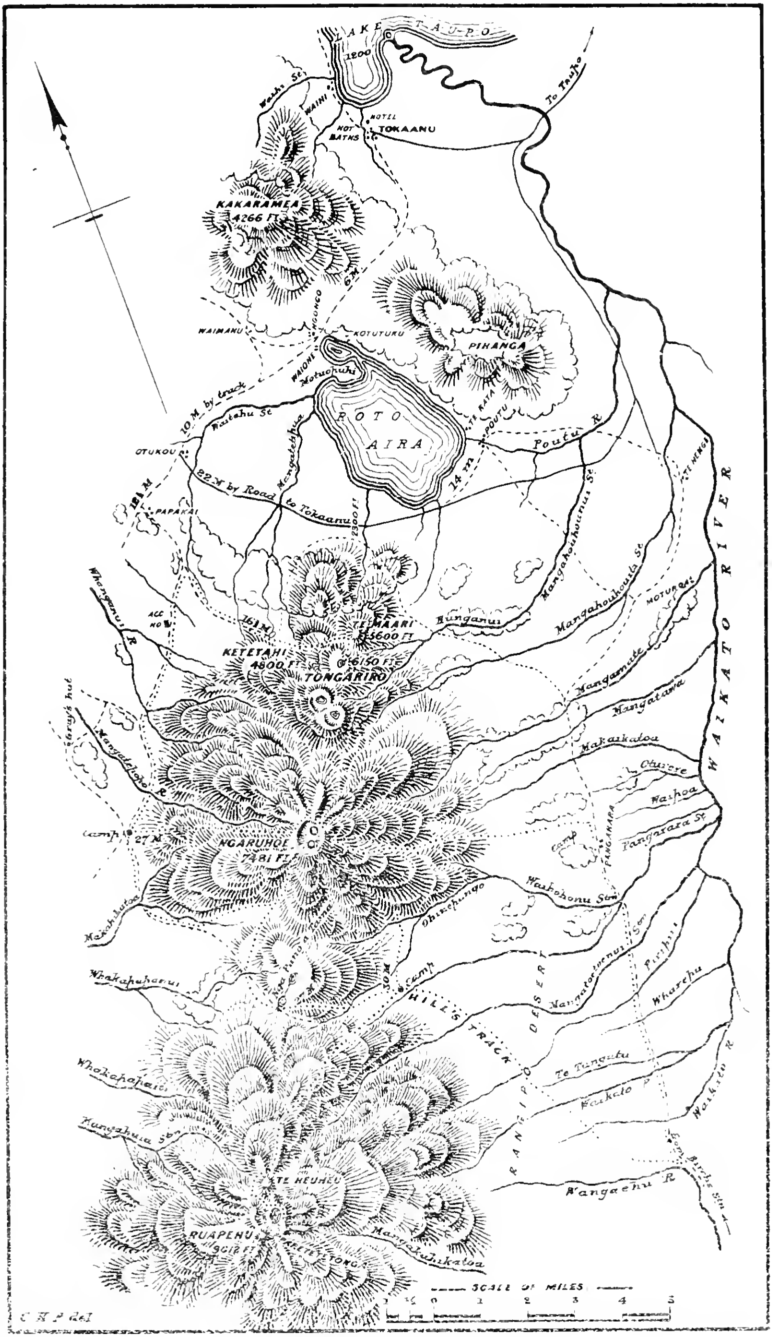
* Trans. N.Z. Inst., vol. xx., p. 307.

no knowledge whatever of there having been an eruption on Ruapehu; but this may arise from the dread among them as to the dangers to be met with in the vicinity of the mountain, and to the absolute sterility of the country thereabouts.

I have already made brief reference to the supposed location of Mount Egmont (Taranaki) on the spot where Rotoaira Lake now stands; and of Tongariro and Ngauruhoe it is said that eruptions always occur at the death, or coming death, of their great chiefs.

The origin of the volcanoes and of all the volcanic phenomena is accounted for by reason of the fact that Ngatoroairangi, the chief priest, or *tohunga*, who piloted the Arawa canoe from Hawaiki, having, in company with Tia, another great chief, taken possession of the country extending from the Bay of Plenty to Ruapehu for his people, ascended Ngauruhoe (which at that time was not a volcano) to perform the needful incantations, and, in accordance with Maori religion, to set up a *tuahu*, or altar, so as to insure to his people safe possession of the country and a happy and fruitful future. When in the midst of his *karakias*, or incantations, the cold became intense, and it seemed as if he must die. It then occurred to him to send for the sacred fire, which was kept during his absence in the custody of his sisters Hoata and Pupu. Seeing them at that moment on Whakaari, or White Island (120 miles distant), he urged them to bring the fire if they would save him from perishing. In response, one of his sisters, leaving a portion of the sacred fire on Whakaari, at once dived into the sea in the direction of Tongariro, and reached her starving brother in time to save him from a cruel death. In her passage underground she set fire to the world below, but here and there she came to the surface to breathe; hence all the hot springs and *puias* between Whakaari and Ngauruhoe. In commemoration of the event Ngatoroairangi left the sacred fire burning in the mountain, and also ordered that it was not to be extinguished in Whakaari; hence these two active craters and all the volcanic phenomena in the North Island.

But, however meagre and unsatisfactory Maori tradition may be with respect to volcanic agencies, the evidence of a long-continued period is to be found not merely within the great plateau immediately surrounding the mountains, the outcome of volcanic eruptions, but the evidence of long continuity is to be met with over all that portion of the North Island where it has been my privilege to travel. In our own town (Napier) the very soil of our gardens is made up in great measure of volcanic products, and the Kidnappers was separated from Napier and Redcliffe, near Taradale, by reason of the immense beds of pumice and other ejectamenta that



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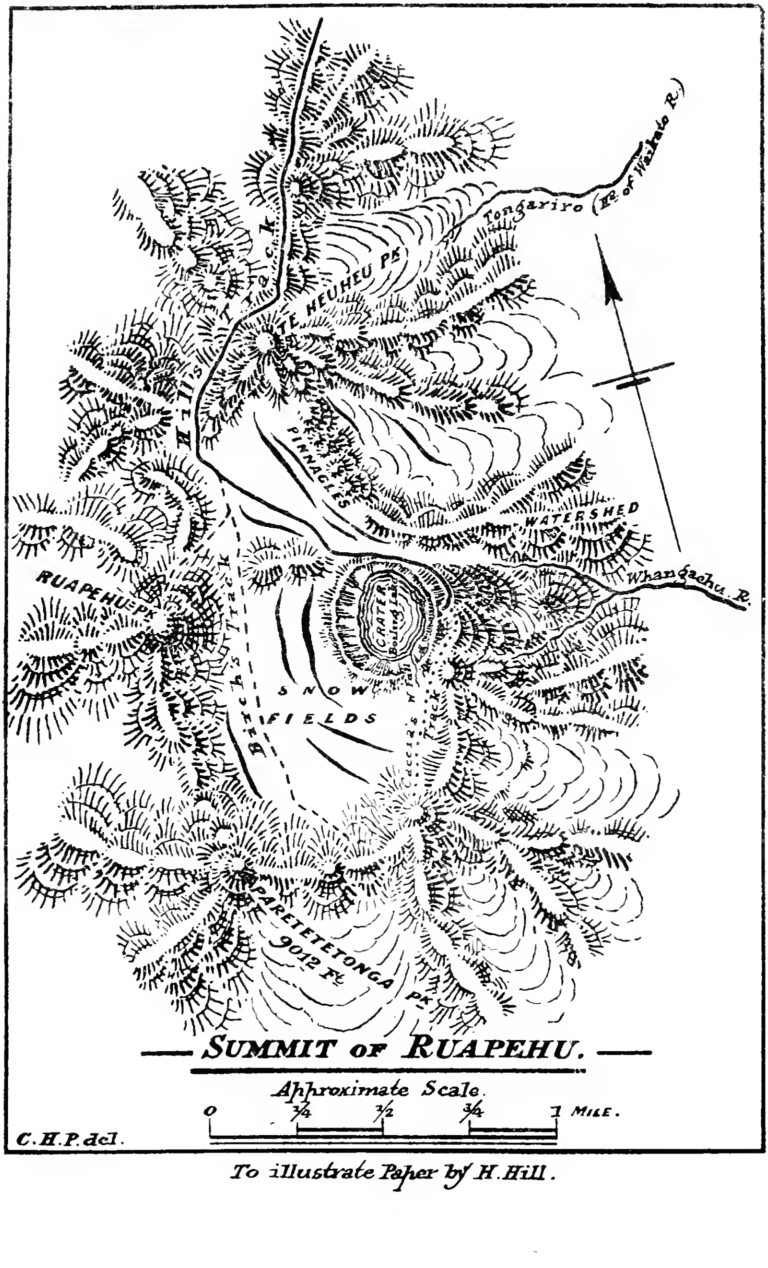

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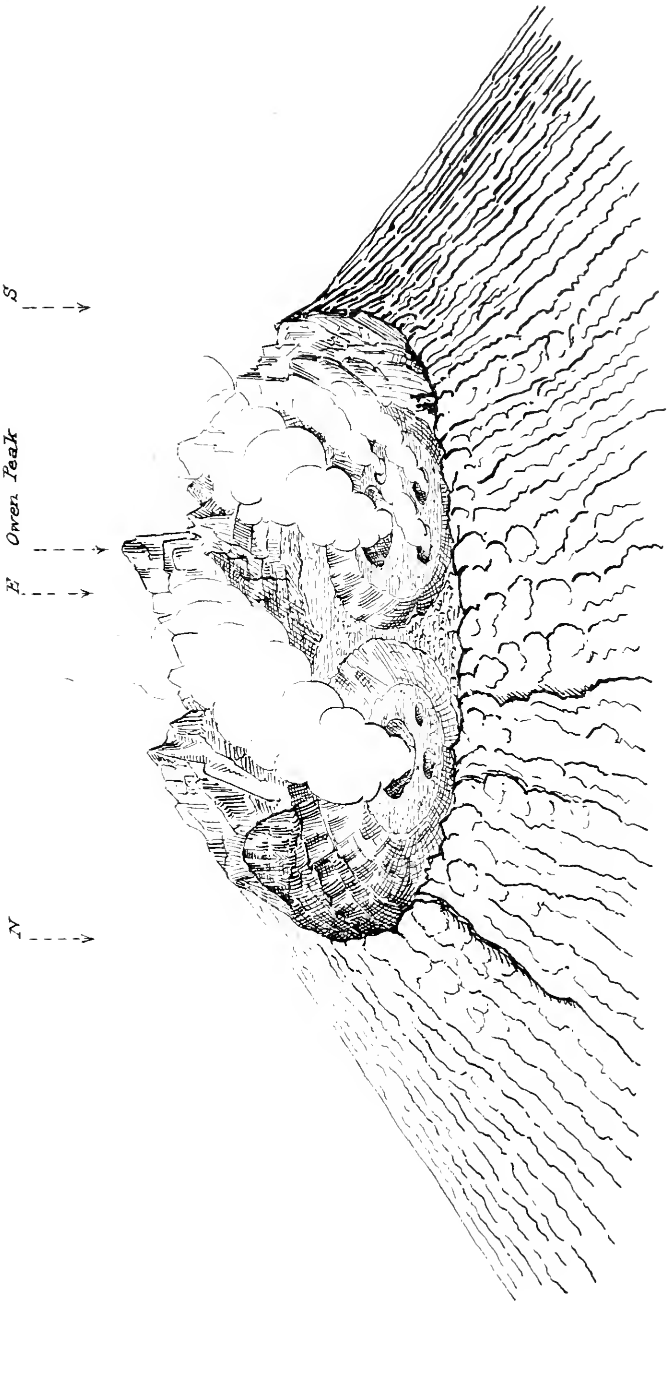
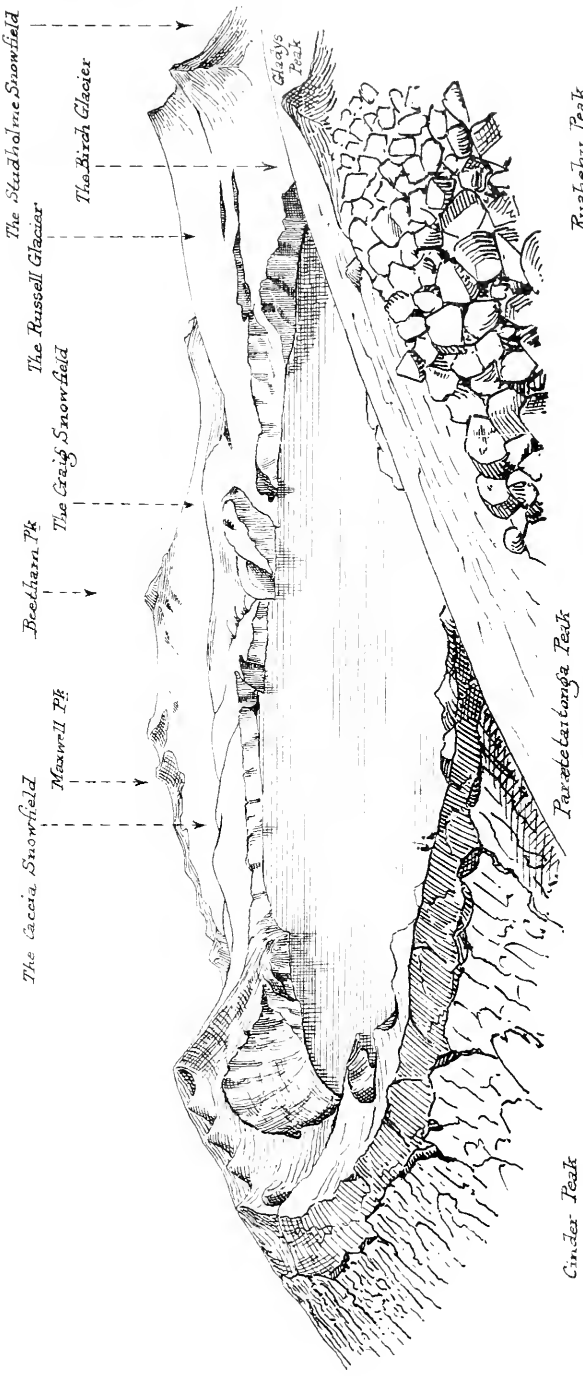


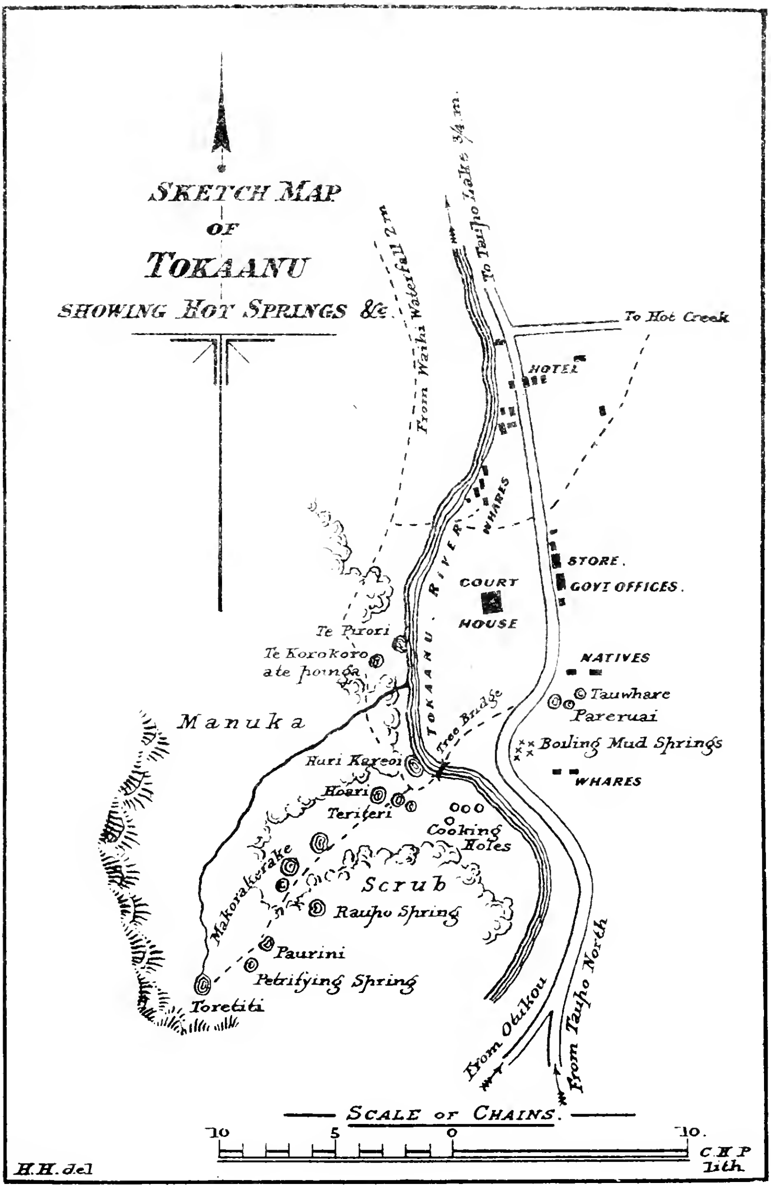
NGAURUHOE CRATER.
From the West.

H. H. del.
C. H. P. lith.



CRATER LAKE. RUAPEHU MT.
(Boiling Lake 550 yds. x 480 yds.)
from the North-east.

C.H.P. lith. H.H. del.


SKETCH MAP
OF
TOKAANU
SHOWING HOT SPRINGS &c.
To Taupo Lake 3/4 m.
From Waihi Waterfall 2 m
To Hot Creek
HOTEL
WHARES
TOKAANU . RIVER
COURT HOUSE
STORE.
GOVT OFFICES.
NATIVES
Tauwhare
Parerua
Boiling Mud Springs
WHARES
Te Pirori
Te Korokoro ate pounga
Manuka
Tree Bridge
Huri Kareoi
Hoari
Teriteri
Cooking Holes
Makorakerake
Scrub
Rauho Spring
Paurini
Petrifying Spring
Toretiti
From Otukou
From Taupo North
SCALE OF CHAINS.
10 5 0 10.
H.H. del
C.H.P lith.

NGAURUHOE, from TONGARIRO.

From a Photograph. C.H.P. lith.

C.H.P. lith.

TONGARIRO, from Summit of NGAURUHOE.

From a Photograph.

once filled the entire area now partly covered by ocean and partly by rich fertile plains. But the distribution of volcanic rocks and the evidence as to the age of the volcano under notice must be left for another paper. So also must an account of the flora to be met with on and around the mountains.

EXPLANATION OF PLATES XLIII.-XLIX.

XLIII.—Map of country round Tongariro.
XLIV.—Map of summit of Ruapehu.
XLV.—Crater of Ngauruhoe in March, 1890, from the west.
XLVI.—Crater-lake on Ruapehu from the north-east.
XLVII.—Sketch-map of Tokaanu, showing location of hot springs.
XLVIII.—Ngauruhoe from Tongariro.
XLIX.—Tongariro from summit of Ngauruhoe.

Art. LX.—*On the Establishment of an Expert Agricultural Department in New Zealand. (Abstract.)*

By W. M. Maskell, F.R.M.S.

[*Read before the Wellington Philosophical Society, 29th July, 1891.*]

Mr. Maskell said that, because there was a gentleman in the Cabinet with the title of Minister of Agriculture, and under him a Department of Lands and a Department of Stock, most people in the colony were under the impression that there is in New Zealand a Department of Agriculture properly established. This, however, was not the case, the titles mentioned being practically (except perhaps for stock) misnomers. In point of fact, there is not at present in the country any official and responsible machinery for investigating the various enemies to cultivation, and for informing and advising cultivators thereon. Agriculture, he might say in passing, was not necessarily farming: there are large numbers of persons engaged in, or interested in, gardening, tree-growing, fruit-growing, floriculture, cultivation of all sorts, who are not farmers, and this should be borne in mind, as will be mentioned presently. Now, on the appearance of a new enemy to the cultivator, of a new pest amongst crops or trees or gardens, or even of a new friend or a new method of procedure, what has to be done by the existing machinery? There is nobody in the colony placed in an official and responsible position, and the so-called Minister of Agriculture has to go outside his department and obtain amateur advice. Take for instance the "Tauranga sheep-disease," as it is called: professors of different colleges are sent for, to investigate it; and that is not a college professor's duty. Take the Hessian fly: an official in the Post Office, who happens to be an excellent entomologist, is sent up to attend to it. Take the so-called "blights:" recourse is had to an officer of the University; and, when a friendly beetle comes to help men to fight these "blights," again the University officer is appealed to. In such cases as the appearance of the horse bot-fly in Canterbury and Auckland, or the fear of some fungus-pest injurious to apple-growers, there is no official responsible person to whom the colonists can go for advice or help. It is not a question of ability or of desire to be useful. All the persons just named have no doubt always been glad to assist, and would always be ready to give the Government and the country their very best services, and undoubtedly the advice tendered by them has been thoroughly honest and well considered, but it is essentially and necessarily amateur and irresponsible, and what is wanted is the stamp of an expert official who can command rather than deserve public confidence. It is no disparagement of the gentlemen who have been hitherto called in as advisers to say that an expert department would be far more satisfactory, and produce better results.

In other countries people have realised this fact, and have established expert Agricultural Departments. In the United States there is the central office at Washington, and, besides that, nearly every State of the Union has its own. In England there is the Board of Agriculture, with a professional staff. In Australia the three colonies of New South Wales, Victoria, and South Australia have expert departments: so has India. The author exhibited to the meeting specimens of the periodical publications of some of these—the "Insect Life" of the Washington office; the *Agricultural Gazette* of the Sydney Board; the "Indian Museum Notes" of Calcutta; the Reports of the State Boards of New York, California, Nebraska, Iowa, and others. One thing was especially noticeable about all these (which were issued at short intervals, some monthly), and that was that they were specially adapted to the circumstances of the country they appeared in. Now, in New Zealand we have nothing, or almost nothing, of the kind. The Government issued lately a little pamphlet about the Phylloxera and other vine-diseases: it is good enough as far as it goes, but it is nothing more than a compilation from facts known in other countries, and does not specially apply to New Zealand.

Two things ought to be very earnestly borne in mind in considering this question. One (noticed above) is that the department required must deal not only with farmers, but with all sorts of persons interested in all sorts of cultivation: it results from this that a mere "practical farmer" would be entirely insufficient to direct it. Independently of the general disinclination of the "practical farmer" to look an inch beyond his nose, a much wider and deeper knowledge is necessary than he is at all likely to possess. Secondly, the department must deal with every kind of friend or foe to cultivation. Animal foes, such as insects, are not always more destructive than vegetable foes, such as the various fungi or noxious weeds. Consequently, the department, if not the officer in charge of it, must be two-sided. In New South Wales and in Victoria and in the United States the various Boards include separate staffs of entomologists and botanists. It is, of course, difficult for any Minister in New Zealand to pluck up courage enough to tell Parliament that two salaried officers are wanted. But he might, at least, start with one; and the author, in a letter sent lately to the Minister of Lands, strongly urged that in England an officer could be obtained competent to at least make a good start with a department, and sufficiently expert in economic entomology and in economic botany. The suggestion made in the letter was that, say, the Royal Agricultural College at Cirencester should be applied to, or Professor Wallace, of the Edinburgh University, to recommend such an officer.

Complaints are sometimes made that the subjects treated of at meetings of the Society are not sufficiently practical. Well, here, at least, is a practical question demanding a practical solution. Whether the solution would be given by the Government and the Parliament might or might not be likely: at all events, it was good to put on record the opinions just expressed; and the speaker trusted that the Society would indorse them by passing the resolution which he proposed, if his views were considered to be correct, to move—namely, "That, in the opinion of this Society, the establishment of a fully-equipped expert Agricultural Department is urgently required in New Zealand."

Art. LXI.—*The Farm: Winter Pasture and its Grazing.*

By J. R. Wilkinson, M.A.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1891.*]

It is a common opinion among Canterbury farmers that there are annually two seasons of no growth of grass on the plains —the first during summer drought, and the second during the severity of winter. These two seasons of no growth are usually well defined, and it goes without doubt that there is no growth in the summer when every tuft of grass is seen to be parched dry; but with respect to the winter season the evidence of no growth is scarcely sufficient, and to make a test I measured regularly during the winter of 1890 the blades on selected shoots of rye-grass and cocksfoot, with the result that, so far as that locality—Richmond, Christchurch—was concerned, there was a continual growth throughout June, July, and August. Measurements were made twice a week, which showed that the minimum rate of growth was during open weather—sunny by day and frosty at night—while a shower of rain always produced comparatively a burst of growth. It was also seen from the totals that the growth during August was as great as that during June and July together, a result hinting that not nature but our system of grazing is at fault when we find, as is so often the case, our sheep-feed scarcer in August than in June or July—a point that will be referred to again.

During the past winter I again took careful and regular measurements every two days of the blades on selected shoots, and plotted the curves of growth on a chart, again showing growth to be continuous but irregular. The observations made this year at Addington were more extensive than last year's, the shoots measured comprising one of rye-grass and one of cocksfoot allowed to grow naturally, and one of rye-grass and one of cocksfoot kept clipped short, at about ¼in. average of blades. The clipped tufts were taken to represent the state of our pastures under our prevalent system of close grazing, and the unclipped tufts to represent pastures not stocked during June, July, and August. It has seemed to me for a good many years that the ordinary system of close grazing secures a minimum yield of grass. Through extensive periods, twice a year, the cry of scarcity of feed is heard in two-thirds of the plains, and an inspection of the pastures of these times shows that the shoots have been eaten to the core, and each plant has become a hard knob, devoid of power of growth and reminding one of an over-pruned tree or of a hedge too often clipped.

A comparison of the growth made by the unclipped tufts with that of the clipped ones shows that the unclipped produced very much more than the clipped.

Taking first the rye-grass, I found that during June the unclipped grew three and a half times as much as the clipped, during July two and two-thirds times, and during August four times as much, the rapid spring growth of the latter half of August having had much greater rate of effect on the unclipped than upon the clipped. I may say that during the recent winter the total growth of the clipped shoot was $4\frac{1}{2}$in. in the three months—June, July, and August—and the total growth of the unclipped in the same time was $12\frac{11}{12}$in.—say, 13in.—or nearly three times as much as the other.

With regard to the cocksfoot the results are different, for the reason that the clipped tuft was a very healthy plant, while the unclipped one was not very vigorous until the latter half of August. During June the tables were turned, and the clipped grew $\frac{13}{12}$in., while the unclipped grew only $\frac{5}{12}$in. During July the clipped grew $2\frac{4}{12}$in., and the unclipped ascended to $2\frac{7}{12}$in.; and during August the superiority of the unclipped over the close-grazed was well shown by $7\frac{5}{12}$in. to $2\frac{8}{12}$in.—not quite three times as much.

The general result is, therefore, that pasture unstocked during the winter produces nearly three times as much feed as equally healthy pasture grazed close. Very noticeable, too, is the narrow width—much narrower than the normal—of the blades of the clipped tufts; and also, in all probability, the damage done to the tuft by the sheep's teeth would still further diminish the yield.

Now, turning to the practical side, we find a factor coming in to interfere very greatly. At the middle of July the old blades began to frost off at the ends, the younger blades not being touched by the frost; and this withering of the old blades went steadily on until the end of August, so that it might almost be said that as fast as the young blade grew the old one died off, and, indeed, at the middle of August there was less feed on the unclipped rye than on the first of the month, on account of rapid withering. The clipped tufts showed no sign of being frost-bitten: and now, comparing the available sheep-feed instead of the total growth, we find that the clipped rye produced $4\frac{1}{2}$in., while the unclipped produced $5\frac{1}{2}$in., or 22 per cent. more; and that the clipped cocksfoot produced $6\frac{1}{12}$in., while the unclipped grew $8\frac{6}{12}$in., or 40 per cent. more. It does not seem, therefore, that a vast gain will be derived from keeping the pastures unstocked all winter, but rather that, judging from last winter, the fields should be unstocked during June, grazed down during the first half of July to secure the feed that would otherwise be frosted, and again unstocked till the middle of August, or later, every day at this period producing three times as much growth as a day in July. Such a method of winter feeding will, of course, necessitate some large fenced-off yards and plenty of artificial food; but it will secure a fairly maximum yield from pasture, and I see no theoretical objection to it save one. It appeared that a shoot of grass grows only at its youngest blade, the second youngest growing very slowly indeed, and the others not at all, so soon as a new blade appears and begins, as it does, to rush ahead. It may be, therefore, that a mature blade gives up its nutritive substance more or less to the youngest blade; so that when it is liable to be frosted it has already become of poor value as feed, and its loss is not of much consequence. Should this surmise prove correct it seems to me that to keep pastures wholly unstocked during winter is a necessity for sound scientific grazing. Should the surmise prove incorrect it would be sound policy to graze the pastures to a considerable extent once in the winter—that is to say, at the commencement of the frosting of the old blades.

In conclusion, I find by inquiry the opinion is very common that grass grows from the root rather than from the blade; and, of course, such an opinión is in accord with bare grazing. On the other hand, the botanist asserts that grass grows from the blade rather than from the root, and he considers, therefore, that bare grazing is thoroughly unscientific and unprofitable.

Postscript.—Since this paper was read I have noticed that the clipped tuft of rye-grass had its vitality so impaired by the clipping that it was unable to stand the slight drought of early summer, and almost completely died out.

Art. LXII.—*On Moth-destruction.*

By Coleman Phillips.

[*Read before the Wellington Philosophical Society, 11th November, 1891.*]

I have for a long time been struck with the vast number of moths which swarm in our gardens, orchards, and fields during the spring, summer, and autumn months of the year, and I have regarded any reduction of their numbers as almost hopeless. The year before last I lost a large area of swede turnips in consequence of caterpillars which I supposed came from the diamond-back moth (*Plutella cruciferarum*); but as the larvæ of these moths only attack the leaves, and my swedes were bored through and through the bulb, the damage must have been done by the caterpillar of the common dart moth, *Noctua* (*Agrotis*) *segetum*, or of the heart-and-dart moth, *Noctua* (*Agrotis*) *exclamationis*, or, rather, of moths similar to these, as Mr. Hudson tells me that the exact English species of these moths are not in New Zealand.

Swarms of little white moths rise about February from our hedges, trees, and even tussocks in a day's ride across the plains. But this is a day moth, and may have to be trapped in the day-time like a butterfly. In September and October our rooms at night are inundated with *Porina cervinata*, or some such moth of the Hepialidæ family, the larvæ of which feed on the roots of grass. Every settler knows how much grass he annually loses from what he calls the wire-worm. I have seen patches of grass many acres in area entirely destroyed for a season by this or a similar caterpillar.

Then, there is the caterpillar from the moth (*Plutella cruciferarum*, I suppose) which bores through the leaves of nearly all our garden vegetables; also cankerworm moths, which destroy our fruit; also the dreaded codlin-moth, for which some friends of mine have tried growing a moth-catching plant, the flowers of which certainly entrap a number of moths very nicely, but its eventual utility I should much doubt. Nevertheless, the catching of twenty or thirty moths each day or night may be very beneficial in reducing the codlin-moth in our orchards not much troubled with the pest as yet. And even this slight reduction may prevent the pest from spreading to clean orchards.

For the diamond-back moth, Mr. Bidwill, of Pihautea, Wairarapa, many years ago tried large bonfires at night; and, for the large moths, he destroyed a number by placing a looking-glass at the back of a lighted candle in an o pen wi w. The moth dashed against the glass and fell disabled.

For codlin-moth, I have read in an agricultural paper of a plan of hanging a lamp in the apple-trees with wings of tin covered with some sticky material. The moths would fasten themselves upon the wings like flies upon treacled paper. I have also read of the manner in which the electric arc lights in New York and London attract the different kinds of moths. Eventually the sparrows have found this out. They are observed chattering around the globes at daybreak, waiting until they cool, and then these little scavengers slide down into the globe by way of the carbons and get a good breakfast; as many as half a dozen birds clambering into one globe. Entomologists have consequently to be up very early to secure good specimens. The attraction of the arc light is only another form of the simple attraction of a lamp upon a drawing-room table. (The arc light also appears to draw the large earth-worms out of the ground, so that lads in New York now collect them for fishermen.)

I therefore determined to experiment with the lamp with wings. I write now in October, and I began the experiment last month. I had a lamp constructed with movable wings. I then covered the wings with castor-oil, and placed the lamp upon the verandah of my house. The large moth *Porina cervinata* came and duly fastened itself on to the wings, and then carefully wriggled off on to the floor, where it crawled about apparently not much hurt, but, in my housekeeper's opinion, doing much harm to the clean appearance of the boards by covering them with oil-tracks.

Next night I determined to give up the sticking process, and see how a milk-dish containing a little kerosene placed beneath the lamp to catch the moths as they fell would answer. I must say this plan worked like a charm. The moths dashed themselves against the lamps, and fell into the kerosene and were immediately killed. I should think I destroyed eight hundred to one thousand moths that night. I have also tried soap-and-water, which acts excellently, but it is as well to grease the top-sides of the dish with castor-oil, and the wings as well. Treacle, soap, honey, castor-oil, and kerosene can each be tried at will. You will see by the apparatus on the table that the dish, wings, and lamp are fixed together, so that they form one machine, easily hung in any tree. Two such machines, shifted from tree to tree, should clear an ordinary-sized orchard of moths. As the apples are now forming, the machines should at once be made use of, as I am not at all sure but that the codlin-moth begins to lay its eggs in the eye and on the skin of the apple as soon as it is fairly formed.

I have caught two to three thousand different-sized moths in one night, but this only rarely. The best nights are dark damp nights. On bright moonlight cold nights in September and October moths do not come out. Many of the moths were very small, and great numbers settled about the verandah in the vicinity of the lamp; these we killed the next morning. As these moths would have laid about five hundred eggs on the average, to develope hereafter into grass-eating worms or caterpillars, I calculated that I had destroyed in that one night 1,250,000 worms. Let us say that two hundred of the apparatus are exposed in the Wairarapa district for thirty nights during spring, summer, and autumn, and five hundred moths are caught each night. This, at an average of five hundred eggs, would give $200 \times 30 \times 500 \times 500 =$ 1,500,000,000 eggs destroyed. After this field-moth has laid its eggs it dies, and myriads of the dead moths cover the paddocks. With regard to orchards, it will be sufficient if fifty to a hundred moths are caught each night. Such a slaughter for a few years would have a very considerable effect upon all moth life in the district. The lamps would act like poisoned grain upon the rabbit-pest. Not that poisoned grain conquers the rabbit-pest, nor will this apparatus conquer the moth-pest. It will only sweep off excessive increase—perhaps free our gardens and orchards. Nature has its own proper check for all living things, and I hope Mr. Koebele will be able shortly to introduce the proper natural enemy for the codlin-moth.

This being the case, what harm am I likely to do by promulgating this plan of moth-destruction? I shall be glad to hear from our worthy Director, Sir James Hector, Mr. Maskell, Mr. Hudson, and other members of the Society their opinions, as I should not like to adopt any wrong measure of clearance. My own opinion is that we have introduced many harmful grubs into the colony without their natural enemies, and that I should do no harm by clearing off excessive increase in the moth stage.

I shall try the apparatus among my turnips and cabbages, and see whether the orchard, garden, and turnip-fields cannot be cleared from night-moths of all descriptions. Day-moths will require a different treatment; but it is the moth stage of all caterpillars or worms that I propose generally to attack.

I may not be able to do much good myself, but other persons may assist me towards the object in view. The task is a gigantic one, but we may succeed in assisting Mr. Koebele's action in introducing the natural enemies. Man being the highest check, this apparatus may always be of use as one method of reduction. As different kinds of moths come out in succession during the summer, the apparatus should be always ready for use. It should be kept well oiled, to prevent the tin from rusting. The dish should be hung to the tree by four strands of wire, and the lamp suspended in the centre. The lamp will not attract the little beetles, which sometimes swarm in such vast numbers in spring, producing a curious humming noise on a dark night, in any oatfield or where ground has been freshly ploughed; but I hope to devise some plan for reducing their numbers also. Entomologists may not approve of this kind of destruction, but agriculturists must protect themselves.

Art. LXIII.—*Is it expedient to make Vaccination compulsory?*

By R. H. Bakewell, M.D., formerly Vaccinator-General and Medical Officer of Health for the Colony of Trinidad; Author of "The Pathology and Treatment of Small-pox"; Fellow of the Royal Medical and Chirurgical Society of London, &c.

[*Read before the Auckland Institute, 20th July, 1891.*]

Finding my name and opinions much quoted in the publications of the Anti-Vaccination League, and in the evidence given before the Royal Commission on Vaccination now sitting in London, I am desirous of recording my opinions on the question of compulsory vaccination in a more formal manner than I have hitherto done. The subject is one of great and increasing importance and interest—few are more so, as it is a question which is personal for every parent of children born on British soil or in British colonies.

Let us begin by defining our terms. I ask, Is it *expedient* to make vaccination compulsory?—not "Is it right?" I use the term "expedient" advisedly, since we have no national or authoritative code or basis of ethics, and the terms "right" and "wrong" are therefore inapplicable. Under a parliamentary system the individual has no rights; his life, his health, his property, are all at the mercy of the supreme power residing in Parliament. Nevertheless, like all despotisms, Parliaments find it expedient to exercise their supreme power within certain self-imposed limits. It would be quite within the competence of Parliament, and would be the logical sequence of the Compulsory Vaccination Act, to enact that, when the parents object to vaccination, their children should be taken from them by force, and vaccinated by force. But the inexpediency of sending a policeman to snatch a baby from its mother's arms in order to have it vaccinated, was stated as the reason for not resorting to legislation of this extreme kind.

Then, what is "vaccination"? It is too well known to need a description of its external symptoms or appearance; but it may be as well to note that there are two kinds of vaccination—the one derived from a disease which appears to be a natural disease of the cow and horse—the true Jennerian vaccinia—and the other derived from the inoculation of human small-pox into the heifer or cow. Owing to the feebleness and apparent inefficiency of the Jennerian vaccine, Mr. Marson, some twenty-five or thirty years ago, inoculated cows with human small-pox, and obtained vesicles of modified small-pox, from which he vaccinated children. This form of vaccine proved much more powerful than the Jennerian vaccine, and was very extensively used. I procured a supply from Mr. Marson when I was Vaccinator-General of Trinidad, and introduced it into the island; many thousands of children were vaccinated from it.

It is important to remember, in the discussion of this question, that vaccine, generally speaking, is only modified small-pox. The reason, and the only reason, for vaccinating infants is to prevent their having natural small-pox; in other words, the law compels them to suffer a mild form of small-pox, inoculated, in order to prevent them from having small-pox in the natural way by ordinary infection. This procedure is vindicated on the ground of public safety, and an appeal is made to the experience of former days, before vaccination was introduced, to show the terrible ravages committed by small-pox, and the comparative immunity created by vaccination.

In my younger days it was contended boldly that a thoroughly successful vaccination, leaving four good and characteristic scars, was an all but absolute preventive of an attack of small-pox for the whole of life. Nobody maintains this view now. It was Marson's view, supported by statistics which he had gathered from his experience at the Small-pox Hospital, London, and from other sources. With two good marks, the mortality was only 3·6 per cent.; with three marks, 3·1 per cent.; and with four marks, 1·6 per cent. But it is to be noted that in 1876–78 the mortality among persons having four marks was 3·1 per cent. at the Hampstead Hospital, one of the finest hospitals in the world, in a magnificent situation, and with every possible aid that medical skill could afford. Now, 3 per cent. of deaths in an acute disease, tending to terminate in health, and among patients having all the advantages just enumerated, would serve to show that there is very little protective influence in the vaccine itself. In an epidemic of typhoid in a tropical climate, amongst patients mostly of the lowest class in the community, living in the most insanitary dwellings, badly fed and badly nursed, I have had a mortality of only three out of ninety-three cases, or 3·2 per cent. I have had a mortality of only 4 per cent. in an epidemic of acute scorbutic dysentery in the same colony among 111 patients. So that a mortality of 3·1 per cent. does not imply any specially protective power over those attacked.

But does vaccination protect the vaccinated person from an attack of small-pox? In other words, if a thousand vaccinated persons and a thousand unvaccinated, living under similar circumstances, belonging to the same race, are exposed to the same danger of infection, will more of the unvaccinated than of the vaccinated be attacked by small-pox? To my mind, there can be but one answer to this question. Undoubtedly a far larger proportion of the unvaccinated will be attacked. I will go even further, and say that, in proportion to the length of time that has elapsed since the vaccination, and the thoroughness of the operation, a much larger proportion of the vaccinated will have small-pox in the mild or discrete form, and so the mortality amongst the whole number attacked of vaccinated persons will be smaller than that of the number attacked who were unvaccinated. It must be remembered that a discrete attack of small-pox is never fatal unless by some gross mismanagement. But if the vaccinated persons get the confluent or hæmorrhagic forms, then, other things being equal, I believe their mortality will be as large as if they had never been vaccinated.

The question still remains whether, vaccination being partially protective against attacks of small-pox, it inflicts any such permanent injury on the constitution as to make it better to risk a possible attack of small-pox than to endure the evils produced by vaccination.

To answer this question we must consider (1) what are the inevitable evil results of vaccination, and (2) what accidents may occur, either unavoidable in themselves, or only to be prevented by the use of precautions which it is hopeless to expect the use of, when vaccination is performed on a large scale.

Now, the direct and unavoidable evils of vaccination are the infliction of an acute febrile disease, accompanied by a painful eruption, and an alteration of the state of the whole blood from its normal condition to one which for some years, and those the most important in the growth and the development of the body, renders it incapable of nourishing or reproducing the small-pox germ. The febrile disease is a temporary affair, and not, in the vast majority of cases, dangerous to life. When children are so delicate or unhealthy as to make the vaccine fever and eruption dangerous they can always be excused the operation.

The permanent change in the blood is quite another matter. I commenced, but have never completed, some microscopical investigations into the conditions of the infant's blood before, during, and after vaccination. It is evident that a fertile field for inquiry is open here; and without a series of well-conducted examinations, extending over children of different races, and in different climates, no positive conclusions could be arrived at. But of one thing we are quite certain, as it does not need the aid of a microscope: there is a large destruction of the red corpuscles during the febrile stage of vaccinia, followed by an anæmic condition. How long this anæmic condition lasts we have no trustworthy observations to tell us; and how far it extends—that is, what is the actual loss of red corpuscles—is, as far as I know, in the same state of uncertainty. Of course, we often find parents complaining that children who were perfectly healthy before vaccination have lost colour, strength, and flesh after it, and have never recovered their previous good health. But these complaints, tinctured as they evidently are by a strong prejudice against compulsory vaccination, must be received with caution. Still, there is such a mass of evidence of this kind that it ought to be allowed some weight.

So much for the inevitable results of vaccination. The accidents of vaccination may be roughly classified under the following heads:—

1. Inflammatory: including erysipelas and other septicæmic diseases; glandular swellings; phagedæna, sloughing, or mortification at the points vaccinated.

2. Eruptive diseases, mostly of a pustular character, occurring with or immediately after the vaccine eruption; eczema, herpetic eruptions, ecthyma, and impetigo.

3. The inoculation of constitutional diseases—syphilis, leprosy, tubercle.

Now, as regards the inflammatory diseases, there are some vaccinators of large experience who assert that they have never seen any ill-results of this kind arising from vaccination. Well, some people are very lucky, but they have no right to argue from their limited experience that such accidents never occur. I have been very fortunate in my midwifery cases; I have never lost a case in my own practice for thirty-five years; but for all that I do not deny that women die in childbirth. I have seen erysipelas more than once or twice, or a dozen times. In the West Indies it used to be common. The inflammation that followed the vaccination of coloured children was very intense, and the number of insects attacking the unfortunate children no doubt contributed to carry the germs of erysipelas to them. Glandular swellings, particularly in scrofulous children, are not rare. I had myself a case in which each vaccine vesicle was followed by mortification of the skin beneath it, and a phagedænic ulceration which required very vigorous measures to stop it. This was in a young woman during the epidemic period in Trinidad. I am not sure whether it was a primary vaccination or a revaccination. The latter, as is well known, causes very severe inflammation, pain, glandular irritation, and erysipelas in the majority of adults, besides severe and most oppressive febrile disturbance: at least, this is the case at the time of epidemics, when revaccination is most practised.

Post-vaccinal eruptions are so very common amongst the children of the poorer classes in England that they form one of the stock arguments against vaccination.

The inoculation of constitutional diseases used to be laughed to scorn in my younger days. It was said in my hearing by Sir John Simon, K.C.B., then Mr. Simon, the Medical Officer of the Privy Council, that no such inoculation could take place without gross carelessness or unskilfulness on the part of the vaccinator. I used to be of the same opinion; but a case I saw some sixteen or seventeen years ago convinced me that an infant might look perfectly healthy, and yet be the subject of unmistakable hereditary syphilis. The evidence that syphilis has been communicated by vaccination is simply overwhelming. I may refer to the report of the Committee of the House of Commons on Compulsory Vaccination; the Third Report of the Royal Commission on Vaccination now sitting in London; the work of Mr. Jonathan Hutchinson, F.R.S., late President of the Royal College of Surgeons of England, on syphilis, in which he devotes a chapter to the description of vaccinal syphilis; and my own experience in this colony and elsewhere. I have seen three cases in this colony alone.

The inoculation of leprosy by means of vaccination is now exciting much attention. It will form one of the subjects which the Commission of Inquiry sent out to India by the National Leprosy Committee will have to investigate. My friend Mr. William Tebb, whose arduous and disinterested labours for many years as Chairman of the Executive Council of the Anti-Compulsory Vaccination League must excite the admiration even of his opponents, has literally circumnavigated the globe in his search after evidence on this point. The alarming spread of leprosy of late years contemporaneously with the extensive diffusion of vaccination must cause thoughtful men to consider the question very seriously. When I was examined before the Committee of the House of Commons I gave evidence to this effect.*

On my return to Trinidad I had to encounter an epidemic of small-pox which spurred us on to vaccinate right and left, and to revaccinate all who would submit to the operation. But so firmly fixed was the belief of the people that vaccination from a child of a leprous family would be a possible cause of the vaccinated person becoming leprous, that not even the fear of such a terrible epidemic of small-pox as was then going on would induce them to allow themselves or their

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* *Vide* Report of the Committee of the House of Commons on Compulsory Vaccination, Answers 3563, 3564, pp. 207, 208.

children to be vaccinated from any vaccinifer in whose family any member was a leper. And then, to my astonishment and dismay, I found that there was hardly a Creole family in the island—white, coloured, or black—free from the taint of leprosy.

The evidence accumulated by Mr. Tebb and contained in the Third Report of the Vaccination Commission is most interesting and valuable. He quotes from many medical men of experience in support of his views. Dr. Arning, formerly of Honolulu, says: "The unusually rapid spread of the disease about thirty years ago may possibly be attributed to the great amount of indiscriminate vaccination carried on about that period. . . . I attach far more importance to an instance of an increase of leprosy soon after vaccination on a much smaller scale and during a much more recent period than the above." Then he alludes to a "very remarkable new crop of leprosy" which had "sprung up at one of the islands in the year 1871–72, about a year after most careless vaccination had been practised."

That bacilli exist in both leprosy and tubercle is beyond all dispute; that the bacilli of these diseases may be grown and cultivated in suitable media is ascertained as a fact respecting one of them—tubercle—and, although not experimentally proved as regards the bacillus of leprosy,* yet is almost beyond doubt. Artificial nutrient materials have hitherto failed, and it is not allowable to try the only natural medium—the blood and tissues of a person living under conditions likely to develope leprosy. I have no doubt, from seeing the origin of leprosy cases, and studying several hundred cases of the disease, that it is not only inoculable, but that it spreads by inoculation or absolute contiguity, and I have no hesitation, after twenty years' consideration of the subject, in affirming again the opinion given before the Committee of the House of Commons.

Inoculation of Tubercle.—Considering the great abundance of tuberculous diseases, and the infinitely various ways by which the tubercle bacillus may be introduced into the system, it may seem hardly worth while to guard against the small chance of inoculating with lymph from a tuberculous child. Yet the same objection would lie about the inoculation from a syphilitic child. Inoculation in either case would almost certainly give the disease.

Having now as briefly as possible considered the essential and accidental dangers of vaccination, we have to answer the practical question, "Is it expedient to make vaccination com-

* Since this paper was read, it is reported that the *Bacillus lepræ* has been cultivated in India.

pulsory?" To this question I give an unhesitating answer in the negative. I hold that it is not expedient to force vaccination on the people,—

1. Because vaccination does not invariably protect from small-pox even for a few months. [See my book on small-pox, pp. 40, 41.]

2. Because the protective influence of vaccination is so feeble after the age of puberty that revaccination becomes necessary whenever the person is exposed to immediate danger of infection.

3. Because even revaccination repeatedly, successfully, and recently performed does not protect from an attack of small-pox—*e.g.*, my own case after *five* successful vaccinations, the last within six months of the attack of small-pox.

4. Because vaccination, even performed with care, may be followed by accidents which may destroy life, or produce permanent constitutional changes of an injurious character, or be the means of introducing the germs of syphilis, tubercle, or leprosy into the system.

5. Because in this colony vaccination is quite unnecessary, inasmuch as small-pox has never spread here, although it has frequently been introduced. Hence it appears that our system of quarantine, although far from perfect, amply suffices to preserve us from small-pox.

6. Because, so far from compulsory vaccination being expedient, vaccination here is highly inexpedient, and may be followed by much evil, while it cannot do any good.

I must guard myself on one point. I am not prepared to recommend that vaccination—that is, as I understand it, the inoculation of a modified small-pox in infancy—should not be practised in Europe, where the conditions of life are totally different. Nobody who has seen small-pox of the severer types—confluent, corymbose, or hæmorrhagic—would be inclined to deny that vaccination, with its possible dangers, is far preferable to an attack of natural small-pox. The horror and disgust inspired by a small-pox patient, the hideous loathsome aspect of the face, the horrid smell, the frightful pits and scars that often result, the blindness and deafness that sometimes follow, and the difficulty of getting nursing attendance for such cases, can only be appreciated by those who, like myself, have attended small-pox patients and hospitals in an epidemic. I saw cases in England—a few dozen, perhaps—but until I had to attend in an epidemic, where we had over twenty thousand cases in a year in a small island, I had no adequate idea of what small-pox was. Young people of the present day have no idea of what ravages small-pox used to inflict. Forty or fifty years ago a very considerable percentage of the population in Britain was pitted by small-pox, and the disfigurement this occasioned amongst women was one cause of the great and rapid spread of vaccination. There is not a woman in existence who would not risk any possible damage to her health or constitution if it would save her from the disfigurement produced by confluent small-pox. There is another point too: the dread of the disease often causes people to take it, and makes it fatal when taken. The protective influence of vaccination, therefore, has a double action, physical and mental.

For these reasons I cannot, in the present state of sanitary science, or rather ignorance, see how vaccination, voluntary of course, can be given up in Europe, or in thickly-peopled countries like North America.

Art. LXIV. *Brake-Fins: A Proposed Appliance for the Better Handling of Ocean Steamers.*

By the Rev. Philip Walsh, Waimate North.

[*Read before the Auckland Institute, 24th August, 1891.*]

When we contrast the modern ocean liner with the old sailing-packet that many of us are able to remember, we cannot but be amazed at the giant strides that have been made within a very few years in the numerous arts and sciences upon the correct application of which a safe and prosperous voyage depends. The confined space on deck, the stuffy cabins, the rough-and-tumble of slippery planks and flying tackle, the salt diet, and the hazardous cookery—all these have given way to a new order of things, and a sea-voyage is now looked forward to as a prolonged picnic in a floating palace furnished with all the conveniences of a first-class hotel, instead of a tedious imprisonment, during which every element contributed its share of discomfort. But the improvement, astounding as it is, has not been uniform; the advance has not taken place along the whole line: indeed, in some departments there has been a positive standstill, if not actual retrogression.

The most noticeable instance of this deficiency is that which regards the handling of vessels under certain important and inevitable conditions. Given plenty of sea-room, when the only question is how to get over the ground—or, rather, the water—in the shortest possible time, there is no comparison between the modern ship and all those that have preceded her, whether impelled by sail or steam; but when it is necessary suddenly to alter the course or to come to a full stop the modern ship is at the greatest disadvantage. The sailing-vessel, with anything like a breeze, would come round on her heel or could be hove-to in an instant, by a turn or two at the wheel and a pull at the yards; and the comparatively short and wide build of the old paddle-steamer, especially if she were fitted with side-wheels of independent action, gave her a great advantage whenever any rapid manœuvre was required. But with the "greyhound" of the Atlantic or Pacific it is quite different. Her immense length and the extreme fineness of her lines cause her to forge ahead in spite of engines stopped and reversed, and increase the radius of the arc on which she will come round. In fact, the very qualities which give her a proportionate advantage when all is clear and straightforward become a corresponding element of inconvenience and danger when it is necessary to navigate a tortuous channel or avoid a suddenly-apprehended obstacle.

In spite of every advance in the science and practice of navigation, there will always be a certain number of dangers to be avoided or overcome. These may be divided into two classes—namely, those which are, so to speak, constant, and those which are on the increase. To the former class belong those which result from the ordinary vicissitudes of wind and weather, and other natural causes, which will continue to tax the skill and resources of the navigator to the end of time; while to the latter must be put down those which are incidental to new modes of structure and equipment, and to the growing extension of ocean traffic, of which the most important is the risk of collision, which is daily becoming more imminent, and which, from the build and tonnage of the ships, and their increasing rate of speed, is fatal to a degree hitherto unknown.

The actual event of a collision has to some extent been foreseen and provided for—that is to say, certain provisions have been made in the structure and equipment of the ship which are intended to reduce the damage and loss of such a catastrophe to a minimum, as, *e.g.*, watertight bulkheads, deck-rafts, and improved boat-lowering arrangements. But, so far as I am aware, beyond the careful use of the ordinary appliances no steps have been taken for the avoidance of the catastrophe itself; and it seems to me that it is precisely here that the weak spot is to be located.*

The object of the present paper is the suggestion of an apparatus which I cannot but think will in some measure

* The twin-screw may perhaps be quoted as forming an exception to this statement. Its adoption, however, is by no means general, at least in the merchant service, with which we are chiefly concerned at present, nor is it materially effective in attaining the desired result.

supply the obvious want, and which I offer in all becoming modesty for the consideration of those who are interested in the subject.

The questions to be solved are two—(1) How to bring a ship going at full speed to a standstill in the shortest possible time; and (2) how to rapidly change her course at a comparatively acute angle.

In a pulling-boat these objects are accomplished (1) by the simultaneous backing of all the oars, and (2) by holding water on one side, while her "way," or existing impetus, maintained by the oars on the other side, carries her round. And, though it is not, of course, to be expected that these manœuvres could be accomplished with the same ease and perfection in the case of a ship of large tonnage as in that of a small boat, still I think that by means of the apparatus I propose they might be effected to such a degree as would be of material assistance in attaining the desired result.

The apparatus I propose consists of a system of strong metal plates, set in pairs at the sides of the vessel, to which they are attached by hinges at their forward ends, and which could be forced outward to any desired angle. In order to be effective in checking the way they should be placed at various depths, and well below the water-line, where they would encounter a maximum of resistance; and to insure the greatest steering-power one pair at least should be well aft of amidships. These plates I have designated brake-fins, as the name seems appropriately to describe their structure and functions. To bring the fins into action would, of course, require the exercise of a very powerful pressure from within, which should be capable of instant application. This I would propose to supply by means of hydraulic chambers fitted with pistons on the principle of the hydraulic jack, the water being supplied by steam-pumps whose action could be controlled from the bridge.*

The actual operation of the apparatus would be precisely similar to that of the oars in the boat before described. The fins would simply act as so many drags on the vessel, and would serve either to assist in bringing her round, or in reducing her speed, according as they were projected on one or both sides. When not in use they could simply be shut back in depressions made for the purpose, so that their outer surfaces would be flush with the external plating.

There are several important questions which would have to be worked out in order to insure the successful operation of the apparatus—as, *e.g.*, those regarding the best form, the

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* It is possible, also, that compressed air might be used for the purpose.

relative dimensions, and the most advantageous location of the plates, as well as those relating to the connecting machinery, and the most economical application of the power employed. These, however, are but questions of constructive detail which do not affect the object of this paper, which is merely to establish the principle involved.

It is, of course, only by actual trial that the practicability of the idea could be demonstrated. Still, the advantages of such a contrivance, were it capable of being carried into effect, are so obvious that it would be well worth while to make a series of experiments, in the first instance with a vessel of small dimensions, of which the cost would be comparatively trifling considering the interest at stake. And, though we may never expect that the action of the brake-fins on a ship will equal that of a Westinghouse brake on an express train, or even that of the oars on a skilfully-handled boat, still, if they will shorten by a cable's length the distance at which she will bring up, or reduce to any considerable degree the angle at which she will come round, they may be the means of giving many a "man overboard" a chance for his life, and help to minimise the increasing chances of one of the most appalling of disasters, a collision at sea.

Art. LXV.—*Mill on Demonstration and Necessary Truth.*

By William Carlile, M.A.

[*Read before the Wellington Philosophical Society, 8th July, 1891.*]

If any one should endeavour to ascertain what is the received doctrine in England at present with regard to the basis of mathematical demonstration, the true nature of the definitions of Euclid, and the ultimate evidence for the axioms, he would find himself met by a very remarkable diversity of opinion on the part of those who have been recognised as the highest authorities on psychology and metaphysics during the past half-century. To find anything like consistency, indeed, he would have to go back to the philosophers of the pre-Kantian age.

Hume's opinion was that the truths of pure mathematics were to be put into one class along with identical propositions, and that truths of matters of fact were to be put into another and altogether different class. However certain the latter might be, their certainty, in his view, depended upon an entirely different sort of evidence from that on which the certainty of the former depended. This doctrine, at any rate, afforded him a basis of classification which enabled him to avoid the hair-splittings and inconsistencies of the modern Humist school. The great leader of that school, Mr. J. S. Mill, takes all the axioms out of the class of necessary truths, and puts them into the class of truths of experience; and he thus, as every one is aware, arrives at the amazing opinion that we are not justified in asserting that two and two could never in any possible circumstances make five. His most distinguished disciple, Professor Bain, does not altogether follow him here. He, indeed, takes the axiom, "Things which are equal to the same thing are equal to one another," with its corollaries, out of the identical or implicated class, and puts it into the matter-of-fact or experience class; but he leaves others of them, such as the predication in regard to two straight lines that they cannot enclose a space, in the identical class. Mr. Mansel, who follows Kant, and uses Kantian phraseology, also puts some of the axioms in one class and some in another; but the strange thing is that the very axioms which Mr. Bain takes out of the identical class Mr. Mansel retains within it, and others which Mr. Bain thinks fall within it he leaves outside it. Professor Huxley, following Bain, says of the axiom, "Things that are equal to the same thing are equal to one another," that it is only a particular case of the predication of similarity—that is to say, I suppose, that it is a proposition of precisely similar import to this: "John is very like Thomas." It must be said, however, that Professor Huxley's views altogether on necessary truth and cognate questions very plainly betray the amateur. He remarks in a previous chapter of his treatise* that the certain reminiscence, "I was in pain yesterday," may be properly said to be necessary. If that were so there would be no distinction whatever between truths of demonstration and facts of memory; and in that case a very great part of all that Plato, Descartes, Kant, Locke, and even Hume himself have written would be words to which no meaning could be attached. Professor Huxley, however, only puts in the crudest form what are in truth the doctrines of his school, and what are professed as such, though in more guarded fashion, by its acutest thinkers. Mr. Spencer, for instance, if he would not call the statement, "I was in pain yesterday," a necessary truth, would so denominate the statement, "I am in pain now." Such statements may possess a degree of certainty that cannot be exaggerated; yet a very little reflection is sufficient to show that the evidence on which they rest is in no

* "Hume," in the English Men of Letters Series.

respect analogous to that which we have for the truth of the axioms of mathematics.

Of necessary truths, properly speaking, the one unfailing criterion is that they should always be truths in regard to abstractions—never, in any case, truths in regard to concrete realities. That the moon which I see above me is one, not two, cannot be a necessary truth, no matter how certain I am of it. I might, indeed, be under a not uncommon hallucination in affirming its unity; but the proposition that "one is not two" stands on altogether a different footing. One is not two. Why? Because it is by hypothesis one. It is this intrusion of an assumption which can be contradicted which makes possible a necessary truth, resting, as all such truths do, on the law of contradiction. As, however, the current confusion of thought with regard to abstraction is at the root of much of the confusion of thought in regard to necessary truth, it may be well at this point to endeavour to arrive at a sound opinion with regard to the true nature of this important mental process.

In a paper read before this Society about two years ago on "Professor Huxley's Metaphysics," I endeavoured to draw attention to the crudity of the opinions in regard to the formation of abstract conceptions expressed by that very Philistine representative of English empiricism. With your permission I will recapitulate a portion of what I then said: "This mental operation" [abstraction], Professor Huxley says, "may be rendered comprehensible by considering what takes place in the formation of compound photographs—when the images of the faces of six sitters, for example, are each received on the same photographic plate for a sixth of the time requisite to take one portrait. The final result is that all those points in which the six faces agree are brought out strongly, while all those in which they differ are left vague; and thus what may be termed a genuine portrait of the six, in contradistinction to a specific portrait of any one, is produced." Similarly he thinks, "In dreams one sees houses, trees, and other objects, which are perfectly recognisable as such, but which remind one of the actual objects as seen out of 'the corner of the eye,' or the pictures thrown by a badly-focussed magic-lantern. A man addresses us who is like a figure seen by twilight, or we travel through countries where every feature of the scenery is vague, the outlines of the hills are ill marked, and the rivers have no defined banks. They are, in short, *generic* ideas of many past impressions of men, hills, and rivers." Here it is plain enough that what is vague is confounded with what is generic. One might as well say that those of Turner's pictures which are successful in conveying the effect of a hazy atmosphere are generic as that a man seen in dreams like a figure by twilight is generic. The fact is that the abstraction "man" must cover both men dimly perceptible and men palpably obtruded in broad sunlight under our very eyes. It must comprise contradictions; hence it is that no image can possibly be made of it. It may not be without interest to turn to a discussion on the same subject about two hundred years old. In treating of the formation of general ideas Locke says, "For example, does it not require some pains and skill to form the general idea of a triangle (which is yet none of the most abstract, comprehensive, or difficult)? for it must neither be oblique nor rectangle, neither equilateral, equicrural, nor scalenon, but all and none of these at once." Bishop Berkeley, in his gravely sarcastic fashion, takes him to task over this description of the general idea of a triangle. "If any man," says he, "has the faculty of framing in his mind such an idea of a triangle as is here described, it is vain to dispute him out of it, nor would I go about it. All I desire is that the reader would certainly inform himself whether he has such an idea or not. And this, methinks, can be no hard task for any one to perform. What more easy than for any one to look a little into his own thoughts and then try whether he has, or can attain to have, an idea that shall correspond with the description that is here given of the general idea of a triangle—*neither equilateral, equicrural, nor scalenon, but all and none of these at once!*" Locke might possibly have answered that he did not mean by an idea precisely what we mean by a mental image; but this answer cannot be put forward on behalf of Professor Huxley with his compound-photograph and dream-representation theories. The difficulty did not escape Kant.* "No image," he observes, "could ever be adequate to our conception of a triangle in general. For the generalness of the conception it never could attain to, as this includes under itself all triangles, whether right-angled, acute-angled, &c., while the image would always be limited to a single part of this sphere." Kant is of opinion, therefore, that it is not images, but what he calls schemata, that lie at the foundation of general conceptions, and his theory, I think, accords with the facts of consciousness. At the same time it must be observed that there is no doubt that when we think of "triangle," "man," or "river" in the abstract the image of some individual triangle, man, or river passes before our mind. We know, when we consider the matter, that this image does not cover the contents of the general conception. We use it merely as a specimen. At the same time we can very readily

* "Critique of Pure Reason:" "Of the Schemata of the Categories."

glide into fallacious thinking by forgetting that it is this and nothing more.*

Professor Bain thinks that in forming general conceptions we can do one of two things: (1) we may call up an image that embraces all the attributes of rivers in general, or (2) we may call up the image of any particular river and use it as a symbol by which to think of rivers in general. It is plain enough that it is only the last of these two things that any one can do. The concept "river," like every abstract concept, is a schema or definition, not an image. It rests on a judgment or a series of judgments. In the simplest possible case—say, that of the concept "one" or the concept "blue"—there is, at any rate, behind such concepts the judgment that the name "one" or the name "blue" shall apply to the number "one" and the colour "blue" exclusively, and not to any other colour or number. This judgment is what Professor Huxley somewhere calls "the convention that underlies intelligible speech." He might have added, "that underlies rational thought." It is this judgment that is contradicted when we say, "One is two," or "Blue is green." Behind the mere sensation caused by one object, or by a blue object, there is, of course, no judgment to contradict. And it appears to be the easiest thing possible for even the very acutest thinkers to confound, in this respect, the sensation with the concept. To deny "that blue is not green," Mr. Mill says, "involves no logical contradiction. We could believe that a green thing may be blue as easily as we believe that a round thing may be blue if experience did not teach us the incompatibility of the former attributes and the compatibility of the latter."† This is all based upon the assumption that to affirm, "Green is not blue," is equivalent to affirming, "This green thing before me is not a blue thing;" while what it is really equivalent to is, "If this thing is green it is not blue." It is "a proposition concerning a proposition, the subject of the assertion being itself an assertion."‡ "Two straight lines

* Mr. Mill, for instance, as will be seen further down, affirms that the reason why, in his view, we can gain from experience what seems to be axiomatic certainty in regard to geometrical truths, is to be found in the capacity of geometrical forms for being painted in the imagination with a distinctness equal to reality. We can thus, he says, copy lines and figures, and argue from the copies as we would from the realities. Granted that we can copy them as well in imagination as on a blackboard, what we argue from is not the specimen on the board, but the rule in accordance with which, or perhaps only in a rough approximation to which, it is drawn. This fallacy of confounding the functions of the specimen with those of the schema has been a fruitful source of error.

† "Examination of Sir W. Hamilton's Philosophy," 4th ed., p. 486.

‡ Mill's definition of a conditional proposition. "Logic," People's Ed., p. 53.

cannot enclose a space" is not equivalent to saying, "These two lines which I judge to be straight cannot enclose a space." That, so far from being necessary, would probably not even be true. What it is equivalent to is plainly this: "If these two lines are straight they cannot enclose a space." Mr. Mill shows himself occasionally to be aware of the existence of such assumptions behind every general conception. He tells us, for instance, that in naming* "we create an artificial association between attributes and a certain combination of articulate sounds." This means that for the purposes of thought and intercourse we agree that the particular colour we know as green shall have the name "green." It is plain, then, that if we afterwards proceed to say that the name "green" is equally applicable to some other colour, such as blue, we break our convention, we sublate our hypothesis, and we involve ourselves in as unmistakable a logical contradiction as it is possible to conceive.

Similarly, if we are asked, "On what sort of evidence does the truth of the axiom which affirms that things which are equal to the same thing are equal to one another rest?" we need not hesitate to reply, "On the law of contradiction." Professor Bain thinks not. He claims for it, alone among the axioms, the character of being a generalisation from experience.† "Equality," he says, "is properly defined as immediate coincidence." If it is, why, then, might not the term "coincidence" be used convertibly with the term "equality"? It is plain enough that it could not. If we predicate equality of two lines we do not mean that they do coincide, but that they possess that attribute whereby they would, if superimposed, coincide. The coincidence of two lines would be a matter of fact to which no necessary propositions could ever apply. Their equality is a matter of abstraction, to which such propositions are alone applicable. Coincidence is given by sense, and sense only, and is open to the intelligence of all beings possessed of sight and touch. Equality is learned through sense, of course, but by thought, and is probably quite beyond the intellectual grasp of the Bushman or the Dammara. We cannot use the term "equal" intelligibly without knowing that the equals of equals are equal, any more than we can use the term "black" intelligibly without knowing that what is black is black. Suppose we try to realise the meaning of the negative of the proposition that the equals of equals are equal. We suppose ourselves measuring off any definite length from one line, and then the same length from another line. We then try to put it to ourselves, "Perhaps these lengths, after

* Ex. Ham. Phil., 4th ed., p. 394.

† "Mental and Moral Science," ed. 3, p. 187.

all, are not the same." If we do, we plainly deny our own assumption that they are the same. The key to the possibility of geometrical demonstration lies in this: in the power that we possess of contemplating one attribute, such as length, as remaining "the same," though in a varied environment. The want of a true theory of identity is indicated, I think, rightly by Mr. Bosanquet ("Mind," li., 3) as being at the root of most of the mistakes of the English school; and this is a case in point. From an identical proposition in the sense of one which affirmed that the length of any given line in any given position is the same now as it was five minutes ago no *geometrical* deduction, at any rate, could be drawn; but with an identical proposition, in the sense of one which affirms that the length of a line can be the same though its position is altered, the case is wholly different. We need no other concession than this to deduce all the properties of the circle. If we inquire, with Spinoza,* what is the efficient cause of a circle, we might answer, with him, "It is the space described by a line of which one point is fixed and the other movable." This line is the radius; and when we conceive of it as the same line, but in varied positions, even Professor Huxley would hardly deny that it would be an identical proposition, with a proof resting on the law of contradiction, to affirm that this line in all its positions is equal to itself. This identity in varied positions would be a not inapt definition of equality. It is a character from which innumerable new truths—of sequence, at any rate—can be drawn; yet it is plain that we arrive at it by the ordinary process of abstraction. When we abstract our attention from the irrelevant circumstances of its position and direction, and contemplate its length alone, we can then, of course, contemplate the length as remaining identical whatever the position and direction may be.

In the Fourth Proposition, which is proved by the method of superposition, Euclid very plainly postulates for the mathematical figures with which he deals this characteristic of being capable of being lifted and moved about and put on top of one another—in other words, of being capable of being regarded as identical in spite of difference of position. This postulate is one which, instead of being taken for granted, ought, I think, to be specifically stated at the beginning of every treatise on Euclid, and clearly kept in view in all geometrical demonstrations. If it were, it would be plain that the construction and the proof resting on it in the Fifth Proposition—the celebrated *pons asinorum*—are mere surplusage. We have in any case to postulate the possibility of taking up the large triangles

* Letter to Schirnhausen.

formed by extension of the sides, reversing one of them, and placing it on top of the other.* Why not at once take up the isosceles triangle itself, reverse it, and superimpose it on its former self? We shall then plainly have two triangles to compare, possessing all the characteristics of those in the Fourth Proposition.

Mr. Mill seems always to speak of the lines and circles of geometry as if they were specimens which we had picked up in our rambles. He would have avoided much confusion of thought if he had contemplated them as what they really are —the lines and circles which we suppose ourselves to have just drawn or to have just constructed.

In the light of the above, let us glance again at what Mr. Mill has to say in regard to the axiom that two straight lines cannot enclose a space. The upholders of the necessity of this proposition, he says accurately enough, uphold it on the ground that we can see its truth by merely thinking of the lines. The answer to this, he thinks, is to be found in the capacity of geometrical forms for being painted in the imagination with a distinctness equal to reality. "Thus," he says, "although we cannot follow two diverging lines by the eye to infinity, yet we know that if they begin to converge it must be at a finite distance; thither we can follow them in our imagination, and satisfy ourselves that if they approach they will not be straight, but curved." That is an accurate description of the process by which we satisfy ourselves that two straight lines cannot enclose a space; but we cannot help asking, Is it a description of the process by which truths of experience are learned? It is one of Mr. Mill's most characteristic doctrines, and one on which he repeatedly and emphatically insists, that† "Whenever we form a new judgment—judge a truth new to us—the judgment is not a recognition of a relation between concepts, but of a succession, a coexistence, or a similitude between facts." Whether we admit that this applies to all new truths or not, we may certainly admit that it applies to all new truths of experience. It is quite plain that a new truth of experience cannot be learned by the process of comparing one of our concepts with another. Yet it is precisely by doing this—by comparing our concept of straight lines with our concept of lines that enclose a space, and finding them incongruous—that Mr. Mill describes us as arriving at the truth that they never enclose a space. His description, in fact, is not a description of the mental process by which truths of experience are learned, but of that

* That is, of course, taking the proof of Props. IV. and V. together, as Mr. Mill does.

† Ex. Ham. Phil., 4th ed., p. 426.

by which we satisfy ourselves of the truth of identical propositions. We think out the truth of such a proposition; and there could be no better definition of a necessary truth than one which "we see to be true by merely thinking of it." It is obvious, indeed, that we could not have started on our course of mental experiment without being already in possession of all that experience could possibly furnish us with in regard to what straight lines would or would not do in any given circumstances. The fact that we could think out any fresh knowledge about them without reference to the world of fact is itself surely evidence sufficient that such knowledge was already implicated in the more obvious knowledge which we had before us about them, and that all that we required to do in regard to it was to unfold it. Kant's great division, therefore, of *a priori* truths into "analytic" or "implicative," and synthetic or augmentative, seems to be misleading. Analytic or implicative truths may be themselves augmentative. Indeed, if the truths are there *a priori*, though not on the surface, what else can they be but implicated?

To recapitulate, then, we may lay down the following in regard to necessary truths: (1) That they are always concerned with abstractions, never with concrete realities; (2) that the opposite of them is in the strictest sense of the word inconceivable, not merely unbelievable; (3) that this is so because if we think of their opposite we find that the last half of the statement sublates the first; (4) that they are truths which can be seen to be truths by merely thinking about them; and (5) that they are in reality truths of sequence only, not of fact.

The last affirmation brings us face to face with an apparently formidable difficulty. How, it may be asked, can it be that if the truths of geometry are truths of sequence only they can be applied to practical use in the world of fact? Mr. Mill's theory, of course. does not enable him to escape this difficulty. Indeed, he expressly indorses Stewart's view that the truths of mathematics rest on hypotheses. Any difficulty that there is, however, is not peculiar to mathematical reasoning, though it comes out in a more obvious light in connection with it than in connection with other sorts of reasoning. All deductive reasoning, it appears, rests on hypotheses, from the simple affirmation that blue is not green to the latest application of the theory of natural selection in the field of politics or sociology. A fact of sequence, such as the equality of the square on the hypotenuse to the two squares on the other sides of such right-angled triangles as we suppose ourselves to construct, has a real interest and importance for us only when we find that it is, at any rate, approximately true of the right-angled triangles of Nature. Without that, it would have at the best the interest of a game of chess, which is itself a process of necessary reasoning resting on hypotheses, but on hypotheses which have nothing in Nature that corresponds to them.

Art. LXVI.—*The Stability of Ships: its Principles made clear by Models and Diagrams.*

By E. Withy.

[*Read before the Auckland Institute, 10th August, 1891.*]

Plates L., LI.

Rather more than twenty years ago public attention was very forcibly called to the question of the stability of ships by the capsizing of H.M.S. "Captain," and the consequent loss of nearly five hundred lives. Not only was the shock produced by this event very great, but the surprise that was generally expressed nearly equalled the shock. The vessel had made two successful preliminary cruises, and was proceeding on a third in company with other men-of-war. She had crossed the Bay of Biscay, and was standing up well to her canvas, when the breeze freshening caused her to list rather more than before, and, without any warning, she steadily settled down, turned completely over, and went to the bottom. Less than twenty men, I believe, escaped and reported the occurrence substantially as I have given it.

Another stimulus was given within the last ten years by the capsizing of the steamer "Daphne" on the occasion of her launch, and the consequent drowning of a number of workmen.

On each occasion an exhaustive inquiry was instituted as to the form and construction of the ships. Naval architects were employed to make such calculations as the existing knowledge of the subject of stability rendered possible. I think I am correct in saying that no addition was thus made to the best information on the subject; but a result of very great importance did follow, and that was, that an enormous impetus was given to the study of the question, and a conviction became wide-spread that, after all, true theory must be more allied with practice than had been the custom.

Both vessels were built by eminent private firms of the first rank, the former on the Mersey and the latter on the Clyde; yet it was evident that these firms did not consider it necessary to apply to their designs such stability calculations as had been rendered possible by the researches of mathematicians. These were, for the most part, embalmed in abstruse treatises, but had been, in the years 1860, 1861, and 1868, made the subject of papers read before the Institution of Naval Architects in London by Mr. F. K. Barnes, Dr. Woolley, and Mr. E. J. Reed. The paper read by the latter gentleman, then Chief Constructor of the Navy, in 1868, was "on the stability of monitors under canvas," and in it he showed the danger of carrying canvas on low-sided vessels. A proposal had been made to cut down some of our old wooden walls, to add armour-plating to their sides, and to rig them for sea-service. The "Captain" was projected by a naval officer as a rigged sea-going vessel to carry guns in round turrets above a low freeboard. Mr. Reed opposed both proposals; but so little value was attached to his calculations that the Admiralty devoted the money for Captain Cowper Coles to go to a private firm and get his vessel built. Controversy is probably dead now as to the personal details, and I allude to them not for the purpose of reviving them, but in order to emphasize the danger of ignoring the warnings of science.

In 1871 Mr. Barnaby, President of the Council of Construction to the Admiralty, read a paper in which the following paragraph occurs: "It is just three years since curves of stability were first introduced to public notice in a paper read here by the late Chief Constructor of the Navy. Few of us supposed then that they would receive such a melancholy notoriety as has since befallen them, and no one attached enough importance to them to calculate them for an actual ship until last August, when, unhappily, the curve only served to show clearly why the ship was lost, instead of preventing the calamity."

The above quotation refers to the initiation of curves of stability. It had been up to this time the practice at the Admiralty to calculate the stability at 7° and 10° inclination, and if satisfactory at these small angles the design was passed. To construct the curve referred to by Mr. Barnaby it was necessary to calculate the stability at several other and larger angles of inclination. When the stability had been thus ascertained the results were plotted upon a scale, and the line drawn through the spots formed a "curve of stability" from which could be read off the stability at any other desired angle within the limits for which it had been calculated. It will be seen that this development of the practice in 1868 was a most important one, and that had it been applied to the case of the "Captain" the peculiar danger to which she was subject would have been observed, and a modification of the design would probably have followed.

The sad fatalities alluded to have greatly increased the number of those who have studied the principles governing the stability of ships, and scarcely a year of the last ten has passed without one or more papers being read before the Institution of Naval Architects. The principal value of these has been that they have introduced various methods by which the calculations can be greatly shortened, and their application thus rendered more generally possible. My object in reading this paper is not to explain the detailed calculations, but to endeavour to popularise a knowledge of the principles of stability by stripping the subject of its technicalities, and by making free use of simple and familiar models and diagrams.

As a preliminary to these explanations it will be desirable to distinguish between two terms—"steadiness" and "stability"—which are sometimes confounded. A ship which rolls considerably is an unsteady ship; but it does not follow that she possesses a small amount of stability. Quite the contrary may be the case, and, if her rolling is short and quick, it is very probably caused by having too much. The explanation of this apparent contradiction is that a stable vessel does not endeavour to stand upright, but to place herself at right angles to the surface of the water in which she is for the moment floating. If she happens to be amongst waves this tendency leads to a continual change of position; if she is in smooth water, and acted upon by a beam wind, she endeavours for the same reason to place herself at right angles to the surface of the water, which, being horizontal in this case, would be the upright position. Seafaring men know well that quick rolling is promoted by the stowage of heavy weights low down in the hold, but they will readily see that this operation, by lowering the centre of gravity, has increased the stability. On the other hand, very long rolling with slow recovery probably indicates a deficiency of stability. "Steadiness" is the quality of resistance in a ship to the tendency of waves to make her roll from side to side, while stability is the quality of resistance to the force of the wind (or of some force outside of and above the water) which tends to make her incline to one side, or, as sailors term it, to "take a list." Steadiness is most desirable in a war-ship, to enable her to take good aim with her guns; and in a passenger-vessel adds greatly to the comfort of passengers. At the same time, all vessels should, for the sake of safety, not only possess a fair amount of stability at small angles, but should have a power of recovery from the very considerable inclination produced by sudden squalls. This quality also stands them in good stead when their cargoes have been badly shifted by stress of weather.

As another preliminary it will be necessary to define "the law of flotation." It may be stated thus: Any floating body displaces exactly its own weight of water. This means that it occupies a space from which it has expelled as much water as would weigh exactly the same as itself. It is therefore only necessary to calculate the bulk of that portion of the floating body which is below the surface of the water, and then to ascertain the weight of an equal bulk of water, in order to find out what must be the total weight of the body when immersed to the given draught.

We may vary the statement of this principle as follows: A ship placed in water will descend until she reaches a state of equilibrium, or to such a point that the downward pressure of her weight is exactly balanced by the upward pressure of the water. This fact is entirely unaffected by the depth of the water in which she floats or by the extent of surface around the ship.

The pressure of the water is constant at every point which is at an equal distance below the surface, and it increases in the same ratio as the depth increases. That the extent of surface has nothing to do with the pressure may be seen by the case of a vessel lying at one side of a dock with, say, 1ft. of water between herself and the wall, while there are 500ft. on the off side. She has no tendency to fall towards the quay. Of the increasing density of water as the depth increases, and of the friction upon the surface of a ship when moving, I intend to take no notice, but shall consider the water as exerting an equal pressure at every point of the ship's surface below the water-line, and in direction at right angles to every point of such surface. It will always be assumed that we are dealing with still water.

To be able to deal with the effects of this pressure we must find out a point through which it acts, or at which it all culminates, and then we shall be able to examine its action in giving stability to bodies floating therein.

At this stage, then, we begin to deal with the stability problem. And in the first place let us consider a contrast and an analogy between a body out of water and the same body floating.

On land, or on any fixed and solid surface, it is the base upon which the body rests which affords it stability. The law of its stability is that a perpendicular from the centre of gravity must fall within the base. The further it falls within, the greater the stability. Consequently, an increase in the area of the base all round the perpendicular adds to the stability. But a knowledge of the latter fact often leads to misconception as to the stability of a ship, it being frequently asserted that "such a ship will be stiff enough because she has a good flat bottom to stand upon." There could be nothing more erroneous than this idea. If there is any part of a ship which may be considered at all analogous to a base it is the water-level section, and an increase of its area adds to stability. The form of the bottom, it is true, has its influence on stability, but flatness of bottom in a sea-going vessel tends to reduce it. The method of a ship when floating is in this respect entirely in contrast with that of a body resting on the ground.

The analogy appears when we consider the case of the body out of water when suspended from a point. The law of its stability in these circumstances is that its centre of gravity will hang perpendicularly below the point of suspension. Let us make use of a model to illustrate this analogy. It will be observed that I have in anticipation found its centre of gravity, and have screwed opposite to the spot a small eye by which to hang it up. A short definition of the term "centre of gravity" may be given as follows: It is that point from which if the body be conceived to be suspended it will remain in equilibrium in any position. This model cannot be hung from the actual point, because it is within its own substance; but by the law of suspension the centre of gravity must be somewhere in the vertical line below the eye. The model hangs horizontally lengthwise, and the deck hangs vertically, so that the centre of gravity must be at the point at which the perpendicular would cut the half-breadth line. This experiment serves to show that we can by this means identify the point in the fore-and-aft, vertical, and athwartship directions. That the model freely chooses its present position is shown by its prompt return to it if disturbed. I will now place it in the water and you will see that it descends, as before stated, until it arrives at a position of equilibrium. If I depress it at either end it rises again directly the pressure is removed. The analogy consists in the fact that the body has a preference for this exact position just as it had for another when suspended. Why is this? May it not be reasonably inferred that when floating there is an invisible but equally definite point of suspension to that which was provided by the hook upon which I placed it just now? Is it not equally reasonable to suppose that it obeys the same law, and will not remain at rest until its centre of gravity falls into a vertical line passing downwards from this invisible point of suspension? This is the fact of the case, and the point of support is that at which the upward pressure of the water culminates. If this is not quite evident let us demonstrate it by supposing that these two points are not so situated, but that the upward pressure is acting perpendicularly a little way from the centre of gravity. It will follow from this supposition that we have the weight pressing down in one line and the buoyancy up through another, not in the same lateral position. Under these circumstances there can be no equilibrium, and the body, therefore, cannot remain at rest. This being so, the weight of the body must force it to descend in the water at one end until a sufficient movement has been made to change the buoyancy conditions enough to bring the two pressures into the same line. From the fact that no such movement did take place it is evident that the two forces were already in opposition, and had established an equilibrium. This proves that our two suppositions were correct, and that the body obeys the same law in water as when suspended.

It can be shown, however, by experiment. If a small weight is placed on one end of the model it at once sinks a little deeper at that end. By sinking deeper it has gained a little more buoyancy there, and evidently just enough to counterbalance the additional weight placed upon it, seeing that it soon comes to rest in the new position . It did this because its centre of gravity had been disturbed, and therefore the perpendicular from it fell a little outside the former line of upward pressure. The result of this gain of buoyancy at one end was to cause the culminating point of upward pressure to follow in the same direction until the two forces were again directly opposed to each other vertically. This culminating point will hereafter be spoken of as the "metacentre."

Before leaving this portion of the subject it may be as well to say a few words upon the meaning of the term "centre of gravity." The words mean centre of weight, but they must be understood to stand for centre of moment of weight. The term would be complete if we had to deal with a plain bar of metal, or a plank of the same sectional area throughout. The centre of gravity of such bodies would be at the half-length, and if they were divided at this point the two halves would be equal in weight. In addition to being of the same sectional area throughout they are homogeneous in substance. But a ship possesses neither of these peculiarities, and it is found that neither is her centre of gravity at the centre of her length, nor would her two parts, supposing her to be divided at this point, equal each other in weight. Supposing that this model was made quite solid and of a homogeneous piece of wood, and that it was sawn across at its centre of gravity, it is not at all likely that the two portions would be equal in weight. The reason is that she is not equal in sectional area throughout her length. I think you will see this clearly if you consider the case of a ship lying at the wharf loaded. Let her centre of gravity in the fore-and-aft direction be ascertained and marked on her side. Let it be assumed, if she was divided at this point, that the two parts would be equal in weight, on the supposition that the centre of weight must be at the centre of gravity. In order to show that this need not be the case I will undertake to shift the centre of gravity without removing any cargo from the forward portion into the after one. I will simply take 20 tons of cargo out of the midship end of the forward part and stow it in the forecastle. Common experience tells us that the result would be to trim the vessel a little more by the head. At the same time, it would not add to the total weight of the forward portion of the ship. But it would give the same weight a greater power of leverage upon the after part. This increased power, which is not due to added weight but to redistribution of what weight was already there, is known as an increase of moment. It has clearly moved the centre of gravity nearer to the bow, and therefore away from the point which had been assumed to be the dividing-line of equal weights. It can no longer be contended, therefore, that the centre of gravity in a ship is the dividing-point of equal weights. Her case is the same as that of a steelyard, by means of which we can weigh large and small packages by moving a small weight along a graduated arm. It is the "moment" of the small weight acting at different parts of a long lever which enables it to balance at one time the small and at another the large package; and no one would contend that if the steelyard and its respective loads were separated at the fulcrum, which is the common centre of gravity of the whole, the two portions would be equal in weight.

I have dealt rather fully with this question of moment, because a true appreciation of it is necessary at every point in the consideration of stability.

It will now be desirable to treat of a similar point to the centre of gravity in connection with the supporting-power of water. It is known as the "centre of buoyancy." This term is applied to the centre of gravity of the water displaced by a ship. It may promote a thorough understanding of the buoyancy question if I deal with the law of flotation by means of several suppositions. Let us suppose that when a vessel is floating in still water we could freeze the water all around and under her; and that it was then possible to lift her completely out of her bed of ice; the cavity from which she had been lifted would be the space from which she had expelled or "displaced" the water; the cubic contents of this cavity would represent the measure of what is called her "displacement." To put it in another way: Let us suppose the cavity to be gradually filled with water, measured into it ton by ton, then the number of tons which were required to completely fill it would be spoken of as the number of "tons displacement" which the ship possessed at the draught of water at which she was floating. This amount would correspond in weight to the weight of the ship and her contents.

Let us next suppose that we could freeze the water which had been introduced into the cavity, and that we could then lift out the mass and handle it without its melting; it is evident that it would represent in bulk, in form, and in weight the water displaced by the ship. It would then be possible, if we could balance this mass in different positions, to ascertain the location of its centre of gravity. This point would be the one which I have alluded to as the centre of buoyancy.

Let us perform in another way the equivalent of the supposed operation. I have here a model of the under-water portion of H.M.S. "Captain," representing just such a mass of ice as that supposed above. It is a homogeneous piece of pine, and has a small eye inserted in one side, opposite to its centre of gravity; and you will observe, when it is suspended, that its longitudinal centre-line lies horizontally, while its flat surface, representing the water-level, hangs vertically. It follows, as before shown, that the centre of gravity must be at the intersection of the longitudinal centre-line with a perpendicular drawn from the point of suspension.

Of course, in actual practice the foregoing freezing experiments are impossible, and the knowledge desired is therefore obtained by calculation from the vessel's lines and sections. The model before you, however, agrees exactly with the calculations made for the "Captain," and therefore shows that the freezing supposition was safe as an illustration.

Having now explained the nature of the centre of buoyancy, we may proceed further with our subject. We shall find that it will simplify the consideration of this question, and materially assist us as we go forward, if we always clearly separate the question of stability, in our minds, into two parts—namely, that of the ship pressing downwards in the first place, and that of the water pressing or buoying upwards in the second place.

With this proviso, I will ask you to consider what changes are effected by careening a vessel from the upright position. Let us look first at that of the ship pressing downwards. It will be necessary to assume that no considerable part of her fittings or lading shall break away and fall to leeward when she is careened. It is then obvious that the fact of her being careened can have made no alteration in the position of her centre of gravity. Indeed, if everything held in its place she might be turned completely over without any alteration taking place in its position. We therefore see that, so far as the action of the ship is concerned, there is no difference caused by careening. She will continue to press downwards with the same energy as before, and through the same point—namely, her centre of gravity.

We may now pass to the second part—namely, that of the water buoying up the ship. It will be necessary here also to make an assumption—namely, that no hole exists in the part brought under water by the act of careening. It will simplify our work at this stage if we deal with one cross-section of a ship—say, the midship one—and assume for the moment that the vessel from end to end is of that form. Fig. 1, Plate L., will serve for this purpose. Please observe that there are two lines drawn across the section—the horizontal one representing the water-line when the vessel is inclined a few degrees, and the other when she is upright. Let us look closely at the changes which have been effected by thus careening the vessel. It at once appears that the wetted surface has been increased on one side and reduced on the other. That implies that the portion of the vessel acted upon in the inclined position by the water-pressure is not identical with that acted upon when she is upright. Does this change make any difference in the stability? Yes, in all cases, with the single exception, which I will deal with by-and-by, of a vessel whose section throughout her length, like fig. 4, Plate LI., is circular. In considering the nature of these changes please bear in mind two facts already stated—namely, that the act of careening has not added to nor reduced the total weight of the ship, and that the displaced water is, under all circumstances, exactly equal to that weight. It follows that the bulk of the vessel under water remains the same, and, as we are dealing with a vessel supposed to have the same form of cross section throughout her length, the area of that section must remain the same. As this is so, then it follows that the amount of area gained on one side in the diagram is equal to that lost upon the other. You will see that the pieces added and deducted are triangles. We may therefore define the position by saying that the triangle of immersion in the given example is equal in area to the triangle of emersion. But while this addition and deduction have not altered the total area of the section, it will be seen that they have materially altered its shape, and that, as a consequence, the centre of buoyancy must have been removed from its original position towards the enlarged or lee side of the section. This important change, then, has been effected by transfers of buoyancy, at the level of the water-line, from one side of the vessel to the other. It was this fact, of the only alteration taking place at the water-level, which caused the remark early in the paper that "if there is any part of a ship which may be considered at all analogous to a base it is the water-level section."

We shall find the present stage a convenient one to draw another distinction—namely, between the two phases of the question of stability. I allude to the fact that every vessel which has any stability at all has an "initial stability" and a "range of stability." You may remember a sentence which occurred early in the paper, as follows: "The form of the bottom, it is true, has its influence on stability, but flatness of bottom in a sea-going vessel tends to reduce it." It is "initial stability" which is thus affected. The "range of stability" is determined only by the form of the vessel in the neighbourhood of the water-level section.

As the finding of the metacentre is necessary before we can determine either of these phases of stability, I will now explain what that point is. In order to avoid this technical name as long as possible, I have alluded to it as the "culminating point of the upper pressure of the water." It is a point which is always in a vertical line above the centre of buoyancy, but its distance from the latter usually varies at different angles of heel. A reference to fig. 1, Plate L., will serve to indicate the metacentre. First consider the section in its upright position with the centre of buoyancy at B. Then incline it, and assume that the centre of buoyancy in the new position is at *b*. Remember that the buoyancy acts vertically upwards through this point. Now, if a line is drawn upwards in this direction from *b* it is clear that it will intersect the centre-line. The point M, at which it intersects, is called the metacentre; and its height above the centre of buoyancy can be readily calculated, for an infinitely small angle of heel, by means of a well-known formula. If it was so calculated for a number of vessels, of which the centres of gravity have been ascertained under similar conditions of loading, it would afford us the data for a very fair comparison of their merits as far as the one test of initial stability is concerned.

The last paragraph brings before you for the first time, in conjunction with each other, the two points which must be determined before the measure of any vessel's stability can be ascertained. These points are the centre of gravity of the vessel and her metacentre. The distance between the two in a vertical direction is known as the metacentric height. When the metacentre is found to be above the centre of gravity the vessel is known to be stable; when their positions are reversed she is unstable; and when they coincide with each other she is indifferent, and will yield, without resistance, to any inclining force. When we know the metacentric height of a vessel we can form a good idea of the amount of resistance which she will, at the outset, offer to an inclining force. It is not of itself the measure of this first act of resistance, known as initial stability; but its value—as will be proved directly—is comparative, because it always bears, in different vessels, at a minute angle of heel, a certain proportion to another measure in each, known as the "righting-lever." The convenience of its use consists in the fact that the calculation for it stops short at an early stage of the more complicated one required to ascertain the range of stability.

We may now pass from initial stability to consider what the range of stability is. It is not only of importance that we should know that a vessel can present a fair amount of initial resistance to an inclining force, but that she can increase and maintain it up to large angles. It will be here necessary to explain what the righting-lever is. It has been shown that when a vessel is at rest her weight is pressing down through its centre and the buoyancy up through its centre in the same vertical line. Hence a condition of equilibrium exists. Two equal forces are acting upon a given point in opposite directions. But let some power be applied to careen her—say the usual one of the wind blowing sideways on her sails. This will destroy the first condition of equilibrium, and a struggle will take place for a time between the wind and the vessel's stability. She will yield easily at first, but, at some particular angle, will have acquired such an access of stability that the wind can press her no further. Thus another condition of equilibrium is produced. The wind and the stability have both met with their match. Can we ascertain the force which each is exerting? Yes; by first ascertaining the length of the righting-lever which she possesses at the given angle of heel.

We must proceed by calculating the centre of buoyancy in the inclined position, and then draw a perpendicular line upwards from it. Then we must find, by the experiment to be explained presently, the position of the centre of gravity of the ship, and draw a line perpendicularly downwards from it. The horizontal distance between these two lines, representing the direction of forces, may be considered as a lever or couple. This is known as the righting-lever. Now, the weight and buoyancy are known to be equal. Therefore, if we multiply either of them—say the buoyancy—in tons by the length of the lever in decimals of a foot we shall get an expression of foot-tons as the actual measure of stability. The force of the wind has been shown to be exactly equivalent to this resisting-power, or stability of the vessel, seeing that it succeeded in forcing her to, and keeping her at, a certain angle of inclination.

It will be seen now that, while the metacentric height is not the actual multiplier for obtaining the measure of stability, yet, if its relation to the length of righting-lever is constant in all vessels at equal angles of heel, it must be very valuable as a comparative measure of stability as between them. Their relationship may be further explained, and the promised proof given, thus: If at a given angle the centre of buoyancy appears further to leeward than at some lesser angle it is evident that the perpendicular drawn upwards from it will intersect the centre-line of the upright position at a higher point, and thus make the metacentric height greater. At the same time, it will be seen that this perpendicular is further to leeward of the line falling from the ship's centre of gravity, and consequently the righting-lever is longer. Now, if I can show that there is in all cases a proportionate increase of these two measurements I have proved the value of the metacentric height as a comparative measure of stability. The proof is as follows: If we careen several vessels, whose relative stability we wish to know, to any given angle, ascertain their centres of gravity, and calculate their metacentric heights, and then construct a triangle on the section of each ship from its own ascertained measurements, we shall find that the three angles of each triangle are similar in all cases. The upper angle is that of the inclination; that between the righting-lever and the perpendicular to the metacentre is a right-angle; while the third is equal to a right-angle *minus* the angle of inclination. We have therefore a series of triangles, all of whose angles are similar. In such cases it follows, also, that their sides must be in the same proportion throughout. This being so, the metacentric height and righting-lever, being two of them, are, as above stated, always in the same proportion to each other.

Let us now return, from this further explanation of its important relationship, to the consideration of the righting-lever. It will be evident that, as we can calculate this measure for one angle, we can do it for as many as may seem desirable, and thus obtain the range of stability. The largeness or smallness of this range depends entirely upon the relative form of the vessel's sides immediately above and below the water-level section.

Before branching off just now into the division of the question of stability into two phases, I had shown, in the case supposed, that the act of careening had so altered the underwater form of the vessel that the centre of buoyancy had been removed from its original position towards the enlarged or lee side of the section. It has since been shown that this results in the lengthening of the righting-lever, and consequently in a gain of stability. Now, let us assume that the length of this lever has been ascertained for a vessel at 10°, 20°, 30°, 40°, 50°, &c., of inclination. Having obtained these lengths, set them up as ordinates from a base-line previously divided into the respective angles of heel. Through the points so obtained run a line, which will be that referred to by Mr. Barnaby in 1871 as a curve of stability, then for the first time calculated for an actual ship. Having traced this curve, we can read off upon it the length of righting-lever at any angles intermediate to those actually calculated, and, by multiplying each by the displacement, get an expression of stability in foot-tons at each angle. If this process were applied to several vessels of different types we could, by a comparison of their respective curves, judge of the variation in, and relative values of, their stability. Some of them might possess a small, some a large, and others a medium range of stability. Some might show that they rapidly attained to a considerable amount of stability, and then went on increasing very gradually. Others, by a steady progression, might increase up to a very large angle. Others, again, might reach their maximum at 30° or 40° of heel, and then steadily diminish. Please observe the line on the diagram (Pl. L.) which represents the curve of stability of H.M.S. "Captain." This vessel steadily gained up to 21°—a very small angle. From this point her stability fell steadily, until at 54° it vanished altogether. A reference to her midship section readily explains the reason of this. You will see that, owing to the low free-board, the gunwale reaches the water at only 14° of heel. The triangle of immersion then begins to lose its area at its broadest end very rapidly, and the width of the water-line decreases with each angle of heel. The result is that the centre of buoyancy, after moving satisfactorily to leeward up to 17°, does so more slowly up to 21°, and then actually retraces its steps, until at 54° it has come back to its starting-point, when the vessel was upright, and is found perpendicularly below the centre of gravity of the vessel. The slightest additional puff of wind will then, owing to meeting with no resistance, cause her to capsize. The width of the respective water-lines referred to is as follows: When upright, 53ft.; at 14°, 54ft.; at 21°, 48ft.; and at 54°, 35ft. The low freeboard, resulting in a great reduction of her range of stability, while at the same time she was fully rigged, was the cause of the loss of this valuable ship and of many lives.

A great difference of opinion formerly existed as to the relative advantage of a good beam or of a high freeboard in affording a large range of stability. In 1871 Mr. Barnaby read a paper which finally settled the controversy in favour of the high freeboard. I can give you ocular demonstration of several facts in stability, but will at the moment only show by experiment the case of the "Captain." This model is accurately made from the vessel's lines. It is weighted so as to draw the same water as the ship did when starting on her fatal cruise. Moreover, the centre of gravity of the model corresponds in position with that of the actual ship. When I hook this cord into the eyebolt in her side, and steadily cause her to list, you will see how soon her gunwale becomes immersed. It takes a fair amount of force to careen her at first, and up to 21°, but after that she gradually lessens her resistance, and at last the least pull turns her over. A very simple analogy will illustrate this question of "range of stability." If, while I am standing up, a pressure is applied sideways to my right shoulder I shall be in danger of falling to the left. But as long as it is possible for me to move my left foot outwards in a direction opposite to the pressure, and to continue doing this as the pressure is increased, I shall be able to make a prolonged resistance. But if anything obstructs the outward movement of my foot at any point it makes me unable any longer to resist the pressure, and I must therefore fall. In lieu of the outward movement of the foot, a vessel has to depend upon the increasing support afforded by the leeward movement of her centre of buoyancy. This can only be maintained as long as her form above water is such as to continually increase with each addition to the inclination the moment of the area of that side of her section. The low freeboard of the "Captain," as we have seen, first checked the due increase of that moment, and then began to seriously undermine it.

All that has so far been said upon stability refers only to the measure of the energy with which a ship endeavours to regain the vertical position. This is known as "statical stability." I have shown, when a ship is careened to and held at a given angle by the force of the wind, that a condition of equilibrium between the two forces of wind and stability has been attained. Such a condition might also be produced at the same angle by suspending a large weight from, say, the mainyard-arm. It would have to be adjusted as follows: Suspend a plumb-line from the yard-arm and measure the horizontal distance from it to the centre of gravity of the ship; then divide the stability measure expressed in foot-tons by this distance. The result will be the number of tons which must be suspended from the yard-arm to produce the given inclination. It is a simple question of balancing, and may be compared to the before-mentioned case of an ordinary steelyard, where a large weight is balanced by a small one having greater leverage. The moment of each acting at the fulcrum balances the other, and is equal to its weight multiplied by its distance from the fulcrum. In the case of the ship the moment is spoken of as being equal to so many foot-tons; in the case of the steelyard it might be termed inch-pounds. While this measure indicates the steady resisting-power of a vessel, yet it does not express the whole problem, seeing that it takes no account of the work performed in bringing about the careening. It generally happens that the act of careening raises the centre of gravity of the vessel, or, in other words, that it lifts her whole weight to a higher level. Such an effect cannot be produced without an expenditure of power. This expenditure may be measured by calculating the height through which the vessel has been lifted and multiplying it by her weight. The operation is rendered simple by the knowledge of the fact that a ship's weight corresponds to that of the water which she displaces. In listing to a given angle, we have seen, under our assumption that a mere section represents the solid, that the area of the section is increased on the lee side and reduced to windward by the area of the respective triangles of immersion and emersion. We have further seen that, while these triangles are equal in area, they are, in all but circular sections, dissimilar in form, and have therefore different horizontal moments. In all cases, therefore, where the moment of immersion is greater than that of emersion, the centre of buoyancy is moved to leeward. The additional fact to which I now wish to ask your attention is that these triangles have different vertical moments, and that they consequently raise the centre of buoyancy vertically. Having ascertained by measurement of the triangles what this vertical rise amounts to, we have simply to multiply it by the area of one of them to obtain a comparative measure of the work done in the act of careening. It may also be found by multiplying the rise of the centre of buoyancy by the total area of the inclined midship section. This measure, when *solid* is substituted for *area*, is known as the dynamical stability at the given angle of heel.

The different nature of these two measures may be illustrated by a reference to fig. 3, Plate LI., which represents a cylindrical model when rolled up an inclined plane. The statical energy of the body in either of the two right-hand positions is measured by its weight multiplied into the length of the respective righting-levers, or the distance in each case from its point of contact to the perpendicular from the centre of gravity. The dynamical work done in raising it to these positions is measured by its weight multiplied into the respective vertical distances through which its centre of gravity has been raised. This latter measure is different from the condition of balancing. It consists of an amount of work done upon, and stored up in, the body which will be given out again during its return to the upright position. In the case of a ship we can imagine her lying at a wharf, and that the inclination was produced by hooking a crane-chain to her rail and heaving away at the handles. When she had been careened, if the handles were let go, they would be made to fly round by her return to the upright position. A clock-weight, after being wound up, does just the same thing, and in running down makes the clock go by giving out again the work stored up in it.

It will scarcely be necessary to remind you that stability is a measure which varies with every change in the stowage of a ship's cargo, even though her draught of water remains the same. This is because the height of her centre of gravity will thereby be altered. It is also evident that the buoyancy varies with any increase or decrease in the mean draught of water, or from an alteration in trim—*i.e.*, in the draughts of water forward and aft respectively. A variation in the position of the centre of buoyancy results from these latter changes. It therefore follows that, as a vessel on a long voyage consumes water, stores, or coal, she alters both elements which determine her stability. Her centre of gravity is altered in position by the change in her lading, and her centre of buoyancy by the reduction in her mean draught of water, while it is more than likely that she has risen more at one end than at the other. A responsibility, therefore, rests not only with her designer to consider these possible changes and provide for sufficient stability under the worst of ordinary conditions, but with the captain also, who should obtain some scientific knowledge of her peculiarities, so that he may stow the cargo in such a way as to prevent the occurrence of any extraordinary conditions.

The main explanations of the principles of stability have now been made; but I wish to refer to and explain three assumptions which it seemed desirable to make with the object of simplifying for the moment certain portions. The first one made was in dealing with the centre of gravity, and was as follows: "It will be necessary to assume that no considerable part of her fittings or lading shall break away and fall to leeward when she is careened." This reservation was necessary to the explanation as it was given, and to the statement that the centre of gravity did not alter its position by reason of a vessel being careened. The fact of cargoes being shifted by stress of weather, however, is not by any means uncommon. Again, the presence of a large quantity of water in the bilges may seriously affect stability, and the same result will follow if a water-ballast tank is only partially filled. It is not beyond our power to calculate the effect of any such change of condition as may be supposed to take place. The caisson for closing the entrance of a graving-dock is made to sink into its place by the admission of water into certain compartments. It would not be safe, however, to admit water into such a structure except into limited watertight compartments. In the absence of divisions, the water by its movements would cease to act as ballast, and would become a source of great danger to the stability of the caisson, and probably cause it to do damage to its own structure and to that of the dock.

The second assumption was in reference to the buoyancy of a vessel remaining intact after she was careened, and read as follows: "It will be necessary here also to make an assumption—viz., that no hole exists in the part brought under water by the act of careening the ship." In making this reservation I had in my mind the case of the sinking of the s.s. "Austral" in Sydney Harbour. For a long time after that vessel was raised and sent to sea again a great deal of prejudice existed as to her supposed want of stability. This idea was entirely groundless; and I believe that few safer or better ships ever floated. The fact was that the covers had been removed from the coaling-ports which pierced her sides amidships; coal was being introduced into her bunkers through these ports, and the operation was continued until the vessel had sunk low enough for the water to enter them. The result was inevitable. The introduction of a comparatively small quantity of water would not only cause her to sink lower, and so increase the inflow every moment, but would cause her to become slightly unstable, and therefore probably to list enough to cover the whole area of the ports very quickly. The great inrush so caused would very soon sink her. Again, in the case of a war-ship the piercing of the top-sides would, if it led to an influx of water, very quickly alter the former conditions of stability. Carelessness in leaving the cabin ports of a passenger-steamer open in rough weather might soon produce the same results.

The third assumption was in reference to the form of the vessel which I took for the purpose of careening. It reads as follows: "It will simplify our work at this stage if we deal with one cross-section of a ship—say, the midship one—and assume for the moment that the vessel from end to end is of that form." Of course we never see a vessel so shaped, but the device enabled me to show the results of the change of form effected by careening more simply by assuming them to be concentrated in one representative section. You will readily see that the portions immersed to leeward and emerged to windward are not mere areas, as for the moment assumed, but solid wedges extending the whole length of the ship, and that, by reason of the fining of the lines and the alteration in form of the vertical sections towards the bow and stern, these are of irregular shape. On the strength of this third assumption I made the following statement: "The triangle of immersion in the given example is equal in area to the triangle of emersion." To understand the intention of this, you must substitute "solid" for "triangle," and understand the sentence to read as follows: "The solid of immersion is equal in bulk to the solid of emersion."

To save myself from a possible misunderstanding, it may be as well, by way of endeavouring to state the fact exactly, to make another slight reservation upon the last statement. It should be remembered that I have only dealt with stability in still water, because it will readily appear that several of the statements made are not applicable to a vessel's movements in a seaway and in stress of weather, nor would they apply to the case of a vessel anchored, or moored bow and stern between buoys in a tideway. But even in still water the pressure of a wind which careens a ship may not act in a direction precisely parallel to the water-surface. In such a case, the effect may be either to slightly lift or slightly depress the ship, and thus cause an equivalent change of displacement. If this ever happens, as it may do, then the solids of immersion and emersion are to that extent not exactly equal to each other. For practical purposes, however, this need not be considered.

There is a peculiarity about these solids, however, which is well worth notice. Each of them has a centre of gravity of its own, and it will very often happen that these are not located at the same point, in a fore-and-aft direction, as that of the main displacement when the ship is upright. When such is the case it is evident that the centre of buoyancy when the ship is careened will not be in the same position as it was when she was upright. The balance of the ship is thus disturbed in the fore-and-aft direction, and the visible effect will be that she will either rise at the bow and sink at the stern, or else do exactly the reverse. It is evident, therefore, that a vessel defectively designed in this particular (for it is a defect) will, with every careening movement, combine a certain amount of pitching and scending. If this happens in still water it is likely to increase the liveliness of the vessel amongst waves at sea. I should, speaking from my own feelings at least, consider this quite an unnecessary aggravation.

Another reservation was necessarily made once or twice regarding the exceptional actions of a body with a circular section. You see when I place such a model in water that it has no stability, and it may therefore be as well to explain the reason of this. Owing to its being a homogeneous body, its centre of gravity lies in its central axis. Again, owing to its circular section, the act of careening does not alter the form of the under-water portion. As a consequence, the solids of immersion and emersion are exactly alike, not merely in bulk (which is always the case), but in form also, and therefore in moment. The result is that their addition and deduction does not affect the position of the main centre of buoyancy, or make it move out to leeward as usual. It therefore remains vertically below the centre of gravity of the model, so that no righting-lever is formed, and therefore no resistance is offered to an inclining force, and no effort made to return to the former position.

We can, however, give stability to a model of this section by lowering its centre of gravity. If a small weight is attached to the lower part of the model it will do this. If it is then careened the centre of gravity will move out from the upright centre-line, up which the centre of buoyancy still acts, and will thus form a righting-lever. This lever would continue to increase in length up to an angle of 90°, and the stability would increase at the same rate. The model, under both conditions, acts in the same way if placed on a plane surface. The reason is that the point of support in both cases acts in the vertical line falling from the centre of rotation. Fig. 4 shows the direction of the forces for the weighted model both in and out of water.

Another way of giving stability to a model of circular section without removing its centre of gravity from the central axis is as follows: I will take off the weight used in the last experiment, and attach a bolster or fender to each side opposite to the centre-line, as shown in fig. 5, Plate LI. It is obvious that the bolsters do not change the position of the centre of gravity, but as soon as either of them touches the water it affords stability. The reason, following the lines of former explanations, is that the solid of immersion, while still of the same volume as that of emersion, is, owing to one bolster being immersed, of a different form, and therefore possessed of a greater moment. It therefore draws the centre of buoyancy to leeward, forms a righting-lever, and endows the model with a measure of statical stability. A little further observation will show that the centre of buoyancy has risen vertically at the same time. This shows that the model has also acquired dynamical stability.

A device analogous to this addition of bolsters will occur to some present as being used sometimes to give stability to a sailing-vessel when it may be necessary to shift her after discharging cargo. A square log of timber, such as a spare spar which she may carry for the purpose of making a topmast or lower yard from, is secured by two ropes and lowered over each side into the water. After this, if the vessel takes a list she lifts the windward balk out of the water, and leaves the other floating free. The weight of the balk thus lifted influences the ship's centre of gravity slightly downwards and to windward, and therefore tends to right her.

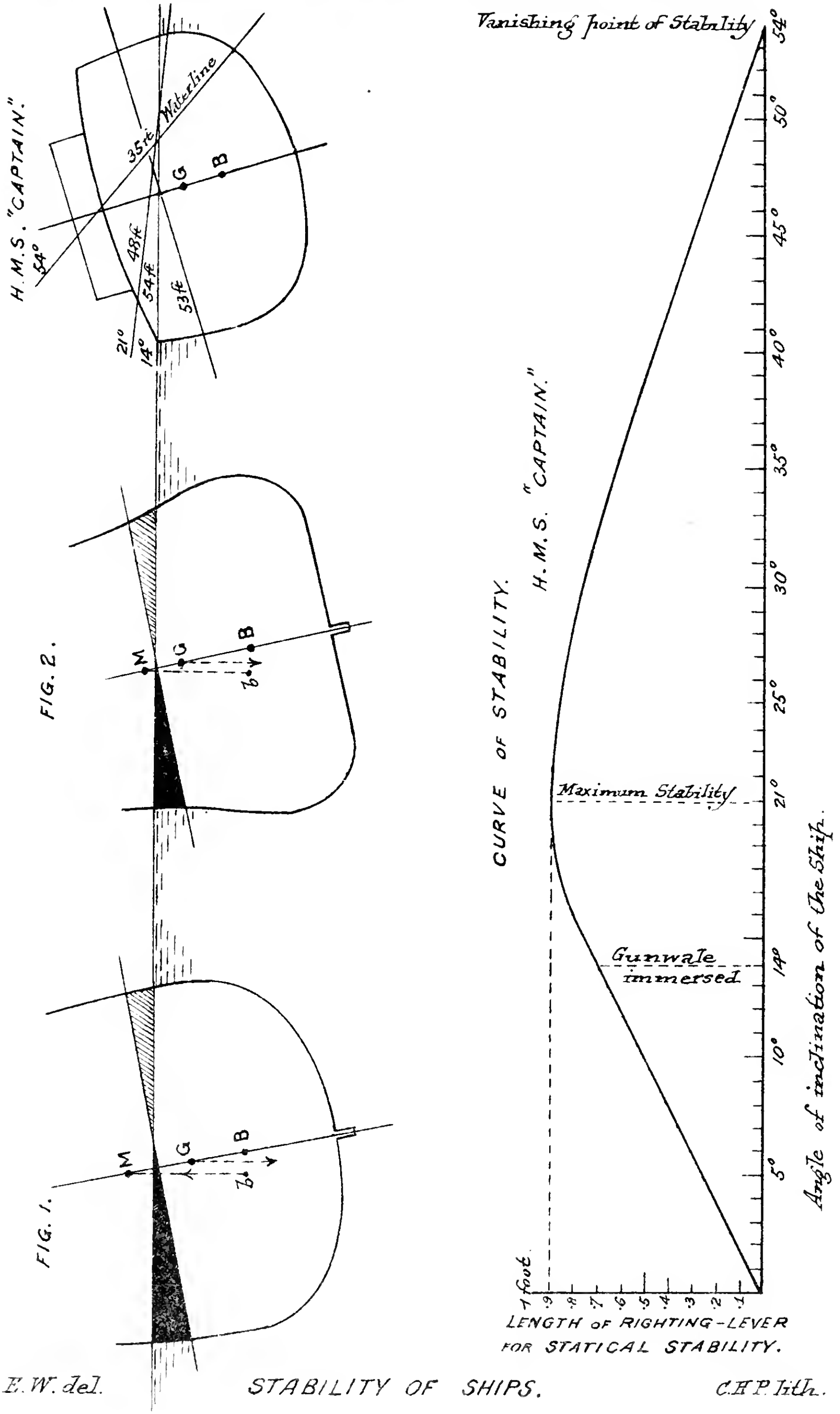
The effectiveness of this plan can be increased if necessary by passing a rope tightly under the ship's bottom and securing it to both balks. If she then takes a list she hauls one balk down under water at the same time that she lifts the other out. One effect of this modification is to draw the centre of gravity rather more down, but not at all out to windward. The other, and the principal effect, is to increase the moment of the solid of immersion and to reduce that of emersion. This draws the centre of buoyancy to windward, and so increases the length of the righting-lever.

The first method merely acts upon the ship's centre of gravity, whereas the second acts upon her centre of buoyancy as well.

The same principle might be adopted to add to the stability of a sponsoned ferry-boat. Such a balk might be secured to each side of the boat above the stays which support the sponsons. With a light load of passengers this would be above water, but the ends should nevertheless be eased off to reduce the resistance when it is immersed by heavier loads. In any case where this might be deemed insufficient the range of stability could be very much more increased by planking over the outside of the stays from the hull right up to the sponsons and making this watertight. The weight thus added would possibly not lower the centre of gravity of the steamer, but it would very greatly increase the moment of the immersed solid when she was careened to the edge of the sponsons, and thus draw the centre of buoyancy to windward, and greatly lengthen the righting-lever.

It is hardly safe to give any arbitrary rules for stability, but it may safely be affirmed, where a vessel's initial stability is satisfactory, that if the width of her water-line goes on increasing as the angle of heel gets larger she must have a good range of stability. A ferry-boat's lading is peculiarly dangerous, because it is not only generally carried high above her centre of gravity, but is a live weight, which in case of panic is almost sure to rush to the lee side. Hence a large range of stability, in the interest of public safety, is imperative. As such boats usually ply in smooth water, there is not the same objection to a great fall-out above the water-line which would attach to a sea-going vessel. In the latter the great leverage which it would afford to the waves would result in heavy rolling, and the receipt of very ugly blows from the seas.

A rather telling illustration of the great stability afforded by a large fall outwards above the water-line is afforded by the preference which a square log shows when floating. If a number of these are rafted together they can be made to float on their flat sides, but if one is floating by itself it will always lie cornerwise. Here is a section of one, and I will place it in water. You will see that it cannot be got to float in any other way than with one corner down. We may first see why it will not float on its flat by referring to fig. 6, Plate LI. As it is a square figure, and is homogeneous, its centre of gravity will be at the intersection of lines drawn cornerwise. Similarly, the under-water portion being rectangular, the centre of buoyancy will be at the half-height and half-width of this portion.



E. W. del. STABILITY OF SHIPS. C.H.P. lith.

FIG. 3.

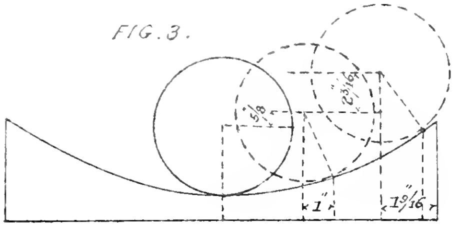


FIG. 4.

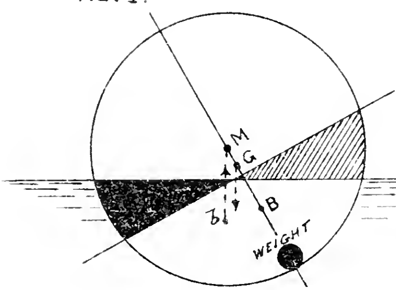


FIG. 5.

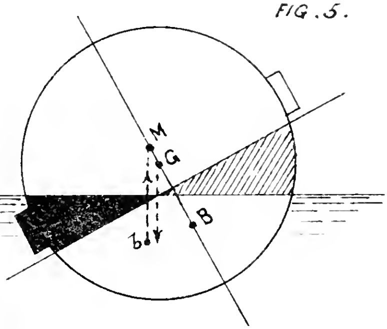


FIG. 6.

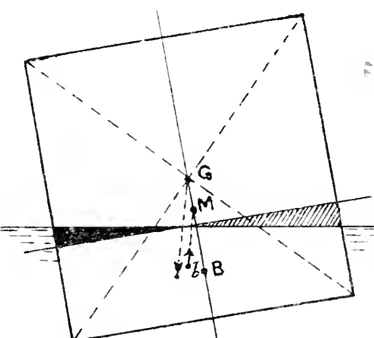
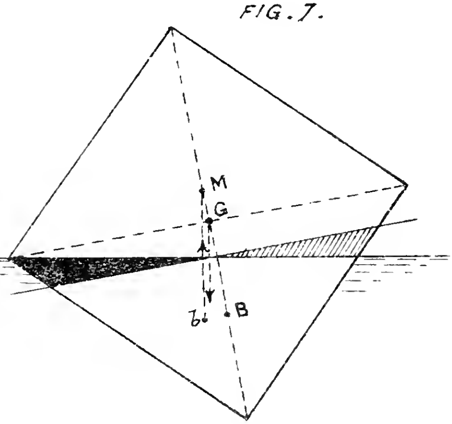


FIG. 7.



UPSETTING LEVER.

E.W. del. STABILITY OF SHIPS. C.H.P. lith.

Now look at the change brought about by careening. The centre of buoyancy moves to leeward to the position *b*, but the centre of gravity moves still further to leeward. The downward pressure of the weight and the upward pressure of the buoyancy are, it will be seen, both acting in the same direction to overturn the log, because the metacentre falls below the centre of gravity. Instead of a righting-lever it possesses an upsetting-lever. These are the conditions which make it impossible for it to float on its side. It consequently assumes the other position—viz., with one corner down.

Let us now see by reference to fig. 7, Plate LI., why it prefers this way. The centre of gravity is of course just where it was, but the centre of buoyancy is at the point B. Now look at it when inclined, and you will see that the centre of buoyancy moves to leeward to *b*, and the perpendicular passes to leeward of the centre of gravity, places the metacentre above it, and thus forms a satisfactory righting-lever, and resists the inclining force.

This model will further serve to illustrate the case of the "Captain." A very little more inclination than that shown would bring its angle under water, and its range of stability would fall off as a consequence, and its breadth at water-line would continue to decrease until it would fall over.

A very different variety of midship section from that of the "Captain," but still a very objectionable one, is represented in an exaggerated form in fig. 2, Plate L. The greatest breadth is considerably below the water-line, and the tumble-home starts from this point, and is large. Such a vessel may have a fair amount of initial stability, although her metacentre must be low; but it is impossible that she can have a long "range" of stability. About the year 1864 a batch of large sailing-ships was built in the north of England for Liverpool shipowners. They were all deep in proportion to beam; their greatest breadth was at one-third up, and they were heavily rigged. They all required ballasting as soon as the builders had run up their topmasts. One of them while loading coal for her first voyage listed against the dock side until her yard-arms touched the quay after she had taken in 800 tons, fully half her lading. This one was lost off the Hebrides on her first voyage. Most, if not all, of the crew reached land in one of the boats. The captain reported that, while sailing along quite satisfactorily to all appearance, she took a further list as the breeze freshened, and steadily settled down on her broadside, just as the "Captain" did. The remaining ships which were not completed were altered as far as possible. Several feet were taken off their lower masts, and in one or two cases the space under the hold-ceiling between the floors was filled in with bricks and cement (with the exception of a small watercourse), all with a view of lowering the centre of gravity. In spite of this these vessels could never possess the most important quality—viz., a good range of stability. It is still abundantly evident that there is much need for a greater diffusion of sound information upon this subject, and for an equally extensive use of it by shipbuilders.

The Transactions of the Institution of Naval Architects for several years past abound with papers upon this subject. Instead of the old jealousy and desire for secrecy, competitors in business have vied with each other in giving full explanations of many new methods which they have adopted for arriving at the desired results more quickly and certainly. The naval architects at the Admiralty have also done equally well, and have greatly advanced the interest which has been taken in the science.

It may be well to say a few words about bilge-keels or rolling-chocks, as it is often stated that these add to a ship's stability. This is quite an erroneous opinion. They are always under water, and therefore cannot affect the position of the centre of buoyancy at any degree of inclination. Their functions are quite different from those of the "bolsters" which were affixed to our circular model, for the simple reason that the latter, being at or above the water-level, increased by inclination the moment of the solid of immersion, and so formed a righting-lever. The work which bilge-keels do is to reduce the range and violence of rolling by presenting a drag to the water. When rolling has ceased they simply do nothing. They increase the steadiness, but do not affect the stability.

I have purposely left a description of one of the most interesting operations to the last. I refer to the method adopted for finding the height of the centre of gravity of a ship. The plan is a most ingenious one, and could not fail to interest any one having a taste for figures, statics, or mechanics. It will at once occur to every one that you cannot handle such an object as a ship or suspend her from various points as we can these models. Neither would it be possible to find it by experimenting with ever such a carefully-prepared model, because no ship is homogeneous in structure, but every ship is so complicated that no model could represent her as to the weight of all her parts. While we are unable to lift and suspend the ship, however, we know the laws which govern the support which the water affords to her. We must therefore cause her to assume different positions in this element, and then work backwards in order to get what we want. It is necessary to measure the exact amount of power applied to produce these changes of position. When we have found out all the facts surrounding, so to speak, the one which we want to get at we are able to deduce from them the required information—viz., that the centre of gravity *must* be at a given spot; otherwise the result of the application of the known power could not have been precisely what it was.

The device made use of is to put on board and move a known weight through a measured distance across the vessel, and to note its effect as shown by the change produced in the vessel's inclination. The ship must be in smooth water, and there must be no wind. She must be moored at each end only; the ropes must be attached at the centre-line, and must not be hauled too taut. Everything must be in its sea-going position, and only enough men to shift the weights must remain on board; those who stay must, when any measurement is being taken, range themselves in the same position on each occasion. These precautions are for the purpose of preventing any force operating to careen the vessel except that of the weights to be moved.

Square cast-iron weights with hand-hole and bar are very handy as the power to be used for careening. They should be stacked up in rectangular form as near to the bulwarks amidship as possible. A board must be fixed up and down in the hatchway, and a plummet or pendulum attached to it for recording the angle of heel. When all is ready, and the men are at their station, the observer notes the exact position. The weights are then carried across the deck and stacked up as far from their former position as possible. The exact distance between the centres of the two positions is taken. This, when multiplied by the weight moved, will give the moment of the power applied. The men return to their station, and the observer notes the change of inclination. This ends the experiment; the draught of water at each end of the ship is carefully taken and drawn across the sections on the drawings. The draughtsman now calculates the buoyancy, centre of buoyancy, and metacentre at the given draught when upright, and carefully ascertains the moments of the solids of immersion and emersion for the inclination produced by the power applied. From these facts he deduces the metacentric height necessary to account for the change of inclination, and, setting it down, from the metacentre obtains the position of the centre of gravity of ship and weights combined. The weights used for careening are finally allowed for, and then he knows the position of the centre of gravity of the ship alone. The operation all through is certainly a great triumph of ingenuity, skill, and accuracy.

This method could be applied to a loaded ship if desired, or, after making the above experiment, a prediction of the condition of such a ship if loaded with any homogeneous cargo could be made by calculating her contents of holds and their respective centres of gravity, and then ascertaining what change their moments must make in the ship's centre of gravity.

Another method may be adopted for ascertaining the centre of gravity of a ship. It requires that she shall at the time be drawing more water at one end than at the other, and it necessitates the use of a graving-dock. If she is drawing more water aft than forward her stern-post will take the blocks first. As the water falls it will leave her after-body somewhat, but the fore-body will sink correspondingly deeper so as always to maintain a condition of equilibrium between her weight and displacement until she settles on the blocks all along her keel. The after-keel block thus forms a fulcrum, and the weight of the ship always presses downwards through its centre of gravity. The centre of buoyancy can be calculated, and it is known that the centre of gravity of the ship is vertically above it. The only question is, At what height up is it situated?—and this can be worked out by a reliable rule.

In conclusion, I wish to express the hope that I may not have altogether failed in trying to give a popular explanation of the leading principles of stability. It has been a very brief sketch, although quite long enough for one evening's work. The subject has been merely entered upon, and is one well worthy of the close attention of all who are connected with the building, sailing, or commercial management of shipping. Theory is often sneered at, and practical experience extolled. My aim has been to show that they may go hand-in-hand, and, as an effort in that direction, I present the paper to the New Zealand Institute.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

TWENTY-THIRD ANNUAL REPORT, 1890–91.

MEETINGS of the Board have been held on the following dates: 29th November, 1890; 10th April and 3rd August, 1891.

The following gentlemen were elected Governors of the Institute by the incorporated societies in conformity with the Act: Mr. J. McKerrow, Mr. S. Percy Smith, and Mr. A. S. Atkinson.

The members who retired from the Board in conformity with section 6 of the Act are the Hon. Mr. Mantell, Mr. W. T. L. Travers, and Mr. T. Mason, and all these gentlemen were reappointed by His Excellency the Governor.

During the year the following gentlemen have been elected honorary members of the Institute: Professor C. V. Riley, of Washington; Professor Otto Nordstedt, of Sweden; and Professor Liversidge, of Sydney.

The Board regret to have to record the loss by death of one distinguished honorary member—viz., Sir Frederick A. Weld, G.C.M.G., who was elected in 1877.

The members now on the roll of the Institute are,—

Honorary members	28
Ordinary members—	
Auckland Institute	205
Hawke's Bay Philosophical Institute ...	99
Wellington Philosophical Society ...	151
Philosophical Institute of Canterbury ...	98
Nelson Philosophical Society ...	38
Westland Institute	76
Otago Institute	117
Southland Institute	72
Making a total of	884

The volumes of Transactions now in stock are—Vol. I. (second edition), 266; Vol. V., 28; Vol. VI., 28; Vol. VII., 120; Vol. IX., 120; Vol. X., 153; Vol. XI., 43; Vol. XII., 48; Vol. XIII., 48; Vol. XIV., 70; Vol. XV., 183; Vol. XVI., 180; Vol. XVII., 200; Vol. XVIII., 163; Vol. XIX., 175; Vol. XX., 175; Vol. XXI., 100; Vol. XXII., 100; Vol. XXIII., not yet fully distributed.

The volume of Transactions just published (XXIII.) was issued in July, and contains sixty-four articles, also addresses and abstracts of articles which appear in the Proceedings. The volume contains 680 pages of letterpress and 49 plates.

The following is a comparison of the contents of the present with that of last year's volume:—

	1891. Pages.	1890. Pages.
Miscellaneous	136	142
Zoology	236	244
Botany	72	56
Chemistry	...	4
Geology	144	62
Proceedings	48	52
Appendix	44	47
	680	607

The cost of printing Vol. XXII. of the Transactions was £284 6s. 9d. for 607 pages, and that for Vol. XXIII. £296 12s. 6d. for 680 pages.

The Honorary Treasurer's account for the year is appended, and shows a balance in hand of £51 10s. 1d.

The amount devoted to the printing of memoirs, in accordance with resolution of May, 1885, is £525; and the sum of £150 has been allotted for the printing of papers postponed from previous years.

A memorandum giving an account of the work done by the Institute since its organization is appended hereto.

James Hector,
Manager.

Approved by the Board.
W. B. D. Mantell,
Chairman.

3rd August, 1891.

New Zealand Institute Accounts for 1890–91.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand on 23rd July, 1890.. ..	90	3	1	For printing Vol. XXIII.	296	12	6
Parliamentary grant for 1890–91	500	0	0	Miscellaneous items ..	17	11	6
Contribution from Wellington Philosophical Society	24	10	0	Carried to Memoir Account	200	0	0
Sale of volume ..	1	1	0	Carried to Deferred-papers Account ..	50	0	0
				Balance	51	10	1
	£615	14	1		£615	14	1

W. T. L. Travers,
Hon. Treasurer.

Memorandum regarding the New Zealand Institute.

The first scientific society in New Zealand was founded in 1851, the first President being Sir George Grey, K.C.B., D.C.L. It was named "The New Zealand Society," and was located in Wellington.

In 1862 a second society was established in Christchurch as the Philosophical Institute of Canterbury, the first President being Mr. Julius Haast (since Sir Julius von Haast, K.C.M.G., Ph.D.). Much useful work was done by these societies, but they met at very irregular intervals, and the funds collected were inadequate for the proper publication of the papers that were communicated by the members. They therefore languished, owing to their being merely local societies, not having the sympathy of the colony.

The Exhibition held in Dunedin in 1865 brought prominently before the public the advantage of a more general organization for the development of the resources of the colony, and soon after the establishment of a scientific department by the General Government the New Zealand Institute Act was passed in 1867, and its administration was placed under the present Director of the Geological and Natural History Survey.

The New Zealand Institute has now been in operation for twenty-four years, which is a sufficient period in the history of a new country to indicate how far the practical results obtained by the working of one of its institutions have fulfilled the anticipations of its original promoters.

The object sought was to foster public interest in the collection and discussion of original observations respecting the resources and natural history of the country. This is done to best effect by the organization of a scientific society; but it was obvious that the geographical circumstances of the colony precluded the formation of any strong central society capable of stimulating and directing such investigations by frequent meetings of its members, as can be done in other colonies possessing a chief centre of population, where all social institutions become naturally concentrated. The constitution of the New Zealand Institute was therefore intended to provide for the combination of local efforts in this direction by enabling the joint publication of the papers read and discussed before local societies.

Experience has shown that in old countries the subscribed funds are generally insufficient for the proper publication of the transactions of small societies; and this drawback is still more felt in the countries where the number of members is small, while the field for original research is large, so that in a few years such societies languish after accumulating much information in manuscripts that, if published, would be of great assistance in advancing the interests of the community.

Each member of the scientific societies affiliated to the New Zealand Institute receives a share of the parliamentary grant in the form of an annual volume of the Transactions for the year of all the various societies. The presentation of this volume is regarded as a substantial equivalent for the subscriptions, and the fund which is created by the subscriptions is applied locally towards the maintenance of public museums and libraries in the different centres of population. In the case of Auckland, for instance, the public museum is almost wholly dependent on this source of revenue for its maintenance; and, if the vote which enables the annual volume to be distributed gratis is withdrawn, the Museum must either be closed or some other provision made for its support.

The educational effect of this organization can hardly be overestimated as a means of cultivating a love of knowledge and in disseminating information. To the influence of the Institute must in some degree be attributed the demand which is now expressed throughout the colony for elementary instruction in science, and the general recognition in New Zealand on the part of the public that it is necessary to obtain, as a branch of elementary education, the qualifications required for the comprehension and utilisation of the scientific literature that is so characteristic a feature of the present age.

The Institute commenced with four branch societies in 1869, and only 258 members, but there are now eight societies affiliated, and the number of members increased to 1,327 in 1881, but has since fallen off to about 950, each of whom pays one guinea a year, which may be considered as a voluntary tax for an educational purpose.

There have now been 1,623 original communications published in twenty-three volumes of the Transactions of the Institute, nearly all of which relate directly to the colony, and place on record matters of fact and observation that otherwise might not have been published. Of these papers 378 are on miscellaneous subjects, chiefly relating to the ethnology of the aboriginal races, or connected with the industrial resources of the colony; 613 are descriptive of the zoology of New Zealand; 203 refer to its botany; 113 are on metallurgy and chemistry in its relation to the colony; and 216 are on its geology and physical geography. In addition to these papers, which are published at length, abstracts of about 970 different communications are given in the Proceedings of the societies. The total number of the communications to the Institute has thus been 2,593. Besides which a number of popular lectures are given each year under the auspices of the various societies, of which no record is kept.

The average size of the annual volume of Transactions and Proceedings is 640 pages and about forty plates.

The funds at the disposal of the Board of Governors of the Institute have consisted only of the annual parliamentary grant of £500, an annual contribution from the Wellington Philosophical Society as an equivalent for rent of the library-room and the use of the lecture-hall, and a small sum arising from the sale of volumes. Nearly the whole of the funds are spent in the printing of the volume of Transactions, only a very small amount being devoted to the maintenance of the Library in the way of binding books. Nor is the information contained in these volumes confined to the colony, as they are widely distributed to the chief libraries in all parts of the world.

Forty-seven of the most distinguished men in science and literature, who have rendered special service to New Zealand, have been elected honorary members, while there are seventy-five corresponding societies and institutions that exchange their publications with the Institute. About three hundred volumes per annum are acquired in this manner, the greater number of which have been placed in the General Assembly Library.

The Museum in Wellington, though nominally under the charge of the Governors of the Institute, does not constitute a charge on their funds, but is wholly supported out of the votes for the Geological Survey Department. The labour of editing the annual volumes and the preparation of the illustrations is undertaken by the staff of the Geological Survey, in addition to their other duties, and without any further remuneration; and it is chiefly owing to this circumstance that a work, which actually produces in the form of subscriptions and contributions by way of exchange of books the value of over £1,700 per annum, is produced from the grant of £500 a year.

Besides the fostering of local societies the Act contemplated the establishment of technical schools throughout the colony; and at the request of the Government a scheme was submitted by the Board on the 20th July, 1870, to provide a normal technical school and to give practical instruction in applied science at the Museum; but no funds were provided for giving effect to this scheme. The functions of the Board under the Act for promoting local institutions for instruction in science have therefore remained in abeyance, and have to some extent been superseded by subsequent legislation and endowments for mechanics' institutes, public libraries, and technical schools for art, mining, agriculture, and other branches of applied science under the control of the colleges and the Education Boards.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *17th June, 1891.*

E. Tregear, President, in the Chair.

New Member.—H. Farquhar.

A copy of Vol. XXIII. of Transactions of the New Zealand Institute was laid on the table; also proof-sheets of Mr. Hudson's work on the entomology of New Zealand, with plates. The latter were greatly admired.

1. Address by the President.

ABSTRACT.

Mr. Tregear commenced by congratulating Sir James Hector on receiving the founder's medal of the Royal Geographical Society. He then referred to the recent reported discovery of the bones of the *Dinornis* in Queensland, and remarked that soundings recently taken showed solid land once to have existed from New Zealand to Australia, and through the Malay Archipelago to Asia. Whether the moa had been evolved from the emu by gradual transformation, or the emu from the moa, would be for the geologists and naturalists to discuss. The President then referred to the theories as to man's origin, whether from a single pair or from many sources; described the primitive state of the human race, with the progress upward from the cave-dwellers to the pastoral peoples, then to cultivators of the soil, then to dwellers in cities. Referring to the question of marriage, he described the emergence of the communal form into the slave period, and thus to the belief in the wife being the private property of the husband. He then called attention to the agreement between anthropology and the other sciences as to the great lapse of time necessary for mankind to have existed and to have passed through the palæolithic and neolithic periods to the building of great cities, which we now know to have been in existence six thousand years ago. Great portions of Asia and Africa, fertile, and abounding in all descriptions of animal and vegetable life, were still unsettled. Many extracts from the reports of travellers just returned from these wilds were quoted to show the adaptability of those places to the uses of the emigrant. The President, however, did not believe that the colonisation of Africa and other places in the possession of native races was as practicable as was generally believed. The enormous fecundity of the dark races, if relieved of the checks caused by bloodshed and war, would inevitably squeeze out the incomers, and prevent men of high organization existing in force sufficient to control the lower and more persistent racial types. Mr. Tregear concluded by expressing his opinion that the future of the world was not so entirely in the hands of intellectual nations as he had once thought; but, if the advance of mankind was threatened by the overflow of barbaric peoples, he trusted that the time of submersion would be short, and the world soon resume its path of progress, refreshed and invigorated with new and stronger life.

Sir James Hector, in proposing a vote of thanks to the President for his most interesting address, reminded members that within the last few months they had been indebted to Mr. Tregear for a most useful addition to New Zealand scientific literature in his comparative "Dictionary of the Polynesian Languages." His address showed that outside mere philology Mr. Tregear was able to take a wide grasp of the great problem of anthropology. With the President's permission he took this opportunity of introducing Professor Pond, who had just arrived from Cambridge to take the classical chair in the New Zealand University at Auckland.

Professor Pond considered it a high honour that he should, on his first landing, have the opportunity of attending the meeting of such a Society. He complimented Mr. Tregear on the admirable arrangement of his new dictionary—the method was excellent. He was told at Cambridge before leaving that he ought to consider it a high privilege, his being selected for his appointment in the New Zealand University, as the examiners in England thought most highly of the work done by the New Zealand students.

Mr. Travers seconded the vote of thanks, which was carried, and spoke in flattering terms of the able manner in which Mr. Tregear treated the subject of his address.

2. Sir James Hector exhibited a young salmon which had been caught in the Aparima River and forwarded to him by the Marine Department. He said that there could not possibly be any mistake with regard to the specimen being a true salmon. The fact that salmon, after years of fruitless experiments, had now been acclimatised was highly satisfactory, though he feared that the formation of our coast-line was such as would prevent the return of salmon to their own rivers. Should, however, the salmon prove their attachment to the streams in which they were hatched, the colony would have gained a most valuable asset, and one which it would be well to protect with the greatest care.

3. Sir James Hector exhibited samples of the different coals and rocks from the coalfields lately visited. With reference to the Black Ball Mine, a tunnel of 1,230ft. had been driven to reach the coal, and two seams had been cut of first-class-quality coal, making a total of about 20ft. thick of coal. Samples of the rocks from the tunnel were also described. Samples of the coal from the new Cardiff and Mokihinui Company's lease were exhibited, and also samples from the Kaitangata Mine, Otago; and a number of fossils found in sinking the Castle Hill Company's shaft at Kaitangata were also on the table and described. Samples of coal from Orepuki were shown, together with a series of fossils from the Middle Waipara, in the northern district of Canterbury. These latter were described as being geologically of very great importance, on account of the presence of *Belemnites australis* in association with dicotyledonous leaves, and in the same boulders remains of *Leiodon haumuriensis*, this being the first time that these Secondary fossils have been found in the Canterbury District.

SECOND MEETING: *8th July, 1891.*

E. Tregear, President, in the Chair.

New Member.—William Percival Evans, M.A., Ph.D.

Papers.—1. "Mill on Demonstration and Necessary Truth," by W. W. Carlile, M.A. (*Transactions*, p. 644.)

Sir James Hector thanked the author for his most interesting paper. It was a subject difficult to criticize until the paper had been carefully read.

Mr. Maskell agreed with Sir James Hector that the best thanks of the Society were due to Mr. Carlile for his excellent paper, which invested a dry and difficult subject with much more interest than probably any one expected. For himself he found several very suggestive points in the paper—not so much as to the particular question treated as on general grounds. In the first place it reminded him of what seemed to be the general fault of all English writers on philosophy and logic—that they never seemed to refer to any but English, Scotch, or a few German authors. Now, if they would study French, Spanish, or Italian works also they might enlarge their views, and possibly gain insight into quite new and correctly suggestive trains of thought. Then, again, Mr. Carlile, he thought, had attached far too much importance to the notions of Professor Huxley, a man who, to the speaker's mind, was as bad a specimen of blatant assumption and of illogical absurdity (except, of course, when dealing with actual facts of natural history) as the modern era has shown. There was one point, only incidentally referred to in the paper, which would perhaps require correction. Mr. Carlile parenthetically remarked that the axiom that two things which are equal to a third are equal to one another would be incomprehensible to a Bushman or a Damaraman. Taken as referring to any particular or existing savage, this would be probably true; taken as a general statement, with the inference that any necessary difference exists between the brain and intellect of a savage and the brain and intellect of a cultivated Englishman, it would certainly not be correct, in spite of the prevailing theory of the present day, which usually affirms it, if not in terms, at least by implication.

The President said that, greatly as he admired the work of Professor Huxley in the domain of natural science, he shared with others the regret that the learned Professor should ever step outside the limits of his own domain and enter the fields of politics and theology, where his logic was by no means unassailable. He (the President) had been struck with astonishment when reading Huxley many years ago to find that he had stated that all dream-images were vague and undefined. This is contrary to the facts of experience of most observers. Undefined images might occupy the mind of one who was discussing a subject like "man" from a racial point of view; but in the case of "triangle" there was no mental conception possible of a triangle generally—it was absolutely necessary to conceive the idea of a triangle as either equilateral, scalene, isosceles, &c. As to necessary truths, it was almost certainly held that the axioms of Euclid were necessary truths; but he had read a clever psychological article in a recent magazine, in which it was asked how it was possible to possess one of these self-evident truths except by inheritance, without breaking the chain of cause and effect. Such a statement as that "things which are equal to the same thing are equal to each other" was not a "self-evident" truth; it required reasoning from experience before the mind could place faith in it. The purely mental conception of a line as having "length without breadth" could not be called useless (although it could not be practically represented), because arithmetical figures used in trigonometry proved that the boundaries of geometrical figures really had position, but not magnitude of breadth. So that this is almost a necessary truth; and, although abstract truths were little more than hypotheses, still, if they were "working hypotheses," they were of enormous value. He might instance the value of the Forty-seventh Proposition of the First Book of Euclid: the discoverer of the principle in this problem offered up a hecatomb of oxen to the gods for so great a truth being found; and it had proved of inestimable value to the world in astronomy, navigation, engineering, &c. He could understand the schoolboy's delight if allowed to prove the truth of the Fifth Proposition of the First Book of Euclid by turning the triangle on its back, but he hardly thought such a simplification would be allowed, although many of the propositions might be swept away as being evident at sight, and not made clearer by the attempted proof. As to Mr. Maskell's assertion that the Bosjesman, or any savage, had as much intellectual power as the civilised European, there would be difficulty in measuring the amount of latent power in any individual; but it was certain that the expression of that power was immensely unequal. It would be almost impossible to assert with gravity that the mind of an African who with great difficulty could be taught the use of numbers beyond two or three was equal to any one of the minds of Bacon, Newton, or Herschel, although a potentiality of mind equal to great intellectual effort might lie unrecognised in the brain of the savage.

Mr. Carlile, in reply, expressed his gratification at the appreciative criticism his paper had received. The President had already explained some of the matters to which exception had been taken. He had not meant to suggest that the simplification of the proof of the Fifth Proposition which he suggested in any way detracted from its validity or importance. There were several of the propositions at the beginning of the First Book which were rather obscured than illustrated by the proof furnished of them: the Thirteenth, for instance. If we regard a point in a straight line as an angle of 180°, it was certain that drawing any number of lines through this point could have no tendency to alter the size of this angle; yet this was what was elaborately proved. He thought a desideratum among the definitions was a definition of what was meant by the size of an angle. It proceeded to speak of the size of angles without furnishing any criterion for their measurement. If this were furnished it would necessarily carry with it the proof of the Fourth, Fifth, and Eighth, and a host of other propositions. The size of an angle, and the length of the subtending side in any triangle, were, it seemed to him, two names for the same thing. There was no use of propositions to prove the fact of their concomitant variations.

2. "On the Shifting of Sand-dunes," by H. C. Field. (*Transactions*, p. 561.)

Sir James Hector said he thought the subject a most important one. In a new country they should be very careful as to how they interfered with the natural changes of the coast-line. He was of opinion that Mr. Field had done good service in bringing this matter before the Society. They in New Zealand would have to guard against selling lands situated in dangerous positions on the coasts. They should also prevent mischievous people from interfering with mouths of rivers, and thus preventing natural changes. Mr. Field's paper had opened up a subject of extreme practical importance to the colony.

Mr. Beetham thought this a valuable paper. It would encourage those who had the opportunity to note carefully such changes as had been spoken of. There was no doubt great alterations had taken place on our coasts and in our rivers owing to the causes mentioned by Mr. Field.

THIRD MEETING: *29th July, 1891.*

E. Tregear, President, in the chair.

The President called attention to the volume of old views of Wellington and other parts of New Zealand, presented to the Society by Major Gudgeon.

Papers.—1. "On the Establishment of an Expert Agricultural Department in New Zealand," by W. M. Maskell, F.R.M.S. (*Transactions*, p. 625.)

The Hon. R. Pharazyn said he quite agreed with Mr. Maskell that it was of the greatest importance that such an expert department should be established, and he would be glad to do all in his power to support such a movement. It had been found in other countries that a department of this kind had worked well, and had proved of the greatest benefit to those engaged in agricultural pursuits.

Mr. G. Beetham was also in favour of a department such as Mr. Maskell described. He believed that if properly represented the Government and the House would favourably consider such a proposition. He complimented Mr. Maskell for the valuable work he had done in this branch of science, and said that the thanks of the Society were due to him for having brought this important matter forward.

Mr. Carlile thought that the farmers would highly approve of the establishment of such a useful department, and he thought the various incorporated societies would assist in urging the forming of a department of this kind.

The President agreed with all that had been said.

The following resolution was moved by Mr. Maskell: "That, in the opinion of this Society, the establishment of a well-equipped expert Agricultural Department is urgently required in New Zealand."

Mr. R. C. Harding, in seconding the resolution, said he could not speak with practical knowledge, like the gentlemen who had already given their views, but, even without such knowledge, the necessity of such a department would be recognised. Many present would remember the cumbrous and oppressive Thistle Acts of the old provincial days, when every province had a different ordinance. These Acts were now acknowledged to have been ill-advised, while in regard to the thistles they were about as effective as a Papal bull against a comet. The present fashion seemed to be to launch a separate and voluminous Act of Parliament against each individual nuisance. The public suffered from ill-considered legislation, and the pests flourished apace. The Act just passed relating to small birds was a case in point. It was crude and unwieldy to the last degree, would prove an intolerable nuisance, and would probably produce all manner of effects other than those intended. Parliament was not qualified to deal with such matters; they lay altogether outside of the scope of its duties. If only in the interests of economy, Mr. Maskell's proposition deserved all support.

The resolution was carried, and it was ordered that a copy thereof should be forwarded to the Hon. the Minister of Lands.

2. "Animal Intelligence," by W. W. Carlile, M.A. (*Transactions*, p. 349.)

Sir James Hector said the author had succeeded in making a very abstract and difficult point in mental philosophy quite interesting. He agreed with the side he took in the much-discussed question of whether animal intelligence differed from our own in kind or only in degree, and whether the production of the highest intellect was the result of progressive and accumulated development. The story of the horses gnawing down the cabbage-trees to obtain moisture is parallel with the well-known habit of the mules in Mexico kicking the great cactus-trees for the same purpose.

Mr. Hulke remarked that the reasoning of animals differed from that of man only in degree. He mentioned several facts relating to insects and animals to illustrate what he meant.

Mr. Hudson gave an account of experiments made by Sir J. Lubbock with ants, which appeared to indicate that insects, when placed out of their ordinary sphere of action, exhibited very limited reasoning-powers.

Mr. R. C. Harding said that the vulgar discrimination between instinct and reason might not be so unscientific as had been assumed. He considered it was based on a difference, not one of degree. Instinct he regarded as the intuitive perception of interior qualities, as distinguished from those merely exterior properties made known to us by the five senses. The instincts might therefore be taken as supplementary senses, on a different plane from the five ordinarily recognised. Between the perception by means of a sense and the intellectual result of rational effort there was an evident distinction, and a parallel distinction could be traced between instinct and reason. The terror of a horse at the odour of an unknown wild beast might be accounted for by inherited memory, but it seemed more reasonable to attribute it to the immediate perception of a maleficent quality. Protective instincts like this were found throughout nature, but were so rudimentary in man that, physically, as compared with beasts and insects, he was the inferior animal. The nearer man approximated to the lower animals in his mode of life and intellectual development the more powerful these instincts appeared to be; but as his rational capacity increased they were ignored, and seemed gradually to disappear. Yet they were by no means to be despised, as where they existed they enabled him to arrive by a short cut at a point which would otherwise only be attained by great and laborious mental effort. Sometimes a child was found to possess almost in infancy faculties which showed how great the undeveloped possibilities of mankind were in this direction. There were well-attested cases of children knowing neither letters nor figures—one a negro boy—who had a natural perception of qualities and relations of numbers, and a skill in dealing with them exceeding that of trained mathematicians. The mental quality that could at once recognise a prime of almost any number of figures at sight, and the power of analysis which could immediately resolve any divisible number into its factors, were not to be attained by the severest training; but this gift was actually possessed by a calculating child. Young Mozart in early infancy possessed a similar grasp of the qualities of sound—a practical as well as a theoretical perception, for he was able to play any instrument at sight. Hereditary memory would scarcely account for phenomena like these, which were interesting as showing how immeasurably human instinct in its higher forms transcended that of the animal creation. Regarding Sir J. Lubbock's celebrated experiments with ants, careful and systematic as they were, and completely as they failed to show anything like intelligent or connected action, he did not think their results warranted us in rejecting the accumulated testimony of past ages on the subject.

The President said that Mr. Carlile's illustration of heredity recalled to his mind that many years ago, when riding a very quiet horse, the animal suddenly leapt aside, and began trembling in great fear, on seeing a piece of rata vine coiled up and lying in the road, recalling the appearance of a snake. This horse was two generations from an Australian progenitor. It had been said that instinct is "inherited memory," and, although that might seem to explain such facts as the orderly movements and almost automatically-regulated actions of ants and bees, it by no means explained any unusual cleverness or exceptional genius. For instance, the musical genius of Mozart could hardly be expected to be produced out of thin air, and yet it could certainly not be called "inherited." Reason had little to explain to us why Mozart as a child was a finished musician, and analogies drawn from one order of beings should be used with great caution if applied to explain difficulties in regard to other kinds of creatures. Experiments had recently been made which show that when insects are subjected to the different-coloured bands of light thrown down by the spectroscope they display different modes of action—lying dormant under one colour, growing intensely excited under another, and so on. It is possible that they live in quite another world than ours so far as impression produced by the senses is concerned; that phenomena which appear beautiful or terrifying to us make no impression upon them; and that knowledge which to us is a sealed book may be to them as an open scroll. The sense of touch in human beings is absolutely null and void compared with that sense in the ant, which almost certainly communicates intelligibly with its fellows by means of contacting antennæ; while the sense of smell in civilised man is almost as feeble as it is useless. It is quite conceivable that other creatures have other senses the effects of which are no more to be appreciated by us than the tints of a landscape or a flower would be by a blind man.

Mr. Carlile, in reply, said he found that he had not been wrong in his anticipation that his instances of animal intelligence would be capped by others. He could not see how Mr. Harding's view as to what appeared to be the results of hereditary memory would square with the facts. The qualities of a thing were simply the impressions it made on the senses—its colour, smell, and so on; and to say that the horror which a New-Zealand-bred horse felt for what looked like a snake was possibly not owing to hereditary memory, but to the horse's perception of some, to us, occult quality, conveyed no meaning to his mind. The theory of an inverse ratio between instinct and reason, started, he thought, by Sir W. Hamilton, accorded with some of the facts of natural history, but was far from being true universally. He cited from Wallace's "Malayan Archipelago" what seemed an instance in point of its truth. A baby orang-outang which they captured, belonging as it did to the anthropomorphic apes, showed all the characteristics of the human baby as regarded its utter helplessness, the result being that its captors nursed and tended it, and became greatly attached to it. The young of monkeys, however low down in the intellectual scale, were much more capable of taking care of themselves at an early age.

Fourth Meeting: *8th August, 1891.*

E. Tregear, President, in the chair.

Sir James Hector gave a short description of the geological structure of the country from the Kaikouras to the southern part of Canterbury, and referred especially to the recent earthquakes in that district, as described in the late reports of the Geological Department.

Mr. A. McKay, Assistant Geologist, then exhibited about a hundred views, taken by himself, on the screen, to illustrate the above remarks. As each view was shown Sir James Hector made descriptive remarks. The views were much admired, and a vote of thanks was accorded to Sir James Hector and Mr. McKay.

FIFTH MEETING: *9th September, 1891.*

W. T. L. Travers, F.L.S., in the chair.

New Member.—R. T. Turnbull.

Papers.—1. "Instances of Instinct in Insects," by G. V. Hudson, F.E.S. (*Transactions*, p. 354.)

Mr. Phillips said he disagreed with the author as regards the hereditary instinct of animals; he believed that animals and man derived their intelligence in constructive ability in a similar manner—namely, from a common vital force, a subject on which he had read a paper before this Society a short time ago. He did not agree to credit everything to evolution. A spider's web is superior to anything that man can construct. There is a force in nature given to man or insects which is common to both, and not necessarily hereditary.

Mr. Maskell said he was obliged to dissent from the conclusions of the author. Whatever the reality might be of the three or four facts given by Mr. Hudson, they seemed entirely insufficient to form a basis for a theory of instinct such as was proposed. For example, in the case of the falling insect mentioned, Mr. Hudson adduced this as an instance clearly pointing to acquired faculties, the result of long series of minute variations and progress. But the case was of extreme weakness unless Mr. Hudson was prepared to assert of his own knowledge that the remote ancestor of this moth—the very first of the race—did not do precisely the same thing. Assuming (what did not seem to be proved) that the moth which fell on this occasion did so from fright,—assuming that the moth could see far enough to detect an approaching enemy (also not proved),—how could anybody say that the very first created moth of the species did not do the same thing under similar conditions? And if it did, where would the progressive inherited variation leading to the instinct of the moth now referred to come in? The founding of theories tending to sap and destroy the first principles of human belief on such vague and unproved assertions as those of the paper was mischievous in the extreme, and the speaker regretted that so many young students of the present day were apt to give way to the temptation of indulging in them.

Sir Walter Buller was somewhat disappointed with Mr. Hudson's paper, because its ambitious title had led him to expect much more than it gave in the way of original research. He could not conceive a more fruitful subject than the one selected by the author; but, instead of the large array of facts and observations from his own experience one might have expected, Mr. Hudson had recorded only two instances of remarkable instinct in New Zealand insects, the rest being quoted from English authors. The paper appeared to him a little crude, but he felt sure Mr. Hudson was on the right track. It seemed to him impossible to reject the theory of hereditary instinct with such evidence before us. Take, for example, the hexagonal cell of the common honey-bee. What the first bee may have done it is, of course, impossible to know, but within the memory of man the bee had constructed its cell on exactly the same model, as the result of hereditary instinct.

Sir James Hector said the paper was evidently an attempt to meet statements attacking the theory of evolution that were made at previous meetings. He held that there was nothing about first causes in that theory, and that it was a powerful aid to the working naturalist in unravelling and unfolding the various steps in the scheme of creation. He recommended members to read some interesting anecdotes bearing on the question of modification of instincts into individual reasoning-powers which are related in *Good Words* by Dr. Günther. He referred especially to the nesting habits in confinement of the magpie and house-sparrow, which showed that inherited memory, or instinct, though very potent, could be overruled by individual effort.

Mr. Harding called attention to what he said at the last meeting on Mr. Carlile's paper. He did not think we could have both reason and instinct. He related how a beaver in captivity showed instinct, but very little reason. There was a communal instinct which enabled savages to construct bridges, and such things, without the aid of architects or surveyors. Mr. Hudson's paper, as a clue to the mystery of nature, was worthless, but it was a good working theory for a naturalist. It was a mistake to put forward such statements as Mr. Hudson had done as if they were actual facts.

Mr. Travers described how the gull carried the shell to a height, and then dropped it, when it broke, and disclosed the fish inside, which the gull fed upon. This was probably the result of an accident in the first instance, followed by reason in repeating the action. The bird could not acquire this from any created habit. Mr. Wallace is inclined to abandon the idea of instinct. Dr. Günther's example of the magpie is remarkable. He did not think Mr. Hudson intended, as Mr. Maskell inferred, to dogmatize. The paper was valuable, and contained most interesting facts. We must inquire into all facts of this kind if we wished to add to our knowledge in natural history.

Sir Walter Buller said he wished to supplement Mr. Travers's account of the instinct displayed by *Larus dominicanus* in breaking shell-fish. During his travels he had thousands of times watched the operation—the bird ascending obliquely to a certain height, then dropping the shell and coming down to feast on the contents. But what had specially struck him was this: The sagacious bird never dropped the shell on soft sand or ooze, but always selected the hard portion of the beach, where the impact of the falling shell would produce the desired result. That fact alone exhibited a certain amount of intelligence on the part of the bird. But there was this curious fact also: The young sea-gull never resorted to this mode of breaking shells. It took from two to three years for the bird to attain its full livery of black and white plumage; it was easy, therefore, to distinguish the young bird in its spotted grey dress, and he could not remember having once seen it rise in the manner described. This would seem to tell against the theory of hereditary instinct, because the habit was evidently an acquired one, and the result of imitation.

Mr. Hudson, in reply, was gratified at the interest taken in his paper. He was sorry that the title had been misleading. He merely offered it as a supplement to Mr. Carlile's paper, and did not pretend that it was exhaustive. With reference to Mr. Phillips's remarks on the "vital force," he was not aware that the existence of any such power had been demonstrated. In connection with Mr. Maskell's remarks, he wished to direct attention to the extensive modifications which man had produced in many domestic productions by exercising selection in certain directions. Natural selection having so much wider a scope, and so much more time to act, it must have produced far greater results than man's selection. With regard to the term "natural selection," he was aware that there were certain objections to its use, but it was shorter than the more accurate one, "survival of the fittest." In stating that the instincts of insects were inherited in the same manner as their structure and colouring, he was only following the almost universal opinion of entomologists. In fact, it appeared to him impossible to explain the phenomena of the insect-world in any other way. How, for example, would it benefit an insect to inherit a resemblance to some inanimate object, unless it also inherited the instinct to assume the peculiar position necessary to complete the deception? He could not understand Mr. Harding's statement as to the superiority of the savage over the civilised man in works of engineering skill. In conclusion, he was surprised at objections being raised to the idea that knowledge would gradually become an inherited attribute in the human race. How much better, for example, it would be if we could inherit all our elementary learning, and thus have so much more time for more advanced studies! There were many instances where insects inherited the faculty of performing most complex actions without being taught, and he did not see why the same law should not apply to man when a sufficiently long interval of time had elapsed to render his activities hereditary.

Mr. Maskell brought under the notice of the meeting a specimen of the horse- or bot-fly. It had appeared in New Zealand during the last year. It affected horses in a most extraordinary way, driving them almost mad. He thought it right to make the appearance of this pest known.

Mr. Travers said he greatly feared that the direct steamers would be the means of introducing many such pests.

2. "Notes and Observations on New Zealand Birds," by Sir W. Buller. (*Transactions*, p. 64.)

The author exhibited several beautifully-prepared specimens to illustrate his paper.

Sixth Meeting: *23rd September, 1891.*

Sir James Hector in the chair.

New Member.—Hastings Lee.

Sir James Hector said that before proceeding to the business of the evening he wished to introduce to the Society Mr. Albert Koebele, an American entomologist, who was making a second trip to the colonies for the purpose of studying the enemies of insect pests. Members would recollect that in 1888 Mr. Koebele, when on a visit to South Australia in search of a small fly (*Testophonus*), a parasite on that dreadful pest *Icerya purchasi*, discovered a single ladybird (*Vedalia*) preying on the pest. He found a second specimen in New South Wales, and then on his arrival in New Zealand he found that the *Icerya* about Auckland was also being destroyed by something, and this too turned out to be *Vedalia*. As an energetic and expert entomologist he at once saw that here was the thing he sought. Passing on to Napier, where *Icerya* had been exceedingly destructive, he was fortunate enough to be able to collect several thousands of *Vedalias*, and he was able to take them away with him and liberate them, still alive, in California. Now, California had been up to that time so eaten up by *Icerya* that the damage was estimated at several million dollars annually. Yet, in twelve or fifteen months after the liberation of *Vedalia* the State of California was practically free from the dreaded pest. This work of Mr. Koebele was in fact one of the grandest things in the interest of fruit- and tree-growers that have been effected in modern times, and he thought no apology would be needed from him for introducing personally to the Society the gentleman who had been so energetic and successful in carrying out this splendid work. He might observe that perhaps the whole thing showed how careful the people of New Zealand ought to have been (and, unfortunately, they had been only too careless) about the introduction of plants from other countries without due investigation of the insect-life on them. But, at least, Mr. Koebele's visits had had this good effect: They had drawn attention in the most practical way to the need of cultivating the natural enemies of pests; and, also, as he taught California how to clear away *Icerya*, he taught New Zealand too the way to extirpate it.

Mr. Maskell desired to cordially indorse all that the Chairman had said, and ventured to add a word or two as to Mr. Koebele's present work. That gentleman had recognised the benefit which New Zealand had done to California in giving it *Vedalia*, and now Mr. Koebele was trying to repay the benefit by introducing to this country and liberating in Auckland insect-parasites from America which would, he hoped, prey largely upon the other "blights" existing here. If America owed something to New Zealand, it was now the turn of New Zealand to thank an American for trying his best to give us a practical benefit in return. He would venture also to say that in America, had there not existed expert Agricultural Departments and expert Boards, Mr. Koebele's two visits would probably have never taken place, and they furnished, therefore, an additional very strong argument in favour of the resolution passed lately both by this Society and by the Legislative Council, to the effect that an expert Agricultural Department should be established here, instead of the sham now existing.

Paper.—"On Stereo-chemistry, or the Arrangement of Atoms; being the Latest Phase in the Development of the Atomic Theory," by W. P. Evans, M.A., Ph.D.

Abstract.

The author sketched briefly the older radical and type theories, showing how each failed to lay sufficiently bare the internal structure of the molecule. The chain theory was then gone into at some length, and its inability to explain many well-known cases of isomerism pointed out. Having thus made evident the necessity for widening the theory, the author proceeded to explain the stereo-chemic hypothesis of Le Bel and van't Hoff. By help of models, the possible derivatives of a single carbon and the combinations of two such systems were developed, it being thus shown how two hitherto unknown classes of isomers were rendered possible—viz., those due to the presence of asymmetric carbon-atoms, and those due to the presence of doubly-bonded pairs of carbon-atoms. Many examples from organic chemistry were then given in support of the hypothesis, special stress being naturally laid on those compounds (*e.g.*, tartaric acid, amygdalic acid, malic acid, propylene glycol, amylic alcohol, camphor, &c.) whose optical activity was not dependent on the solid state. In conclusion, attention was drawn to the fact that the stereo-chemic method had already been extended to other elements, notably nitrogen and oxygen; that it had done much service in the development of organic rings, had explained in a very satisfactory manner several hitherto abnormal anhydrides and oximes, and bade fair to be of considerable use in comparing the chemical energies of the several members of any special group.

Sir James Hector complimented the author on his splendid paper. He hoped that before long the services of Dr. Evans would be secured as a teacher in one of our colleges. He pointed out how necessary it was for Wellington to have a college where a lecture of this kind would be of much benefit to students, and he hoped Dr. Evans would on a future occasion give the Society further experimental proofs of the theories he advanced.

Mr. Hulke said he had listened with great pleasure, for the subject of the paper had been for some time past of great interest to him. If there was any foundation of truth in the theory, then the polariscope would be to the chemist what the spectroscope was to the astronomer. All innovations met with opposition. When, half a century ago, the increasing number of organic compounds necessitated a revision of chemical nomenclature, Dumas tried hard to stop the change. He sneered at constitutional formulæ, and the designation of compounds by their common-sense names. And so with the new theory. Its authors were ridiculed by some of the greatest chemists of the day. Because Wisliceuns favoured it Kolbi attacked him in no measured terms, accusing him of quackery and charlatanism akin to spiritualism; and now Kolbi is gone, and Wisliceuns sits in the professorial chair formerly occupied by his bitter opponent.

Dr. Evans, in reply, said that unfortunately very few experiments connected with stereo-chemistry had much attraction for any one but a chemist, and nearly all demanded a much longer time than that placed at the disposal of a lecturer. With regard to the remarks of the Chairman on the relations between optical activity and living organisms, he might say that such a connection had been almost conclusively proved not to exist. The special acid mentioned by Sir James Hector—namely, tartaric acid—had been synthetically produced in all its modifications; and these had proved themselves the exact counterparts of those derived in the usual manner from the juice of the grape. Many other optically-active substances had also been synthesized with like results. Moreover, all attempts to bring about optical activity by means of ferments and other living organisms, in fluid whose molecules did not possess asymmetric carbon systems, had resulted negatively.

Seventh Meeting: *21st October, 1891.*

Sir James Hector in the chair.

Papers.—1. "Further Coccid Notes: with Descriptions of New Species, and Remarks on Coccids from New Zealand, Australia, and elsewhere," by W. M. Maskell, F.R.M.S. (*Transactions*, p. 1.)

Mr. Maskell read extracts only from the paper, and drew attention to a collection of insects on the table which had been described by him. He pointed out the great interest there was in the study of these scale-insects, especially from an economic point of view. He was sorry that so little interest was taken, especially by those who were more immediately affected by these pests. They were ready enough to ask for information, but rarely acted on the advice given. It was disheartening to those who devoted so much time to the economic side of the question, and almost enough to make those engaged in it give up such work. He would still do all he could to induce the Government to establish an Agricultural Department. The proposal had generally been received well in the Houses of Parliament, but he was afraid that until more pressure was brought to bear the Government would not move in the matter. He probably would ask the Council of this Society to still further assist him in bringing about the object desired.

Sir W. Buller said he had listened with pleasure to Mr. Maskell's interesting and practical remarks. He thought, notwithstanding what Mr. Maskell had said, that work of this nature would in time be appreciated, and he thought that an Agricultural Department would be established, thanks greatly to the exertions of Mr. Maskell.

Mr. Travers said farmers and fruit-growers would thoroughly appreciate the establishment of an Agricultural Department. Many of them were benefiting by the advice given by those who worked on the scale and other insects. The making-known the life-history of these pests was of the greatest value.

Mr. Harding thought that the Agricultural Department would become an accomplished fact.

Sir J. Hector said that Mr. Maskell deserved the thanks of the Society for having contributed such a valuable paper. He thought, with regard to the establishment of an Agricultural Department, it was necessary that some more definite scheme should be decided on, and more information provided, before a department of this kind could be formed. It was not quite such a simple matter as might be supposed. It required to be carefully thought out. In the meantime the Government were doing all they could in the matter. He hoped Mr. Maskell would still continue his valuable work on these insects, especially that part bearing on the economic branch of the study.

Mr. Maskell did not wish what he had said to refer specially to what he had himself done in this particular branch of scientific research. He referred generally to the small amount of interest taken in this important work.

2. "Further Notes and Observations on Certain Species of New Zealand Birds," by Sir Walter Buller, K.C.M.G., F.R.S. (*Transactions*, p. 75.)

The author exhibited several handsome specimens.

Mr. Travers agreed with Sir Walter Buller that many of our rare birds were fast disappearing. He said that the introduced ferrets, &c., were in a great measure the cause; they were destroying the domestic fowls, and had to be killed as vermin.

Mr. Phillips said that if the ferrets were vermin, and there were no rabbits, they should certainly be destroyed; but that they had been most useful in getting rid of the rabbits was most certain.

Sir Walter Buller said we had far better never have introduced such animals; the rabbits would have died out, or could have been otherwise destroyed, but we should find it difficult to get rid of the ferrets.

Eighth Meeting: *11th November, 1891.*

The Hon. W. B. D. Mantell, F.G.S., in the chair.

Paper.—"On Moth-destruction," by Coleman Phillips. (*Transactions*, p. 630.)

The author exhibited a lantern and fittings by which it was proposed to catch the moths in large quantities.

Sir James Hector said that Mr. Phillips had certainly done good work in pointing out a simple and effectual way of getting rid of these insects that are so destructive in our gardens and fields of crops; it was the first time, as far as he knew, that the lantern had been used in a practical way for this object. He did not think any useful insects would be destroyed.

Mr. Hudson agreed that the lantern idea was novel for the purpose of destroying moths on such a large scale. He was afraid it would not reach the worst kind of pests, which he thought were the slugs. The wireworm referred to was not a moth, and its beetle had no wings; the lantern would, however, attract some of the wood-boring beetles with wings. He did not think we had the wireworm in New Zealand.

Mr. Richardson thought we had the wireworm here. The reason why so many were captured was that the light of this lantern was so much greater than ordinary lights.

Mr. Phillips did not claim to have invented this lantern; he had only adapted and improved it for this purpose. He intended supplying them to his neighbours. He said that one of the moths he caught did terrible damage to the grass, oats, and turnips—the fields swarmed with them.

Annual Meeting: *24th February, 1892.*

W. M. Maskell, F.R.M.S., in the chair.

The annual report and balance-sheet were read and adopted.

Abstract.

The report stated that eight meetings had been held during the year, and the attendance had been larger than usual. This was no doubt owing to the fact that the subjects treated in the papers read were more varied than had generally been the case. Twenty papers were read. Five new members had joined the Society during the year, and the total number now on the roll was 155. The statement of accounts showed that the receipts amounted to £137 1s. 3d., and the expenditure to £103 18s. 7d., leaving a balance of £33 2s. 8d. There was also a fixed deposit of £21 towards the prize fund.

Election of Officers for 1892.—*President*—Sir Walter Buller; *Vice-presidents*—A. McKay, G. V. Hudson; *Council*—A. de B. Brandon, W. T. L. Travers, C. Hulke, W. M. Maskell, Sir James Hector, Dr. Evans, E. Tregear; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Mr. Travers moved that a vote of thanks should be awarded to the retiring President (Mr. E. Tregear) for his past services, with an expression of regret at the illness which had caused his absence from the Society's meetings and from the meeting that evening.

Sir Walter Buller, in seconding the motion, expressed great admiration of the Maori-English lexicon brought out by Mr. Tregear. It was a remarkable work, and it would be a landmark in Polynesian history.

Other members also expressed admiration of the work, and the motion, with the addition of an expression of appreciation of the book, was then carried.

Papers.—1. "*Status quo:* a Retrospect.—A Few More Words by way of Explanation and Correction concerning the First Finding of the Bones of the Moa in New Zealand; also Strictures on the Quarterly Reviewer's Severe and Unjust Remarks on the Late Dr. G. A. Mantell, F.R.S., in connection with the same," by W. Colenso, F.R.S. (*Transactions*, p. 468.)

The paper evoked some discussion, the Hon. W. B. D. Mantell expressing himself strongly in sympathy with the author, but stating that he would reserve further remarks until the paper was printed.

The Chairman expressed regret that so many years had elapsed before this question as to the discovery had been settled, and he hoped that Professor Owen would have an opportunity of replying to the paper just read.

2. "On Earthquakes in the Vicinity of Wanganui," by H. C. Field. (*Transactions*, p. 569.)

3. "On the Discovery of Moa-bones in the Vicinity of Waikanae," by H. C. Field. (*Transactions*, p. 558.)

4. "On the Large Kiwi from Stewart Island (*Apteryx maxima*)," by Sir Walter Buller, K.C.M.G., F.R.S. (*Transactions*, p. 91.)

5. "On a New Mistletoe," by T. Kirk, F.L.S. (*Transactions*, p. 429.)

6. "Description of New Plants from the Vicinity of Port Nicholson," by T. Kirk, F.L.S. (*Transactions*, p. 423.)

7. "Remarks on the Genus *Abrotanella*, Cassini, with Descriptions of New Species," by T. Kirk, F.L.S. (*Transactions*, p. 418.)

8. "Notice of the Occurrence of Australian Orchids in New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 425.)

The reading of the following paper was deferred: "The Moas and Moa-hunters," by Mons. A. de Quatrefages; translated from the French by Laura Buller; communicated by Sir Walter Buller.

AUCKLAND INSTITUTE.

FIRST MEETING: *8th June, 1891.*

Professor F. D. Brown, President, in the chair.

New Members.—T. Allen, E. S. Brookes, jun., Rev. H. S. Davies, W. G. Rathbone, T. O. Williams, M.D.

The President delivered the anniversary address.

ABSTRACT.

The President began by regretting his want of literary genius—that singular gift which enabled some men to invest the most trivial thought with human interest, and to lend to the most unpromising subject the charm which in ordinary hands it would never even remotely suggest. Lacking as he did that divine endowment, he considered it best to make no pretence about the matter, but to proceed to deal in an ordinary and commonplace manner with their every-day existence as an Institute. After referring to the foundation of the Institute, and the importance of forming, as they had been doing, a scientific reference library, he went on to speak of the meetings held by the society, which, he said, had often been to him a source of reflection. Members frequently said that they did not attend these meetings because they were much too dull for them; and this, to his mind, was the expression of a profound truth. Their meetings were dull, very dull, and he feared they could not avoid the dullness and so remove the reproach. In the first place, the practice of holding meetings of scientific societies for the purpose of reading papers was one for which there was no justification but that of precedent. As in many other cases, the object for which the practice was initiated had become, owing to changed circumstances, of no value, and yet scientific societies had continued it till the present day. In ancient times the only method of publication which authors could adopt was to assemble their fellow-citizens and recite to them their new productions, and in the Middle Ages most new literature was conveyed by word of mouth—poems were made public by the agency of minstrels and troubadours; but now an immense amount of knowledge was placed, in the form of books and newspapers, at the disposal even of the most remote country resident. Even at the time of the Restoration books were comparatively scarce; and, as it was at this time that the first of the now existing scientific societies, the Royal Society, was formed, there was nothing more natural than that it should be considered one of their first duties to meet together and make known the result of their labours. Other societies, afterwards formed, followed the precedent, and thus the practice of reading papers had arisen. But in these days of cheap printing, when newspapers, magazines, and books were circulated in enormous numbers, the old methods of making known the works of poets and authors had fallen altogether into disuse, and the question then arose why scientific papers should be treated in a different manner. He could not see that the writers of papers derived any advantage from the reading of them—the desired publication could be obtained without that; and, as to the hearers, those who were interested in the subjects would probably prefer to read the papers quietly at home. In this connection he urged that the interval between the reading of papers and their publication was too long, and that one of the most useful reforms they could initiate would be the publication of a quarterly instead of an annual volume. The best argument in favour of reading the papers was that it gave an opportunity of discussing the subject; but discussion was frequently impossible because of the thing brought forward being a statement of fact, and, when possible, was often avoided on the ground of personal courtesy. They did not like to express publicly the opinion that their next-door neighbour was a person whose judgment was always wrong, and whose reasoning was invariably at fault. On the whole, he was afraid they had no alternative in regard to their meetings; they would have to admit the reproach, and continue to be somewhat dull. They might, however, derive satisfaction from the thought that the reading of scientific papers was by no means the chief object of their existence, since they maintained an important public museum. He then dealt with the great value of the Museum to the city, laying particular stress on the importance of extending the popular branch of the collections, and of arranging and displaying them in the most interesting, instructive, and attractive manner possible. All this required space, and space could only be obtained by subdividing the collections, and placing a large portion of them in another building. What was, in his opinion, absolutely necessary, if they were to make any further advance, was the erection of an additional hall in which they could place their ethnological collections, and especially their specimens of Maori workmanship. While speaking of these Maori collections he parenthetically mentioned the magnificent collection deposited by Captain Gilbert Mair, and took the opportunity of tendering to that gentleman the thanks of the Institute and of the community. The President then went on to argue that no grand, ornamental, permanent edifice was required, but one in which attention was paid to the necessity for elasticity in the accommodation, for facility of modification, so that additions and rearrangements could be effected without restriction. His experience with the University College had impressed him with the superiority of temporary buildings for young and growing institutions, because the expenditure of small sums from time to time had resulted in the gradual adaptation of means to ends. Of course it was absolutely necessary, in order that their collections might be preserved, that the structure should be strong and fireproof. He found, on the authority of his friend Mr. Bartley, that a building 103ft. long and 50ft. wide could be erected on that particular site for £610. The cost of fitting it up would be about £400, and the rearrangement of the exhibits now in the Museum would take about £200 more. This would be £1,200 in all, a sum well within their means. They had recently received by a sale of a block of land on the Coromandel Peninsula a sum of £1,000, with an agreement to pay two other thousands at intervals of a year. This sum they did not actually need for the maintenance of the Museum, as last year they had not only paid all ordinary fixed expenses, but had spent £50 in providing cases and otherwise improving the interior of the building. Thus they were well able to afford the cost of a modest but substantial building, and he trusted that ere long they would be able to place before the public such a well-ordered and complete collection of Maori workmanship as befitted Auckland, as befitted a city the history of which was so intermingled with that of the natives.

On the motion of Dr. Bakewell, seconded by the Rev. Dr. Purchas, a vote of thanks was accorded the President for his address, several gentlemen expressing approval of his suggestions relative to the erection of a new building.

The President acknowledged the compliment, and said the question of erecting the building he had spoken of would no doubt be fully considered by the Council.

SECOND MEETING: *22nd June, 1891.*

Professor F. D. Brown, President, in the chair.

New Members.—E. Craig, C. Malfroy, P. Sylow.

Papers.—1. "On the Prospects of finding Workable Coal on the Shores of the Waitemata," by James Park, F.G.S. (*Transactions*, p. 380.)

2. "On Geyser-action at Rotorua," by Camille Malfroy, Chevalier of the Legion of Honour. (*Transactions*, p. 579.)

This paper was illustrated by a series of maps, diagrams, and photographs, specially prepared and exhibited (by limelight) by Mr. Josiah Martin, Vice-president.

The President complimented Mr. Malfroy upon the excellent paper which he had prepared. He thought that the views advanced were in entire harmony with the facts observed. He considered that the Government of the colony should be congratulated upon having such an excellent observer as Mr. Malfroy in a position of such importance.

THIRD MEETING: *20th July, 1891.*

Professor F. D. Brown, President, in the chair.

New Member.—H. C. Choyce.

Papers.—1. "Notes on the Discovery of some Ancient Maori Relics at Parua Bay, Whangarei," by A. J. Millar.

"On felling some bush in September last we found two skeletons placed in hollow trees growing not very far apart. A greenstone ear-ring and some eardrops were near one of the skulls. Some giant puriri trees were growing not far from where the skeletons were found, and these we did not cut down, wishing, if possible, to preserve them. When burning the rest of the clearing-off in March, however, the trees caught fire, and several of them were burnt through and fell. Then the other remains appeared to view, consisting of numerous skeletons—charred, of course, and some of them almost calcined. Close to the bones we found several polished greenstone axes or chisels of small size, and some stone sinkers, together with several chips of obsidian, used no doubt in the process of stone-scraping. The remains were found in a hollow situated between two low-lying spurs near the sea. The fact that so many human bones were discovered within an area of little more than two acres leads me to suppose that the hollow puriris have many years ago been made to serve as a depository for the remains of the dead Maori. One of the chisels found is only 1½in. long, and barely ½in. in width. It is of greenstone, polished, and semi-transparent. One of the eardrops is a beautiful specimen. It is about 3in.

long, and not thicker than an ordinary penholder. Its colour is a beautiful light-green, and it is as near as possible transparent."

2. "New Species of Coleoptera, Part I.," by Captain T. Broun.

3. "Is it expedient to make Vaccination compulsory?" by R. H. Bakewell, M.D. (*Transactions*, p. 634.)

Dr. Challinor Purchas considered that vaccination should be retained and be made compulsory; but he was not an advocate for the transference of lymph from the human subject. By using calf-lymph, which could now be easily obtained in New Zealand, the risk of the inoculation of syphilis or leprosy alluded to by Dr. Bakewell could be obviated.

Fourth Meeting: *10th August, 1891.*

Professor F. D. Brown, President, in the chair.

Mr. E. Withy gave a popular lecture, illustrated by diagrams and models, on "The Stability of Ships: its Principles made clear by Models and Diagrams." (*Transactions*, p. 653.)

At the conclusion of the lecture a vote of thanks was moved by the Mayor (Mr. J. H. Upton), and carried by acclamation.

Fifth Meeting: *24th August, 1891.*

Professor F. D. Brown, President, in the chair.

New Members.—J. Mitchell, C.E., Professor Pond.

The President drew attention to a number of recent additions to the Museum, which were arranged on tables in the lecture-room for exhibition to the meeting. Among them was a fine collection of minerals received in exchange from the United States National Museum, and a series of rocks and minerals illustrating the geological structure of the Thames Goldfield, presented by Mr. James Park, Lecturer at the School of Mines, Thames. Particular attention was drawn to the skin of the rare flightless duck of the Auckland Islands (*Nesonetta aucklandica*), presented by Sir W. L. Buller.

Papers.—1. "On the Occurrence of Native Zinc at Hape Creek, Thames," by James Park, F.G.S. (*Transactions*, p. 384.)

2. "New Species of Coleoptera, Part II.," by Captain T. Broun, F.E.S.

3. "Brake-fins: a Proposed Appliance for the Better Handling of Ocean Steamers," by the Rev. P. Walsh. (*Transactions*, p. 641.)

Sixth Meeting: *14th September, 1891.*

Professor F. D. Brown, President, in the chair.

Mr. James Stewart, C.E., gave a popular lecture on "The Rotorua Railway and District." (*Transactions*, p. 591.)

The lecture was illustrated with numerous lantern views.

Seventh Meeting: *19th October, 1891.*

Professor F. D. Brown, President, in the chair.

Professor A. P. Thomas, F.L.S., delivered a popular lecture on "Pasteur, Koch, and their Work."

The lecturer gave a brief sketch of the career of Pasteur, especially alluding to his researches into the nature of tartaric acid, into fermentation, and to his discovery of a remedy for the silkworm-disease pebrine; also to his more recent investigations into the nature of hydrophobia. A similarly interesting account was given of the scientific work of Koch, and the lecture closed with an account of the methods in use at the present time in studying the life-history of micro-organisms, and the probable direction which future research would take. The lecture was illustrated with the lantern.

Eighth Meeting: *2nd November, 1891.*

Professor F. D. Brown, President, in the chair.

New Member.—J. Kirker.

Papers.—1. "Descriptions of New Species of Coleoptera, Part III.," by Captain T. Broun, F.E.S.

2. "Catalogue of the Described Species of New Zealand Araneidæ," by A. T. Urquhart. (*Transactions*, p. 220.)

3. "Descriptions of New Species of Araneæ," by A. T. Urquhart. (*Transactions*, p. 230.)

4. "On some Recent Additions to the New Zealand Flora," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 409.)

5. "Additional Notes on the Genus *Carex*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 413.)

6. "On the Occurrence of Native Silver at the Thames Goldfield," by James Park, F.G.S. (*Transactions*, p. 386.)

7. "Note to accompany a Specimen of Kauri Timber taken from a Cottage erected more than Fifty Years ago," by Dr. J. L. Campbell.

"The accompanying piece of kauri timber was this day—the 24th October, 1891—in my presence and in the presence of the Curator of the Auckland Museum, taken from the front wall of a cottage standing on the business premises of Brown, Campbell, and Co., Shortland Street, and was then and there handed over to the Curator. The cargo of timber from which the cottage was built was purchased by me in February, 1841, at the sawpits in Whangaroa and Tutukaka Harbours, and was put on board the schooner 'Black Joke,' which I had chartered to bring it to Auckland. It was all carried up from the beach in Commercial Bay by myself and partner, William Brown. We became the purchasers of the allotment on which the cottage stands at the first Government land-sale, which took place on the 19th and 20th April, 1841. The cottage was first occupied on the 24th June of the same year. In case of accident by fire consuming the house, this piece of weatherboard has been removed, and is now presented to the Museum to testify to the durability of heart of kauri after fifty years and four months' exposure to sun, wind, and rain. The cottage is still in a perfectly sound condition, and is occupied by the firm's storeman and family."

Mr. E. Bartley exhibited a sample of kauri flooring taken from an old building which he had to remove in proceeding with the erection of an addition to the Museum, and pointed out that it also was perfectly sound. The building was erected in 1842.

An interesting discussion on the durability of timber and the proper season for felling it arose, in which Mr. Bartley, Mr. Stewart, Mr. Cranwell, and the Chairman took part.

8. "The Tradition respecting the Aboriginal Inhabitants of Whakatane," by the late Lieut.-Colonel St. John; communicated by T. Kirk, F.L.S. (*Transactions*, p. 478.)

9. "The Auckland Volcanoes," by Hugh Shrewsbury, M.A. (*Transactions*, p. 366.)

Annual General Meeting: *22nd February, 1892.*

J. Martin, F.G.S., Vice-president, in the chair.

Abstract of Annual Report.

Thirteen new members have been elected during the year. Twenty-three names have been withdrawn, leaving the total number on the roll at the present time 195.

The total revenue of the General Account has been £736 10s. 7d. The invested funds of the Costley bequest have yielded £374 15s., and £154 7s. has been derived from the members' subscriptions. The rents and profits transferred from the Museum Endowment Account amount to £168 15s. 4d. The total expenditure has been £1,566 13s. 9d. Of this sum, £789 12s. has been expended on the addition to the Museum buildings now being erected, the balance of £777 1s. 9d. representing the ordinary expenditure incurred in the maintenance of the Museum and Institute. The invested funds of the Institute amount to £11,752 9s. 10d.

Eight meetings have been held during the year, at which twenty-one papers on various scientific and literary subjects were read.

Arrangements were made early in the year for the erection of an addition to the Museum, intended to contain the ethnological specimens. The building is well advanced, and will probably be completed in a few months' time. As the whole of the collections will be rearranged when it is finished, few changes of importance have been made in the Museum during the past year. The chief additions have been some valuable exchanges of mammals, birds, and minerals received from the National Museum, Washington, and some fine mammals from the Imperial Museum of Natural History at Florence. The valuable collection of Maori ethnological specimens deposited in the Museum by Captain Gilbert Mair, and alluded to in the last report, has been fully arranged and labelled, and has attracted much attention.

Reference was made to the crowded state of the library, which now contains over five thousand volumes, and a recommendation was made that additional accommodation should be provided at an early date.

Election of Officers for 1892.—*President*—Professor F. D. Brown; *Vice-presidents*—James Stewart, C.E., and J. Martin, F.G.S.; *Council*—Rev. J. Bates, W. Berry, Rev. J. Campbell, C. Cooper, T. Peacock, Professor Pond, J. A. Pond, E. Roberton, M.D., Professor A. P. Thomas, F.L.S., J. H. Upton, E. Withy; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—J. Reid.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *7th May, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

Second Meeting: *4th June, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

Papers.—1. "On the Foliated Rocks of Otago," by Professor F. W. Hutton. (*Transactions*, p. 359.)

2. "On a Species of *Regalecus*, or Great Oar-fish, caught in Okain's Bay," by H. O. Forbes, F.Z.S.; communicated by J. T. Meeson, B.A. (*Transactions*, p. 192.)

Third Meeting: *4th July, 1891.*

J. T. Meeson, B.A., Vice-president, in the chair.

Paper.—"Hypnotism," by Robert M. Laing, M.A., B.Sc.

Fourth Meeting: *6th August, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

New Members.—Drs. W. Thomas and A. L. Devenish-Meares.

Paper.—"On the Ancient Relations between New Zealand and South America," by Dr. H. von Jhering, Rio Grande do Sul, Brazil; translated by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 431.)

Fifth Meeting: *3rd September, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

New Member.—S. Page.

Sixth Meeting: *1st October, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

Papers.—1. "The Moas of New Zealand," by Captain F. W. Hutton, F.G.S. (*Transactions*, p. 93.)

2. "Notes on a Species of *Platycercus* (*P. erythrotis*, Wagl.) from Antipodes Island," by H. O. Forbes, F.R.G.S.; communicated by J. T. Meeson, B.A. (*Transactions*, p. 190.)

3. "On some Points in the Anatomy of a Species of Sea-bear caught off Sumner, Canterbury, New Zealand; with Notes on the New Zealand Eared Seals," by H. O. Forbes, F.R.G.S.; communicated by J. T. Meeson, B.A. (*Transactions*, p. 198.)

With regard to seals, Professor Hutton said that the question of the presence of hair or fur was of no value in determining the species, as seals threw off their fur when they reached a certain age.

4. "Preliminary Notice of Additions to the Extinct Avifauna of New Zealand," by H. O. Forbes, F.R.G.S.; communicated by J. T. Meeson, B.A. (*Transactions*, p. 185.)

5. "Notes on the Earthquake of the 5th July, 1891, in Cook Strait: an Attempt to define the Epicentrum," by G. Hogben, M.A. (*Transactions*, p. 577.)

At the close of the meeting Professor Hutton exhibited the skin of a flycatcher, which had been sent to him by Mr. Joshua Rutland, of Pelorus Valley, with the statement that it had been shot on a fruit-tree at Kenepuru, near the foot of Mount Stokes, by Mr. J. McMahon. It was a species of *Muscicapa*, and apparently *M. grisola*, the English spotted flycatcher. Professor Hutton was not aware that any of these birds had been turned out in New Zealand, and it was not a species likely to be imported. At the request of Mr. Rutland the skin had been given to the Canterbury Museum.

Annual Meeting: *4th November, 1891.*

Professor F. W. Hutton, F.G.S., President, in the chair.

Papers.—1. "Contributions to the Molluscan Fauna of New Zealand," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 270.)

2. "List of the Introduced Land and Fresh-water Mollusca of New Zealand," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 279.)

3. "List of Land and Fresh-water Mollusca doubtful for New Zealand, or not inhabiting it," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 281.)

4. "Miscellaneous Communications on Land and Fresh-water Mollusca," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 283.)

5. "On the Dentition of some New Zealand Land and Fresh-water Mollusca, with Descriptions of New Species," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 286.)

6. "The Farm: Winter Pasture and its Grazing," by J. R. Wilkinson, M.A.; communicated by the Secretary. (*Transactions*, p. 628.)

7. "Notes on the Earthquake of the 24th June, 1891, at Auckland," by G. Hogben, M.A. (*Transactions*, p. 574.)

8. "Note on the Boulders in the Port Hills, Nelson," by Captain F. W. Hutton. (*Transactions*, p. 365.)

9. "On New Species of Lepidoptera," by E. Meyrick, B.A., F.Z.S. (*Transactions*, p. 216.)

The annual report and balance-sheet were then read and adopted.

In accordance with the laws of the Institute, the Council begs to submit to members the annual report for the year ending the 31st October, 1891. During the year seven ordinary meetings have been held, at which eighteen papers have been read. They may be classified as follows: Geological, 6; zoological, 9; botanical, 1; seismological, 2. These were contributed by seven authors. This shows an increase of three in comparison with the number read last year. On the other hand, there is a decrease in membership, the number now on the roll being 65, as against 98 in 1890. Three new members were elected, but 36 were struck off the list. There has been an almost continuous decrease since 1879, when there were 219 members on the roll; but it must be noted that, of those, 103 had joined that year. There was a temporary increase in 1890.

As will be seen, the balance-sheet which the Treasurer will submit to you shows a total receipt of £66 3s., and a total expenditure of £48 13s. This leaves a credit balance of £41 19s. 1d., including the amount carried over from last year (£24 10s. 1d.).

Election of Officers for 1892.—*President*—Professor Bickerton, F.C.S.; *Vice-presidents*—W. H. Symes, M.D., H. R. Webb, F.R.M.S.; *Treasurer*—G. E. Mannering; *Hon. Secretary*—Robert M. Laing, M.A., B.Sc.; *Council*—T. Danks, F. Barkas, B. Bull, S. Page, R. Speight, and Dr. Thomas; *Auditor*—C. R. Blakiston.

The retiring President, Professor F. W. Hutton, then read his presidential address, "The History of the Moa." (*Transactions*, p. 93.)

OTAGO INSTITUTE.

First Meeting: *12th May, 1891.*

A conversazione was held in the Museum buildings, when a number of interesting biological preparations, made in the Biological Laboratory, were exhibited under microscopes. Several cases of Indian butterflies, from the collection presented by Major-General Fulton, were also exhibited.

Second Meeting: *9th June, 1891.*

Professor F. B. de M. Gibbons, President, in the chair.

Papers.—1. "Note on the Occurrence of Cancer in Fish," by Professor Scott. (*Transactions*, p. 201.)

It was stated in the discussion which followed the reading of Dr. Scott's paper that the Acclimatisation Society proposed to obtain the opinion of the officials of the United States Fisheries Commission on the subject of the cancerous growth. Specimens in illustration of the paper were exhibited.

2. "On certain Volcanic Appearances in Dowling Street, Dunedin," by L. O. Beal.

Mr. Beal exhibited samples of the rock and earth from the Dowling Street cutting.

3. "On the Structure of the Mammalian Ovum," by Professor T. J. Parker, F.R.S.

The author states that sections of the ovary of a kitten recently prepared for class purposes in the Biological Laboratory exhibit the unusual character of a number (six or eight) of nuclear bodies in the vitellus. Each is globular, about 0·01mm. in diameter, and consists of a cortical and a medullary substance, taking on slightly different tints with borax-carmine. They are apparently germinal spots, which have passed from the germinal vesicle into the vitellum—a phenomenon which has been described by His in fishes, and by others in Myriapods and Ascidians. The germinal vesicle contains, as usual, a single germinal spot.

Professor Parker exhibited a series of spirit specimens illustrating the growth of a curious fungus—*Ileodictyon*—and also some curious cup-shaped sponges from Tasmania presented to the Museum by A. Hamilton.

Mr. F. R. Chapman exhibited a number of Maori bone implements, fish-hooks, neck-ornaments, &c., found in the neighbourhood of Dunedin.

THIRD MEETING: *14th July, 1891.*

Mr. Adams, Vice-president, in the chair.

Mr. G. M. Thomson, F.L.S., gave a lecture on the Dunedin water-supply, with illustrations projected on the screen by means of a lantern microscope.

FOURTH MEETING: *11th August, 1891.*

Professor F. B. de M. Gibbons, President, in the chair.

Papers.—1. "On the Structure of *Boltenia pachydermatina*," by James Watt, M.A.; communicated by Professor T. J. Parker, F.R.S. (*Transactions*, p. 334.)

2. "On the Extinction of the Native Birds on the West Coast," by James Richardson.

A long and interesting discussion followed the reading of this paper, which attributed the disappearance of the kiwi and kakapo to the ravages of ferrets.

Sir Walter Buller pointed out that the decrease had been apparent before the introduction of ferrets, and was inclined to think that the Norway rat was responsible for much of the mischief. It was suggested that steps should be taken by the Society to represent to the Government the desirability of proclaiming some suitable islands as reserves, on which the rarer species of New Zealand birds might be placed in safety.

Professor Parker exhibited two rare species of fish recently added to the Museum collection, and portions of a fossil swordfish found in the limestone on the estate of Messrs. Sutherland, near the Milburn Lime Company's works.

FIFTH MEETING: *9th September, 1891.*

Professor F. B. de M. Gibbons, President, in the chair.

New Members.—James Richardson, Spencer Cook.

The Secretary announced that a letter had been forwarded to the Colonial Secretary from the Council on the subject of reserves for the protection of certain of the native birds.

Paper.—"On the Foundation and Settlement of Canterbury," by Dr. Hocken.

This was a further contribution to a series of lectures on the early history of New Zealand.

SIXTH MEETING: *14th October, 1891.*

Professor F. B. de M. Gibbons, President, in the chair.

Paper.—"On the Working of Greenstone, or Nephrite, by the Maoris," by F. R. Chapman. (*Transactions*, p. 479.)

The reading of this paper was followed by an exhibition of a fine collection of greenstones from the collections of Messrs. Chapman and J. White.

ANNUAL GENERAL MEETING: *10th November, 1891.*

Professor F. B. de M. Gibbons, President, in the chair.

Papers.—1. "On the Genus *Aptornis*, with more especial Reference to *Aptornis defossor*, Owen," by A. Hamilton. (*Transactions*, p. 175.)

Mr. Hamilton exhibited a complete mounted skeleton of *Aptornis defossor*, and a number of bones of the extinct eagle (*Harpagornis moorei*), from caves in the District of Southland.

2. "On New Zealand Araneæ," by P. Goyen, F.L.S. (*Transactions*, p. 253.)

3. "Notes on Sea-fishes," by G. M. Thomson, F.L.S. (*Transactions*, p. 202.)

4. "Note on the Cleistogamic Flowers of *Melicope simplex*," by G. M. Thomson, F.L.S. (*Transactions*, p. 416.)

5. "On some Maori Bone Pendants from Otago," by A. Hamilton.

6. "Notes on some New Zealand Amphipoda and Isopoda," by Charles Chilton, M.A., B.Sc. (*Transactions*, p. 258.)

Professor Parker exhibited a species of *Branchellion*, a leech with external gills, belonging to the family Rhynchobdellidæ, and occurring as an external parasite on the common skate (*Raja nasuta*). A single specimen had been found some years previously, but on the present occasion a skate dissected in the Biological Laboratory presented a colony of thirty or forty of the parasites on an area of 3in. or 4in. in circumference. They varied in length from ¼in. to 1½in., and were all so firmly attached by the posterior sucker that on their removal the fish's skin presented a number of smooth, circular, convex areas. The smaller specimens, treated with Flemming's chrom. osm. acetic solution, flattened under a compressor, and mounted entire, make very beautiful microscopic objects. The only species of this interesting genus mentioned in the ordinary works of reference is *R. torpedinis*, of Europe, a parasite on the torpedo. If the present form turns out to be new, it might be called *R. rajæ*. Professor Parker also exhibited specimens of *Dujardinia*, a polychætous worm, from Port Chalmers.

The balance-sheet and annual report were then read and adopted.

ABSTRACT.

The revenue from subscriptions collected was £107 2s., making, with the balance brought forward, £204 11s. The expenditure on the library was £65 6s. 9d., and sundries £26 10s. 8d. ; leaving a credit balance of £112 13s. 7d. There is also on fixed deposit a sum of £286 13s. 5d. The liabilities amount to about £30.

ELECTION OF OFFICERS FOR 1892. — *President* — C. W. Adams; *Vice-presidents*—Dr. T. M. Hocken and Professor F. B. de M. Gibbons ; *Council*—F. R. Chapman, D. Wilkinson, G. M. Thomson, Alexander Purdie, Dr. Belcher, and Professors Scott and Parker ; *Treasurer*—E. Melland ; *Secretary*—A. Hamilton ; *Auditor*—D. Brent.

The retiring President, Professor Gibbons, then delivered a most interesting address " On the Rise and Development of the Science of Political Economy."

WESTLAND INSTITUTE.

ANNUAL MEETING: *10th December, 1891.*

ABSTRACT OF ANNUAL REPORT.

The report dealt exhaustively with the prospects of the society, and stated that the opening of the Museum had increased its attractions. The financial statement disclosed that there was a balance to credit, though the disbursements had been considerable on account of Museum and library improvements. The thanks of the society were conveyed to the Borough Council for their substantial subsidy and grant. The roll of members contains seventy names. The trustees' meetings have been well attended, showing that members take great interest in its welfare. The improvements in the library are of a permanent character, and have greatly improved the room. The reading-room has been supplied with the usual papers, augmented by copies of illustrated papers. The trustees desire to thank those proprietors who donate their paper to the room. The revenue for the current year was £155 2s. 8d.; disbursements, £142 12s. 8d.; credit balance, £12.

ELECTION OF OFFICERS FOR 1892.—*President*—Captain Bignell; *Vice-president*—W. C. Fendall; *Hon. Treasurer*—T. O. W. Croft.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *11th May, 1891.*

H. Hill, B.A., President, in the chair.

The President delivered his inaugural address.

Abstract.

The President regretted the departure of Messrs. Hamilton, Harding, and Macdonald, and said that to Mr. Hamilton was due the growth of the Museum, and especially of the magnificent collection of Maori curiosities, which he deemed second to none in the colony. He dilated on the necessity for encouraging in young people the habit of observation, and deplored the general want of enthusiasm in scientific matters. He considered that the New Zealand Institute did not use its great influence effectively in fostering and promoting science, and thought that scientific workers out of reach of specialists might be much assisted if they could transmit to head-quarters free of expense specimens for identification. Type collections, he also considered, should be distributed to provincial museums by the central department.

The President then mentioned the meeting of the Australasian Association for the Advancement of Science at Christchurch in January last as the great event of the year, and called attention to the graceful and complimentary remarks made by Sir J. Hector in his presidential address regarding the Rev. W. Colenso, F.R.S., and his scientific labours — remarks that the members would appreciate none the less that they were spoken of the founder of their own branch of the Institute.

Of events of worldwide interest, he mentioned the journeys of Nansen in Greenland and Stanley in Africa. Nansen's journey across Greenland, he said, points to the whole of that country south of 75° lat. being covered with a vast glacial sheet, estimated by Nansen at not less than 6,000ft. thick; while Stanley's discoveries are of extreme interest as making living truths of the supposed myths of old writers in long-past centuries. But surpassing these is the great discovery by Professor Koch, who towards the close of the year announced to a wondering world that he had found a specific for the cure of consumption. When Tyndall, some seven years ago, called attention in the *Times* to Koch's discovery it was received with something like scorn, as was Pasteur's great discovery for the cure of hydrophobia; and, though the expectations first held out have not been entirely fulfilled, still a vast impetus has been given to biological science. He then gave a succinct account of the theories of Liebig and Pasteur on the causes of fermentation and putrefaction.

The President went on to say that the discovery of the lowest form of animal organisms in connection with the highest opens up several questions of biological interest bearing on the theories of life as enunciated by Lamarck, Darwin, and others. Having given a summation of their respective theories, he continued as follows: "In order to get a clear conception as to the progress and development of life on the earth, it may be well if I refer briefly to the theories which have been set up as to the origin of this earth of ours. Kant, Laplace, and Herschel (W.) explained the harmony prevailing in what is known as the solar system by premising that at one period an original nebula existed, of which the remains at the present time are the sun and the several planetary bodies, with their satellites. This nebula was diffused in space at least as far as the farthest member of the system. As it began to condense towards a centre interspaces of matter were left behind, and these, in their turn, continued to condense by the dispersion of their heat, and thus the planets grew. Whilst it is difficult to explain by the nebular theory, as this system is called, the cause of the condensation of materials composing the nebula about special centres, it is possible to explain the sequence of materials which might be said to form the earth's crust or envelope. Thus the air surrounds the earth, then come the water and surface rocks, and these are severally much lighter specifically than the average density of the earth. As we know it the earth is round, spheroidal as to shape, and consists of land and water with an aërial envelope. It is usual to say that the land is only about one-fourth of the earth; but this is true only so far as the surface is concerned, the proportion of water- to land-surface being as 145 is to 52. But the actual quantity of water, after all, is very small when the land and water, bulk for bulk, are compared. The average depth of the entire ocean is said to be about 12,000ft., whilst the average height of the land is not more than 2,500ft. The quantity of water upon the earth at the present time is sufficient to cover the entire surface to a depth of nearly 8,000ft., or, say, a mile and a half. As a frozen mass it would cover the earth to a depth of nearly 9,000ft. A cubic foot of water percolating through the land would not, I estimate, be traceable to a depth of 100ft., the effect being the same as if a cubic inch of water were distributed over a square surface of 100in. with a depth of 1in. Thus, if all the waters of the ocean were to be absorbed by the land, then, on the estimate of percolation given above, it would not affect the crust to a depth of more than 150 miles. That the earth's crust absorbs water is certain, and as far as our knowledge goes there is no reason why all the water which occupies so much of the earth's surface as ocean should not pass into the crust and be absorbed by it. Thus the earth might become, simply by the process of absorption, uninhabitable. As far as is known, the materials which form the earth were originally arranged according to their specific gravities; in fact, it appears to me that a large body like the earth is inconceivable on the supposition that the envelope, or outer covering, is specifically heavier than the materials which such envelope would enclose. The contraction of that part of the original nebula which goes to make up the earth took place through the diffusion of heat into space, and contraction of the earth will proceed until the whole heat now centred in the earth, together with that received from the sun, will be similarly diffused in space. And that this is the order of nature seems probable from the facts which geology and physiography teach as to the structure of the earth and the development of animal and vegetable life. With no degree of certainty can it be said when or in what manner life first appeared on the earth—whether in a hot temperature or a cold one; but we know that the lower forms of life must have existed before the higher, and even the vegetable before the animal. The physical conditions were such that no other plan was possible. Experiments show that the lowest forms of life, to which reference has already been made, including bacteria and amœbæ, cannot even exist in a temperature much below the boiling-point of water, and their potency for harm as fermentative agents is destroyed in temperatures below freezing-point.

Huxley says that bacteria are killed by a temperature of 60° C. (140° Fahr.), whilst they thrive best in a temperature of about 30° C. (86° Fahr.); and the fact that fresh meat can be carried from New Zealand to England in cool-chambers is a proof of the non-growth of bacteria in temperatures below freezing-point. Now, if we pursue this nebular theory so far as it relates to the earth, it is evident that the air must have cooled first. It is the outer envelope of the earth, and no heat could pass from the earth as a body into space without passing through the air. Heat can only pass from a hot medium to one less hot, and whatever heat the earth has lost in the course of time must have passed into space through the atmosphere as a medium. But we find at the present time that there are large areas of the earth, including land- and water-areas, so cold that they are much below the temperature of freezing-point the year round. And yet the cold, even in such places as are to be found within the Frigid Zones, cannot be as intense as the cold to be found in the upper parts of the atmosphere. But the true zonal region of cold is curiously distributed over the earth. In the Torrid Zone a spot is reached in vertical space known as the snow-line; a similar spot can be reached in diminishing elevations from the equator to the poles; in fact, the snow-line, as Nansen has pointed out with respect to the glaciers of Greenland, is at the sea-level not far from the Arctic Circle. Little is known with respect to the condition of the Antarctic Zone; but Captains Cook and Wilkes, as also Sir James Ross, report the existence of an immense ice-barrier in that zone, which the late Professor Croll estimated to be some twelve miles in thickness (see 'Climate and Time'). Here, then, we find barriers of cold in vertical space overshadowing land and water, and diminishing in height from the equator to the Arctic and Antarctic Circles; barriers of cold in the Frigid Zone; and, curious as it may appear, there is a cold-communicating area in the lower depths of the ocean, linking together, as it were, the cold areas of the north and south polar regions. Near the Arctic Circle, at a depth of 1,400 fathoms, the water was found to be 32½° Fahr., while in the Red and Arabian Seas, at a depth varying from 1,400 to 1,800 fathoms, the temperature was only 33½°. Thus there are cold barriers now surrounding the earth in every direction, which circumscribe the limits of inhabitability, if not of all animal and vegetable life, certainly of all the higher forms; and this circumscribed area, try how we may to avoid it, is slowly but surely becoming more circumscribed by reason of the loss of terrestrial heat that is slowly going on. Here, then, we see prospects of the coming time in the history of the earth as a planet, when the cold will be so intense that the higher and even the lower forms of life such as we are now acquainted with will cease to be, and when all inorganic life will have reached its greatest density. And between these two great time-periods, the incoming and outgoing of organic life on the earth, there will be a middle period of maximum variation and development, in which the seasonal contrasts will present their widest variety, and the organic world its greatest differentiation and growth. On the other hand, the nearer we approach the two great time-periods, the seasonal contrasts will be smaller, and the organic and inorganic differentiations will be fewer. And these conditions as to climate, life, and differentiation are what we should expect in dealing with a cooling earth. At one period in the history of the earth the heat which was given off was such that the climatic conditions of the North and South Polar Zones as to moisture and temperature were better suited to organic life than were the other zones. A cooling earth, assuming the rocks to be generally similar in the different zones, would sooner become suited for the abode of life in the Polar Zones than elsewhere. More heat was given off from the regions around the poles than from the region around the equator, for the reason that a six-months day, followed by a six-months night, in the Polar Zones, will produce wider variations of temperature than a twelve-hours day and a twelve-hours night will do in the Torrid Zone. Hence, I think it may be assumed that in the earlier periods of the earth the polar regions were warm regions, and were possibly the abode of organic life earlier—indeed, much earlier—than the Temperate and Torrid Zones, unless the land in those zones was very much higher than the land in the Frigid Zones, which is improbable. How long the north and south polar regions continued to be favourable to the development of animal and vegetable life cannot be ascertained with any degree of certainty, but there is plenty of evidence even now to prove that both plants and animals of tropical, subtropical, and warm temperate facies lived in those regions even as late as the Tertiary period. But such evidence, though valuable as showing that a warm climate once prevailed where now ice and snow of immense depth and thickness are to be found the year round, is not sufficient to determine whether the north and south zones were the first abodes of organic life on the earth. In order to determine this we require to deal with a succession of geological time-periods long anterior to the Tertiary—from the time, in fact, when the rocks give evidence that life had appeared on the earth to the present day, when differentiation is so marked in each of the three natural kingdoms. If traces of organic life could be found in the older rocks of the Frigid Zones, showing a gradual progress from the lowest forms of animal and vegetable life up to the types of fossil life found among the Tertiary rocks of those zones, the evidence would be complete; but there is no such evidence yet to hand. So far as acquaintance has yet been made with the stratified rocks in the various continents, it is found that the lowest organisms and simplest forms of animal and vegetable life appeared in the oldest rocks, and as we pass upward in the series through the Palæozoic, Mesozoic, and Tertiary ages we find not only traces of increased life, but also traces of progressive life from lower to higher types. But it is hardly possible to account for progressive forms of life, with their attendant variations, except on the supposition that in the course of time such climatic changes took place that the earth became better adapted to the maintenance of higher forms, and that the life that was before the changes began adapted itself to the new conditions as they were in progress. To change meant to live, then, as it does now. In the case of a cooling earth, every climatic change that produces greater seasonal contrasts tends to greater differentiations in the organic world. The geological records show that life, which began with the lowest forms, has progressed by a series of differentiations and adaptations; that from the simple it has gone on to the complex, and from the complex to the yet more complex. From the cell to the tissue, from the tissue to the individual, from the individual to the species, and so on to the class, the genus, and the order—such is the progress of life, and such its development in time, as told on the tablet-stones of the past. And does not this progress from the lower to the higher, from the simple to the complex, in the organic world strike the keynote as to the incoming of new forms of diseases by new adaptations of lowly organisms in the physical world, operating, as Darwin points out, through countless millions of years? We cannot suppose that differentiations and new adaptations have not their attendant ills. The body will be rendered liable to disease of new forms and new kinds, just as it undergoes variations and new developments. Adaptations are in progress now, as they have ever been; and, while scientific skill may and will continue to discover means to lessen pain and diminish suffering, science will not, cannot, free humanity from the ills that flesh is heir to through the ages; for, try how we may, science will never be able to transform the body mortal into the body immortal."

SECOND MEETING: *8th June, 1891.*

L. Lessong, C.E., Vice-president, in the chair.

Papers.—1. "Plain and Practical Thoughts and Notes on New Zealand Botany," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 400.)

2. "On the Native Dog of New Zealand," by Taylor White. (*Transactions*, p. 540.)

THIRD MEETING: *9th July, 1891.*

H. Hill, B.A., President, in the chair.

Papers.—1. The Right Rev. Dr. Stuart, Bishop of Waiapu, delivered an address "On the Rise, Progress, and Power of the Native Press of India."

2. Dr. Moore gave a short account of the introduction of the Bumble-bee to New Zealand.

FOURTH MEETING: *10th August, 1891.*

H. Hill, B.A., President, in the chair.

Paper.—"Ruapehu and Ngauruhoe," by H. Hill, B.A. (*Transactions*, p. 603.)

The paper was illustrated with views of these mountains thrown on a canvas screen by the aid of a magic lantern.

FIFTH MEETING: *14th September, 1891.*

H. Hill, B.A., President, in the chair.

Papers.—1. Dr. Spencer gave an account of Dr. Koch's specific for the cure of consumption—viz., "tuberculine."

2. Mr. Pinckney read a paper on "Ferns."

3. Mr. Westall's paper "On the Influence of the Ruahine Mountains on the Rainfall of Hawke's Bay" was read.

SIXTH MEETING: *12th October, 1891.*

Papers.—1. "Vestiges: Reminiscences: Memorabilia of Works, Deeds, and Sayings of the Ancient Maoris," by W. Colenso, F.R.S., F.L.S., &c. (*Transactions*, p. 445.)

The author showed photographs in illustration of some of the forms of Maori house-decoration.

2. "Description of Three Species of Newly-discovered New Zealand Ferns," by W. Colenso, F.R.S., F.L.S., &c. (*Transactions*, p. 394.)

Specimens of these three ferns, in their various stages, were shown by the author.

3. "A Description of some Newly-discovered Indigenous Plants, being a Further Contribution towards the making known the Botany of New Zealand," by W. Colenso, F.R.S., F.L.S., &c. (*Transactions*, p. 387.)

4. "A List of New Species of *Hepaticæ novæ-zelandiæ*, named by F. Stephani, Leipzig," by W. Colenso, F.R.S., F.L.S., &c. (*Transactions*, p. 398.)

Mr. Taylor White sent papers as follows, which were taken as read:—

5. "Crescent Shadows."
6. "Language and the Cow."
7. "Language and Water."

Annual General Meeting: *22nd February, 1892.*

H. Hill, B.A., President, in the chair.

Abstract of Annual Report.

Six ordinary meetings were held during the year, which were well attended. The number of papers and addresses read was fifteen, compared with twelve for the previous year. The Council report a noticeable improvement in the financial position. The year commenced with a debit of £78 3s. 3d. The present liability is £39 7s., against which there are subscriptions amounting to £47 5s. still due. The value of the books belonging to the society is about £350, and there are articles of great value in the Museum. The number of members now on the roll is 100. The thanks of the Institute are given to Mr. Hamilton for his generosity in presenting so many articles to the Museum; to Dr. Moore for a presentation of the "Science Series" to the library; and to Mr. Large, the Honorary Treasurer, for his efforts in connection with a concert which added £10 to the funds. Seven Council meetings were held during the session. A satisfactory arrangement has been made for compiling a complete catalogue of the articles owned by and deposited with the Institute.

The report and balance-sheet were adopted.

Election of Officers for 1892.—*President*—H. Hill, B.A.; *Vice-president*—Dr. Moore; *Hon. Secretary*—George White; *Hon. Treasurer*—J. S. Large; *Auditor*—T. K. Newton; *Council*—Dr. Spencer, and Messrs. Lessong, Pinckney, Craig, Ringland, and Humphries.

Votes of thanks to the retiring officers were unanimously accorded.

It was stated that the President had consented to deliver a lecture at the first meeting of the coming session (in May next), the subject being "The Volcanic District from Ruapehu to the Bay of Plenty." It was also stated that the lecture would be illustrated by photographic transparencies, shown with the aid of the oxy-hydrogen light.

NELSON PHILOSOPHICAL SOCIETY.

First Meeting: *22nd April, 1891.*

A. S. Atkinson, Vice-president, in the chair.

Exhibits.—A pair of eggs of the giant penguin, from Macquarie Island, by Mr. Marris; a pair of eggs of the wandering albatros, from Auckland Islands, by Mr. E. Lukins; a piece of black marble, from Takaka, by Mr. H. P. Washbourne; a pair of cuttle-fish bones, by Mr. E. Lukins; a stuffed shark, by Mr. R. I. Kingsley; a large cornelian, from Matakitaki, by Mr. R. I. Kingsley.

Paper.—"On the Recent Annual Session of the Australasian Association for the Advancement of Science, held at Christchurch, January, 1891," by Mr. Sidney Black.

The author dealt with the evening papers, and excursions taken by the members. The paper was of an interesting character, and considerable discussion ensued.

A resolution was passed expressing the Society's regret at the continued severe illness of the President, the Right Reverend Dr. Suter, Bishop of Nelson.

Second Meeting: *16th June, 1891.*

A. S. Atkinson, Vice-president, in the chair.

Presentations.—A collection of moa-bones, by Mr. Washbourne; a preserved specimen of the kelp-fish, by Mr. Martin; two pieces of cloth, made from New Zealand flax by a newly-discovered process of the donor, Mr. Haycock.

Exhibits.—A number of very old papers and engravings, by Mrs. Beaver; three boxes of specimens of shells and minerals, also a piece of sponge from the Boulder Bank (good enough for commercial purposes), by Mr. E. Lukins; a piece of marble, containing a large cavity lined with crystals, Mr. Holyoak, Motueka; a genuine Brahmin spoon, used in idol-worship, and also a number of valuable old documents, by Mr. R. I. Kingsley.

Papers.—1. "On the Sectional Work of the Australasian

Association for the Advancement of Science," by Mr. Sidney Black.

This was a most interesting paper, containing abstracts of the most able papers read before the Association at its last meeting. A most animated discussion resulted, in which all members present took part.

2. "On the Statistics relating to Professor Koch's Cure for Tuberculosis," by Dr. J. Hudson.

ELECTION OF OFFICERS FOR 1892.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. Boor; *Hon. Secretary*—Sidney Black; *Hon. Curator*—R. I. Kingsley; *Hon. Treasurer* — Dr. Hudson; *Council*—J. Holloway, Dr. Mackie, Dr. Cressy, Rev. W. Evans, and Rev. F. W. Isitt.

APPENDIX

METEOROLOGY.

Comparative Abstract for 1891 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean. Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation = 100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
Auckland...	30·070	1·320	59·2	12·6	41·0	143·0	27·0	0·365	73	36·040	149	...	...	5·4
Previous 27 years ...	29·983	...	59·1	...	...	...	...	0·387	72	42·382	184			
Wellington	29·991	1·563	55·6	13·9	50·0	140·0	20·0	0·364	84	35·125	166	202	700 on 10th Jan.	3·9
Previous 27 years ...	29·925	...	51·7	...	...	...	...	0·334	72	50·566	159	...		
Dunedin	30·012	1·607	50·7	13·5	53·0	142·0	22·0	0·267	70	32 734	151	149	570 on 7th July	5·4
Previous 27 years ...	29·876	...	50 2	...	...	...	...	0·278	74	34·659	160	...		

Average Temperature of Seasons, compared with those of the Previous Year.

Stations.	Spring. September, October, November.		Summer. December, January, February.		Autumn. March, April, May.		Winter. June, July, August.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
Auckland	58·3	58·3	65·8	66·8	60·3	59 9	54·2	51·9
Wellington	54·9	55·0	61·6	61·5	57·3	59·4	49·3	46·5
Dunedin	51·2	52·8	58·9	57·3	52·0	50·9	42·5	42·0

GENERAL REMARKS FOR 1891.

January.—Showery changeable weather, especially over centre and South; prevailing N.W. and S.W. winds and fresh. Earthquake over centre on 13th.

February.—Generally heavy rain, with S.W. and N.W. winds; early part of month rather fine and bright.

March.—Fine weather; rainfall much below the average, and winds light and from N.W. and S.W. Slight shock of earthquake over centre on 9th. Meteor on 10th and 31st.

April.—A good deal of rain during this period, especially over centre and in North, with strong N.W. and S.W. winds; finer in South. Earthquake on 7th, over centre, slight. Aurora on night of 17th.

May.—On the whole seasonable weather, with about the average quantity of rain and moderate winds. Eclipse of moon on 25th at 4 a.m.

June.—Generally fine weather, especially in North and South; moderate winds. Slight earthquake on 2nd and 30th over centre, and on 24th in North.

July.—Showery unpleasant weather generally and cold, with frequent fogs. Earthquake over centre on 5th and 10th.

August.—Small rainfall over centre and in North, but heavy in South; winds moderate. Earthquake over centre on 10th, 16th, and 20th.

September.—Very fine dry month; total rain greatly below the average, and moderate winds. Earthquakes over centre on 25th.

October.—Fine weather, with moderate winds from N. and N.E. in North, N.W. over centre, and W. in South.

November.—Small total rainfall in North and over centre, though pleasant showers, but in South very showery and disagreeable.

December.—Very fine bright weather in North and over centre, but heavy rain in South and frequent thunder. Earthquake on 4th, 8th, and 15th.

EARTHQUAKES reported in NEW ZEALAND during 1891.

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Thames	..	..	..	..	..	24*	..	..	..	..	..	..	1
Auckland	..	..	..	..	..	24*	..	..	..	..	..	..	1
Te Aroha	..	..	..	..	..	..	..	..	..	..	19, 20	..	2
Rotorua	..	17*	..	..	..	..	15*, 27, 30	..	..	..	20*	12	6
Gisborne	..	..	..	..	..	..	..	1*, 25*	..	..	..	..	2
Napier	..	..	..	..	..	..	..	1*, 17*	..	..	..	4*	3
Hastings	..	..	..	..	..	..	..	17*	..	..	..	..	1
New Plymouth ..	..	..	..	..	..	24	..	..	..	..	..	..	1
Manaia	..	..	..	..	..	..	10*	..	..	..	..	..	1
Wanganui	..	..	..	..	..	4*, 24	..	..	..	..	..	4*	3
Marton	..	..	..	..	..	..	..	..	..	..	..	4*	1
Feilding	..	..	..	..	..	..	..	..	..	..	..	4*	1
Woodville	..	..	..	..	..	..	..	..	..	..	..	4*	1
Ekatahuna ..	..	..	..	..	..	..	..	..	..	..	..	4*	1
Masterton	..	..	..	..	..	..	5*	6, 20*	26	4, 9	..	4*, 8, 15	9
Tenui	..	..	..	..	..	..	..	..	..	..	..	4*	1
Carterton	..	..	..	..	..	..	5*	20*	..	..	..	4*	3
Featherston ..	..	..	..	..	..	..	5*	20*	..	..	..	4*	3
Greytown	..	..	..	..	..	..	5*	20*	..	..	..	4*	3
Alfredton	..	..	..	..	..	..	..	..	..	..	..	4*	1
Palmerston North ..	..	..	..	..	..	..	5*	..	..	..	..	..	1
Wellington ..	13	..	9	7	..	2, 30	5*, 10	10, 16, 20*	25	..	..	4*, 8, 15	14
Havelock	..	..	..	..	..	..	..	..	..	..	..	4*	1
Pahiatua	..	..	..	..	..	..	..	..	..	..	..	4*	1
Kaikoura	..	..	9*	..	..	..	..	12*	..	..	..	..	2
Lincoln	..	..	..	..	..	..	..	..	19	..	..	..	1
Christchurch ..	..	..	..	..	..	..	..	10	16*	..	..	..	2
Lyttelton	..	..	..	..	..	..	..	..	16*	..	..	..	1
Westport	..	..	..	..	..	..	..	10	..	..	..	..	1

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks.

NEW ZEALAND INSTITUTE.

HONORARY MEMBERS.

1870.

Finsch, Otto, Ph.D., of Bremen
Flower, W. H., F.R.S., F.R.C.S.
Hooker, Sir J. D., K.C.S.I., C.B., M.D., F.R.S.
von Mueller, Baron Sir Ferdinand, K.C.M.G., M.D., F.R.S.
Owen, Sir Richard, K.C.B., D.C.L., F.R.S.
Richards, Admiral Sir G. H., C.B., F.R.S.

1872.

Grey, Sir George, K.C.B., D.C.L.
Huxley, Thomas H., LL.D., F.R.S.

1873.

Bowen, Sir George Ferguson, G.C.M.G., P.C.
Cambridge, The Rev. O. Pickard, M.A., C.M.Z.S.
Günther, A., M.D., M.A., Ph.D., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.

1875.

Sclater, Philip Lutley, M.A., Ph.D., F.R.S.

1876.

Etheridge, Prof. Robert, F.R.S.
Berggren, Dr. S.

1877.

Sharp, Dr. D.

1878.

Müller, Professor Max, F.R.S.

1883.

Thomson, Sir William, F.R.S.
Ellery, Robert L. J., F.R.S.

1885.

Sharp, Richard Bowdler, M.A., F.L.S.
Wallace, A. R., F.L.S.

1888.

McCoy, Professor Sir F., K.C.M.G., Sc.D., F.R.S.
van Beneden, Professor J. P.
von Ettingshausen, Baron C.

1890.

Riley, Professor C. V.
Nordstedt, Professor Otto, Ph.D.
Liversidge, Professor A., M.A., F.R.S.

1891.

Goodale, Professor G. L., M.D., LL.D.
Davis, J. W., F.G.S., F.L.S.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life-members.]

Allen, F.
Atkinson, A. S., Nelson
Barraud, W. F.
Barron, C. C. N.
Barton, W.
Batkin, C. T.
Beetham, G., M.H.R.
Beetham, W. M.
Bell, E. D.
Best, E., Gisborne
Blair, J. R.
Bold, E. H., C.E., Napier
Bothamley, A. T.
Brandon, A. de B.
Brown, W. R. E.
Buchanan, John, F.L.S.*
Buller, Sir W. L., K.C.M.G., D.Sc., F.R.S.
Byrne, J. W.
Caldwell, R.
Campbell, Major
Carlile, W. W., M.A.
Chapman, Martin
Chatfield, W. C.
Chudleigh, E. R.
Cohen, W. T.
Colenso, W., F.L.S., Napier
Connal, E.
Cooper, A. McD.
Dasent, Rev. A.
Davis, J. W.
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The Colony of Tahiti.
Society of Natural Sciences, Batavia.
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Department of Agriculture, Washington.
Geological Survey of U.S. Territory, Washington, D.C.
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New York Academy of Sciences.
American Philosophical Society, Philadelphia.
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Academy of Natural Sciences Library, Philadelphia.
Wagner Free Institute of Science of Philadelphia.
Academy of Natural Sciences, Buffalo.
Academy of Natural Sciences, San Francisco.
Academy of Natural Sciences, Davenport, Iowa.
Harvard College, Cambridge, Massachusetts.
Director of Library of Missouri Botanical Gardens, St. Louis, Mo.
Natural History Society of Frankfurt à O.
Royal Society of Literature and Arts of Belgium, Brussels.
Royal Imperial Institute for Meteorology and Earth-Magnetism, Hohe-Warte, Vienna.
Jahrbuch der Kaiserlich-königlichen Geologischen Reichsanstalt, Vienna.
Ornithological Society, Vienna.
Botanical Society of the Province of Brandenburg, Berlin.
Dr. Bastian, Berlin.
Royal Library, Berlin.
Geographical Society, Berlin.
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Physico-economic Society of Königsberg, E. Prussia.
Verein für vaterländische Naturkunde in Würtemberg, Stuttgart.

Society of Geography, Leipzig.
Redaktion des Biologischen Centralblatts, Erlangen.
Biblioteca e dell' Archivio Tecnico del Ministero Córdoba dei Lavori Pubblici, Roma.
R. Accademia dei Lincei, Rome.
Imperial Museum of Florence.
Royal Geographical Society of Italy, Florence.
Orto e Museo Botanico (R. Instituto di Studi Superiori) in Firenze.
Tuscan Natural Science Society, Pisa.
Museum of Zoology and Comparative Anatomy of the Royal University of Turin.
Editor of *Cosmos*, Turin.
Academy of Science, Modena.
Societá Africana d'Italia, Naples.
National Library, Paris.
Société de Géographie, Paris.
Museum of Natural History of France, Paris.
Natural History Society, Angers.
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Royal Danish Academy of Sciences and Literature of Copenhagen.
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M. Teyler, Haarlem.
Naturwissenschaftlicher Verein, Bremen.
Academia Nacional de Ciencias de la Republica Argentina.
School of Mines, Rio de Janeiro.
Society of Engineers, Rio de Janeiro.

Libraries and Societies in New Zealand.

Library, Auckland Institute.
Library, Hawke's Bay Philosophical Institute.
Library, Wellington Philosophical Society.
Library, Nelson Philosophical Society.
Library, Westland Institute.
Library, Philosophical Institute of Canterbury.
Library, Otago Institute.
General Assembly Library.

Library, New Zealand Institute.
Library, University College, Auckland.
Library, University College, Christchurch.
Library, University College, Dunedin.
Library, Auckland Museum.
Library, Canterbury Museum.
Library, Otago Museum.
Library, Otago School of Mines.
Library, Thames School of Mines.
Library, Reefton School of Mines.

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